Hospital Drug Usage Evaluation

by

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Hospital Drug Usage Evaluation

A thesis submitted to

the Faculty of Medicine

Department of Clinical and
Experimental Pharmacology

in candidacy for the degree of Doctor of Philosophy

by

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DEDICATION

To my wife Debra and sons Benjamin and Daniel;
for love, support, humour, enduring patience and tolerance.

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TABLE OF CONTENTS

Chapter 2 — Additional citations — The following are additional citations which have appeared in the literature since this chapter was written. No 'new' information is enunciated but it is clear that DUE is being used increasingly to evaluate the quality of drug use in a variety of settings. As well as general commentary on DUE (1-16), particular interest has focussed on antiinfective drugs (17-20), sedative and/or neuroleptic medication (21-29), drug use in the elderly (30-33), computerisation of DUE activities (34-37) and intervention models (38-48). The citations provided deal mainly with institutional experience of DUE since these were the items dealt with in my research. There are many others dealing with individual DUE projects which are not cited. These are easily retrieved from computerised bibliographic indexes (eg Medline).

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Chapter 4 — *the following text - which provides links to the bibliography - was inadvertently omitted from the final print and should be inserted as an addendum on page 49, under section heading " 2. INFORMATION SYSTEMS". immediately following paragraph 1.*

Brodie (1) determined that drug utilisation is best expressed as doses administered rather than by other purchases (or expenditure/payments). A minimum data set could describe individual drugs, drug group or drug class drugs cost in descending order of frequency of use or expenditure (2). Drug usage is ideally expressed in dose units rather than dollars but will be dependent on the structure of drug distribution systems and the capabilities of information system. Unlike Australia, many hospitals in the US operate unit-dose drug distribution systems. There are several reasons for this:

- a 1977 recommendation by the American Society of Hospital Pharmacists which stated that *".. in the interests of patient safety, all drugs dispensed by the pharmacy for administration to patients should be in single-unit packages.."* (3)
- a recommendation in 1977 by the US Joint Commission of Accreditation of Hospitals that unit dose be the drug distribution system of choice (4).
- the requirement in the U.S. to collate consumption information in order to invoice patients for each and every dose of each and every medicine administered.

The situation in Australia is very different because similar recommendations have not been made. Also, because patients are not billed for their drug consumption, systems are not in place to capture consumption information. This may change in the future (eg with 'casemix' models) but at present few Australian hospitals are capable of delivering such data (5).

Chapter 7 — Limitations of financial data and pharmacy information systems are described in Chapter 4, in particular page 49 footnote 1 and page 50 paragraphs 3,5 and 6 and Section 2.1.4 page 55. Verification of individual data with pharmacy purchase records occurred as necessary during report preparation. Reports at all levels incorporated necessary corrections and/or were qualified through footnotes, for example legends for Figures 1-7, pages 79-85.

Chapter 8 — A description of the study method and data recorded is provided on pages 107-108. Data were obtained from patient case notes and clinical record sheets (eg fluid balance charts) and by structured interview of patients and/or ward staff. Fluid intake was recorded as < 1500 mL per day; > 1500 mL, or; 'not recorded'. Reduced fluid intake (eg <1500 mL per day), reduced mobility and dietary factors (eg low fibre intake) are known to contribute to constipation.

Chapter 9 — Patients undergoing dental procedures were admitted to one of two surgical wards. These wards were visited by me daily over 8 weeks and data for relevant patients recorded. Data for patients discharged or undergoing surgery were collected retrospectively. I believe the data set included most patients undergoing dental procedures during the period although denominator data are not available to quantify patient numbers relative to total admissions for this patient group over the period. Nevertheless, study findings were still considered to be of sufficient concern to result in amendments to clinic treatment protocols (see pages 122-123).

Chapter 10 — Pharmacy records of r-tPA issues and transfusion records (ie. clinical data, previous streptokinase therapy) were concordant. Data set included all patients administered r-tPA for non-coronary artery occlusion at the RAH over an 18 month period. Study findings measured adherence to practice guidelines applicable to the RAH during the period studied. Despite a complete data set for this study, health outcomes described by study findings for such a small patient sample should not be interpreted as being applicable to a broader patient population. They may, however, serve as a basis for review of other populations.

Chapter 11 — This review was a cross sectional study, intended to quantify anecdotal reports of sub-optimal drug use and confirm that interventional activities were warranted. Data were derived from clinical areas identified as high users (from pharmacy records) of cefoxitin and/or metronidazole. As many of the allocated wards as time allowed were visited daily by me. Medication charts for available patients were reviewed and relevant data recorded. The following day, wards not attended the previous day were visited. No attempt was made to review records retrospectively for patients not present on wards when I visited. The cycle continued for 2 weeks, resulting in wards being visited several times during the study period. Denominator data for patients receiving drugs of interest were not available due to limitations of pharmacy record systems and drug distribution systems previously described (Chapter 4, pages 49-56).

Chapter 12 — Audit criteria (Figure 1, page 139) were constructed by 1) review of the medical literature (see 1-8 below; see also, page 140 references 1-4); 2) assessment by RAH infectious disease specialists with research interests in the area (page 140, reference 5); and from 3) recommendations provided by the 6th edition of the Antibiotic Guidelines (published by VMPF, 1990/91). Nevertheless, study findings and recommendations for the RAH may not be relevant to other institutional settings due to possible differences in patient demographics and local microbiological sensitivity patterns.

1) Fick RB, Reynolds HY. Changing spectrum of pneumonia: news media or clinical reality. Am J Med 1983;74:1-8.

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Chapter 13 — Method—This was a cross sectional incidence study. Due to time and resource limitations it was not possible to review all patients admitted to the hospital during study period. The sample size represents 13.8% of total patients admitted to the RAH during the study period, 19.5% of evaluable patients and 54.8% of selected sample patients, respectively (Table 1, page 143).

Page 142, paragraph 2—'..standard systems.' These refer to literature methods for classifying ADRs by organ system affected, type, severity and causality; see bibliography citations 1-3,5-7 on page 152. Additional references not cited but used for this study include:

1) Rawlins M. Adverse reactions to drugs. BMJ 1981:282;974-6.
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Results—All ADRs were recorded regardless of when they occurred; 41 (15%) of ADRs reported occurred more than 20 years previously. Footnote Table 9—heartburn and dyspepsia were recorded as separate ADRs making a total of 9 ADRs described which is consistent with the figures in Table 9 page 146.

Study limitations—Adequacy of sample size was not tested. Demographics of patients not interviewed were not compared with interviewees. It is not known whether the inclusion of patients not interviewed may have influenced results. This circumstance does not negate the study findings although it may limit extrapolation of findings.

Chapter 21 — *insert the following as an addendum immediately under section heading "3. DISCUSSION" on page 207. The existing text follows the last paragraph of this addendum.*

During my research many drugs were investigated using a variety of data instruments and study methods. Topics were studied over many time periods and by implementing different types of criteria (Chapter 2, pages 21-23). Reviews occurred in the context of regular rotation of junior medical and nursing staff, and changes in the composition of the drug committee and senior medical staff. The studies also occurred during a prolonged period of major organisational restructuring accompanied by implementation of new pharmacy information and drug distribution systems. In addition, over the years many clinicians, pharmacists and other staff were involved in criteria development, data acquisition and evaluation. Despite this variability, it is noteworthy that study findings, with few exceptions, consistently described one or more elements of sub-optimal prescribing for all topics reviewed. Moreover, corrective strategies—again implemented using different methods—consistently showed improvement in outcomes measured by financial savings or more appropriate usage. Where topics were revisited, improvements in drug utilisation, measured in different ways, were also apparent. That suboptimal prescribing was noted regardless of the drug studied or the methodology used, underscores the reproducibility of DUE methods I employed. That findings were similar despite the variety of topics and patient populations studied and the different methods employed, also demonstrates the value of DUE as a clinical management tool in a variety of contexts. It also strengthens my conclusion that DUE is a useful tool for measuring and modifying drug use in an institutional setting.

Despite these comments, I must acknowledge that the qualitative research methods described in this thesis have inherent limitations. These include sampling methods, data sources, data acquisition, data reproducibility, lack of control groups and assignment of causality to outcomes resulting from interventions. It is not known whether these limitations affected study findings. My findings and conclusions should therefore be interpreted with recognition of the general limitations of the methods I employed.

My DUE methods did not subscribe to the discipline of randomised, controlled, double blind clinical trials. Rather they were practice tools intended to measure patterns of drug use in uncontrolled 'real world' clinical settings. An example of this was the development and application of criteria for the DUE program. Criteria needed to be practical. There was little point in defining practice objectives which were not achievable in the setting of a busy teaching hospital. In addition, some practices were so entrenched in the clinical culture of the institution that enthusiastic (but naive) attempts to effect dramatic changes were doomed to failure (eg vancomycin review). At the same time, care was taken to ensure that criteria were not so loose as to have no substance (see pages 21-24).

For the criteria based audits in this thesis, criteria were established using principles enunciated in Chapter 2, pages21-24. Development of true 'evidence based' criteria would have required comprehensive and systematic review of published and unpublished studies using meta-analysis (1). This is a time consuming and specialised activity which does not always provide the answers required (2) and which would have been unsustainable in the context of the DUE program at the RAH. Instead, authoritative texts, review articles and editorials from key journals and/or opinion leaders formed the basis for many criteria used in this thesis. These were supplemented by national recommendations, for example the Antibiotic Guidelines published by the VMPF, or local guidelines already in use at the RAH, and/or following consultation with local clinical experts. When literature meta-analyses were available, they were considered with other material. Primary literature was used when authoritative commentaries were not available.

It was not possible to assess whether deficiencies in sampling methods or data acquisition would have altered conclusions or recommendations. Sampling methods employed included those described in Section 8.4, pages 26-27. These ranged from capture of total patient populations to cross sectional sampling undertaken systematically or using other methods (eg tables of random numbers). For some reviews, it was not practical or possible to collect data for all patients receiving a drug or undergoing certain procedures. For other studies, not all required data were available for evaluable patients. However, the objectives of each study were clearly defined before studies began. Also careful consideration was given to: 1) questions to be answered, and; 2) the data elements which were needed to answer those questions, before studies commenced. Data collection instruments were field tested before individual studies began. Instruments and data acquisition techniques were refined over time to optimise efficiency of data collection and to minimise data variance. Source documentation was evaluated before studies commenced and wherever possible, data recording was reduced to simple yes/no answers (eg through the use of check boxes) to facilitate acquisition and analysis. For example, if criteria declared that certain dosage adjustments were required in renal impairment, rather than record renal indices and estimate creatine clearance, the only data recorded were: 1) that the patient had evidence of renal impairment (as defined by the criteria); 2) that dose adjustments did or did not occur and 3) adjustments did or did not satisfy the criteria.

Internal control groups were not used except where certain topics were revisited. Even then it was not possible to ensure matched groups. Compounding the issue was that unless there was a short time span between 'before' and 'after' studies, audit criteria required revision and often differed between studies. When criteria did not change, comparisons were possible although results were sometimes adjusted for other variances. Where criteria differed, comparisons were qualified in the light of those differences. Alternatively, findings and conclusions were derived using analytical methods which were not influenced by differences in methodology (eg Chapter 15). Nevertheless, it must be acknowledged that in the absence of control groups, it is impossible to say categorically that the DUE process alone was responsible for all the outcomes described, particularly educational interventions. However, based on the success of similar interventional strategies in other institutions, it is reasonable to propose that DUE activities contributed to changes observed. For non-educational interventions, (eg vancomycin, cefoxitin, Augmentin™, thrombin topical powder), changes in prescribing were a direct result of DUE activities.

My thesis did not investigate the reasons for the suboptimal prescribing identified through the reviews undertaken. This was thought to be unnecessary since these factors are well described in the literature (3-13). There was no reason to assume these factors — which have also been described for Australia (5,6) — did not apply to the RAH. This hypothesis, however, remains untested. Similarly, intervention models which are also well described in the literature (14-32) and summarised in Chapter 2 pages 27-28, were not formally evaluated in my research. Furthermore, no attempt was made to assess which of the many possible intervention strategies were most suitable to achieve particular outcomes. The methods used in my research are summarised in Chapter 23, pages 266-269. Educational interventions were preferred by clinicians; administrative controls were most effective.

Comparison of my study findings with those of other investigators was difficult because of differences in hospital and patient demographics, information systems, and administrative, financial and/or structural elements of health systems and/or institutions. Correspondingly, although my methods and findings may serve as a model for other institutions, other investigators should take into account differences between the RAH and their institutions. However, other studies did help by suggesting potential research projects and providing ideas about study methods, criteria and examples for ways of analysing and presenting data.

My research was a learning process, not only a personal one but one for my supervisors, the hospital pharmacy, the drug committee and hospital clinical staff. Some compromises were inevitable. In certain circumstances — particularly during the early phases of my research when trying to establish project credibility and support — final assessments erred on the side of conservatism, offering prescribers 'the benefit of doubt'. These compromises did not affect the integrity of the research methods but did temper some of the criticisms of prescribing raised as study conclusions. To have done otherwise would have crippled the program in its early stages.

As described in Chapter 23, page 270, later changes in the economic climate of the RAH resulted in increased clinical administration support for changes to prescribing policy. Changes to drug policy effected in later years were achieved with much less effort (and sometimes without the need for collection of large amounts of data), than were possible during the early phase of my studies. This was despite good data from often large samples describing evidence of non-compliance with practice guidelines. Fortuitously, this changing climate, although driven by a desire to contain expenditure, assisted both in acceptance of the DUE program and assisted in achieving its clinical objectives. Even with such a favourable environment in later years, quantitative and qualitative methods were still needed to identify which components of drug utilisation were amenable to change. This observation demonstrates that there is a range of factors which influence prescribing and that some may be harnessed to common benefit (ie cost containment and patient care).

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Signed:

Gary Misan

22 September, 1997

DECLARATION

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

Signed:

Gary MH Misan

Date: 20/5/97

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- To the medical, nursing and Pharmacy staff of the RAH.
- During the course of this research the author was appointed inaugural Chairman of the SHPA.[i] National Committee on Drug Usage Evaluation, a position which was held for 4 years (1992-95) and also as a founding member of the ASCEPT[ii] Drug Utilisation Review Clinical Interest Group (1994). Assistance and comments from members of these groups are also acknowledged.

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[i] SHPA – The Society of Hospital Pharmacists of Australia.
[ii] ASCEPT – Australasian Society of Clinical and Experimental Pharmacologists and Toxicologists.

PUBLICATIONS

The following papers or abstracts have resulted from work associated with this thesis. All abstracts have been presented at scientific meetings.

Papers

1. Misan G. Drug usage evaluation. *Aust Pres 1996;19 (Suppl.1):16-18*

2. Misan GMH. S.H.P.A. Position Statement on the provision of drug utilisation data. *Aust J Hosp Pharm 1996;26 (2): 247*

3. Misan GMH, Alderman CP, Brown SE, Burgess NG, Coulthard K, Demos L, Dollman CM, Rossi SOP, Wiltshire SL. S.H.P.A. Standards of practice for drug usage evaluation in Australian hospitals. *Aust J Hosp Pharm 1996;26 (2):240-246*

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PREFACE

This PhD dissertation has 2 **aims**:

1. to describe the implementation of a Drug Usage Evaluation (DUE) program in an Australian hospital setting, principally the Royal Adelaide Hospital (RAH).
2. to research the feasibility of collecting quantitative drug utilisation data from Australian public hospitals in an effort to provide baseline data from which to commence national DUE activities.

My **hypothesis** was that DUE was an effective tool for measuring the pattern and quality of drug use in a hospital environment and for promoting the quality use of medicines in that setting.

My research commenced in 1988 and was undertaken in part during an appointment as project pharmacist to the Royal Adelaide Hospital Drug Committee. The duties associated with this appointment included implementation of a DUE program at the hospital.

All projects described were defined and coordinated by me and undertaken either by me alone or with assistance from other personnel under my direct supervision. I would like to acknowledge the valuable assistance for data collection provided at various times by a pharmacist research assistant, medical and pharmacy students, pharmacy interns and clinical and dispensary pharmacists. The co-operation provided by hospital medical and nursing staff is also noted. The particular support of the Division of Clinical Microbiology, Infectious Diseases Unit and the Department of Clinical Pharmacology is acknowledged.

My thesis contains 23 chapters and is divided into 5 parts: (1) *Chapters 1–3*, an introduction, literature review and a description of the evolution of the DUE program at the RAH, including some results from early DUE activities which preceded my research; (2) *Chapters 4–7*, methods, results and discussion of my quantitative DUE research, including examples of macro and micro drug utilisation profiles for the RAH; (3) *Chapters 8–21*, my qualitative DUE research, which describes the application of different qualitative methodologies and sampling techniques; (4) *Chapter 22*, methods, results and discussion of my research into the feasibility of collecting quantitative drug utilisation data from public hospitals around Australia; (5) *Chapter 23*, a general discussion of findings from the preceding chapters, noteworthy experiential observations, future opportunities for research, a short summary of the general findings of my project and finally my conclusions. The chapters are followed by appendices of supporting information which include examples of different types of data collection sheets.

The thesis is for the most part presented in double sided format. Certain sections, for example the inclusions in chapter 22 and the appendices, are presented in single sided format to facilitate production and binding. Each chapter commences on a right hand, odd numbered page with a leading edge strip, which simplifies navigation through the document. This structure has necessitated the occasional deliberate insertion of a blank page at the end of chapters where the body of the text also finishes on a odd numbered page. These blank pages are not numbered but have been accounted for in the page numbering sequence. The pages of the appendices are not numbered.

The reader should note that all criteria, corresponding findings and recommendations must be viewed in the context of medical knowledge at the time. That is, strategies or recommendations in the individual case studies may no longer be applicable because new evidence has become available for particular practices over subsequent years. For example, the criteria for the H_2-receptor antagonist review recommended that the use of H_2-receptor antagonists be restricted to patients with endoscopically proven peptic ulcer disease. This was valid in 1988 when these drugs were still expensive and their role as maintenance therapy still unclear. Since that time, the safety and efficacy of H_2 antagonists have been well established and recommendations for use have been relaxed. In some countries H_2 antagonists are available without prescription. In the 1990's, the management of peptic ulcer disease centres on the eradication of causative factors such as *H. pylori.*

Finally, I have made note that the terms drug utilisation review (DUR) and drug usage evaluation (DUE) are used interchangeably in the medical and pharmacy literature. Drug usage evaluation is the more modern term and is used preferentially in this thesis. For the reader's interest, the evolution of drug utilisation review/drug usage evaluation terminology together with my preferred definitions are provided in *Chapter 2.*

Gary MH Misan
April 1997

ABSTRACT

Drug Usage Evaluation (DUE) is quality assurance activity for drug therapy. It measures patterns of drug use by reviewing utilisation rate, cost and/or expenditure trends. It also assesses quality of use by comparing drug use and outcomes with predetermined criteria and standards which describe optimal use. DUE serves as a basis for more specific drug or procedure directed quality assurance activities and for the implementation of educational programs and/or other strategies directed at improving the quality of drug use.

The first part of my thesis describes my implementation of a Drug Usage Evaluation (DUE) program at the Royal Adelaide Hospital (RAH), in order to demonstrate the value of DUE as a tool for measuring and modifying drug use and improving the quality of use of medicines in a large teaching hospital. The program operated under the authority of the RAH Drug Committee, was cyclical and was comprised of 2 integrated components:

1. Quantitative review:
    - routine quantitative reviews of usage rate, cost and expenditure data
    - determination of user groups and review of usage patterns
2. Qualitative review:
    - descriptive reviews
    - criteria based reviews

Retrospective, concurrent and prospective reviews of drugs, drug management of particular disease states and the drug aspects of medical procedures were undertaken. Reviews ranged from simple studies to expansive reviews of drug use. Audit criteria were developed in association with relevant experts before reviews were undertaken. DUE findings were reported to the Drug Committee and subsequent recommendations published in the Pharmacy/Drug Committee bulletin or the hospital formulary.

Projects involved clinical pharmacists, pharmacy trainees, medical students and clinicians. Over 40 drugs, drug groups, procedures or diseases were evaluated including antibiotics, anti-emetics, anti-ulcer drugs, intravenous fluids, sustained release morphine, anaesthetic agents, cytotoxic drugs, laxatives, antiviral drugs and tissue plasminogen activator. Re-evaluation demonstrated improvements in utilisation for a number of drugs following implementation of corrective strategies. These included education programs, formulary restrictions, required consultations and prospective monitoring.

Through the application of criteria, the program defined an acceptable quality of use, assessed the quality of that use, coordinated strategies to correct misuse, evaluated those strategies, showed improvements in utilisation, and saved money. Total savings in excess of $900,000 are described.

The second part of the thesis relates to the feasibility of collecting quantitative drug utilisation data from Australian public hospitals. This is in an effort to provide baseline data from which to commence national DUE activities. My research arose from concern over the lack of centralised information on individual drug use from the public hospital system. The aim was to investigate the feasibility of establishing a comprehensive, central database for routine collection and reporting of indi-

vidual drug usage data from public hospitals. The research was funded by a grant from the Commonwealth Pharmaceutical Benefits Scheme Education Program.

The project was conducted in 3 phases including a survey of public hospitals. The study found that the range of Commonwealth, State and industry drug utilisation data sources provide an encouraging starting point from which to gather public hospital utilisation data in a central source.

A survey of 252 public hospitals showed that over 75% of hospitals were able to provide utilisation data, mostly in the form of a printed report. Overall, reporting accounted for approximately 60% of available beds surveyed, 35% of total Australian public hospital beds and represented approximately 60% and 45% of surveyed and total Australian hospital drug expenditure. Fewer than 20% of hospitals were able to provide electronic data files of utilisation data.

An assessment of sample electronic reports demonstrated little consistency in data descriptions, record or field structures. This lack of standardisation presents major problems for data collection and aggregation and will limit future automated collection and reporting. These difficulties could be resolved by development of a standard drug classification and coding system and, definitions for data and file formats. Several groups could assist in this process. A model is proposed for data collection commencing with submission of printed data from the teaching hospitals and moving towards a broader sample for automated data collection and aggregation, over a 5 year period.

I conclude firstly that the DUE program at the RAH was valuable for measuring and modifying drug use and, that the program was both successful in implementation and cost effective in operation. My results demonstrated that this DUE model could contribute to quality use of medicines in a teaching hospital and could be applied in other hospitals. Secondly, my research has also shown that sufficient information exists within Commonwealth and State regulatory bodies and public hospital pharmacy departments to initiate a program of representative sampling and reporting of quantitative drug utilisation data from Australian public hospitals.

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LIST OF ABBREVIATIONS

Abbreviation	Full Description
A&E	Accident and Emergency
ACT	Australian Capital Territory
ADR	Adverse drug reaction
AHFS	American Hospital Formulary Service (Drug Information)
AHI	Australian Hospital Index (IMS)
AIH	Australian Institute of Health
AMH	Australian Medicines Handbook Pty Ltd
ANDRG	Australian National Diagnosis Related Groups
APAC	Australian Pharmaceutical Advisory Council (Commonwealth of Australia)
APMA	Australian Pharmaceutical Manufacturers Association
ARTG	Australian Register of Therapeutic Goods
ASCEPT	Australasian Society of Clinical and Experimental Pharmacologists and Toxicologists
ASCII	American Standard Code for Information Interchange
ASHP	American Society of Health System Pharmacists
ASIG	Antimicrobial Special Interest Group of the Australian Society of Microbiology
ASM	Australian Statistics of Medicines
ATC	Anatomical Therapeutic Chemical (Drug Classification System)
BBS	Bulletin Board Service
BNF	British National Formulary
BSA	Body Surface Area
CF	Cystic Fibrosis
CNC	Clinical Nurse Consultant
CPI	Consumer Product Information
DD	Drugs of Dependence (ie opioids and other substances of abuse)
DDD	Defined Daily Dose
DOFMS	Department of Orofacial and Maxillary Surgery
DRG	Diagnosis Related Group
DUE	Drug Usage Evaluation
DUR	Drug Utilisation Review
DUSC	Drug Utilisation Sub-committee
DVA	Department of Veterans' Affairs
ECG	Electrocardiograph
EDI	Electronic Data Interchange
ENT	Ear Nose and Throat
FMCS	Financial Management Computer System (Royal Adelaide Hospital)
FMRU	Family Medicine Research Unit (University of New South Wales)

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Abbreviations *continued...*

Abbreviation	Full Description
GI	Gastrointestinal
GU	Genitourinary
HIC	Health Insurance Commission (Commonwealth of Australia)
HIV	Human Immune Deficiency Virus
HUCS	Health Utilisation and Cost Study
IBM	International Business Machines
ICF	Intermediate Care Facility
ICU	Intensive Care Unit
IDDM	Insulin dependent diabetes mellitus
IM	Intramuscular (injection)
IMS	International Medical Statistics Pty. Ltd.
IMVS	Institute of Medical and Veterinary Science (SA)
IPS	Individual Patient Supply Drug Distribution System (Royal Adelaide Hospital)
IPU	Individual Patient Use (Commonwealth of Australia)
IV	Intravenous (injection)
JCAH	Joint Commission for the Accreditation of Hospitals (US)
LMH	Low molecular weight heparin
MRSA	Multi (or methicillin)resistant Staphylococcus aureus
MS-DOS	Microsoft™ Disk Operating System
MSSU	Mid-stream specimen of urine
MTHG	Melbourne Teaching Hospitals Group
NCR	No carbon Required
NHMRC	National Health and Medical Research Council
NSAID	Non-steroidal anti-inflammatory drug
NSW	New South Wales
NSW TAG	The New South Wales Therapeutic Assessment Group Inc.
NT	Northern Territory
OBRA	Omnibus Reconciliation Act (1990, US)
OFM	Orofacial and Maxillary Surgical Unit (Royal Adelaide Hospital)
pa	per annum
PACT	Prescription Analysis of Cost (UK)
PBAC	Pharmaceutical Benefits Advisory Committee
PBS	Pharmaceutical Benefits Scheme
PC	Personal computer
PEAC	Pharmaceutical Education Advisory Committee
PHARM	Pharmaceutical Health and Rational Use of Medicines working party

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Abbreviations *continued...*

Abbreviation	Full Description
PSA	Pharmaceutical Society of Australia
PSRO	Professional Standards Review Organisation (US)
QLD	Queensland
QUM	Policy on the Quality Use of Medicines (Commonwealth of Australia)
RAH	Royal Adelaide Hospital
RACGP	Royal Australian College of General Practitioners
RPBS	Repatriation Pharmaceutical Benefits Scheme
r-TPA	recombinant tissue plasminogen activator
SA	South Australia
SADUAG	South Australian Drug Usage Advisory Group
SAHC	South Australian Health Commission
SAS	Special Access Scheme (Commonwealth of Australia)
SHPA	The Society of Hospital Pharmacists of Australia
SNF	Skilled Nursing Facility
SROM	Sustained release oral morphine
TAS	Tasmania
TB	Tuberculosis
TGA	Therapeutic Goods Administration
TPN	Total Parenteral Nutrition
TURP	Trans urethral resection of the prostate
UR	Patient Unit Record (ie. Case Notes)
US, USA	United States of America
UTI	Urinary tract infection
VBA	Microsoft™ Visual Basic Application Code Language
VDUAC	Victorian Drug Usage Advisory Committee
VHA TRADE	Victorian Hospitals Association Trading Company Pty. Ltd.
VIC	Victoria
VMPF	Victorian Medical Postgraduate Foundation
WA	Western Australia

HOSPITAL DRUG USAGE EVALUATION

CHAPTER 1

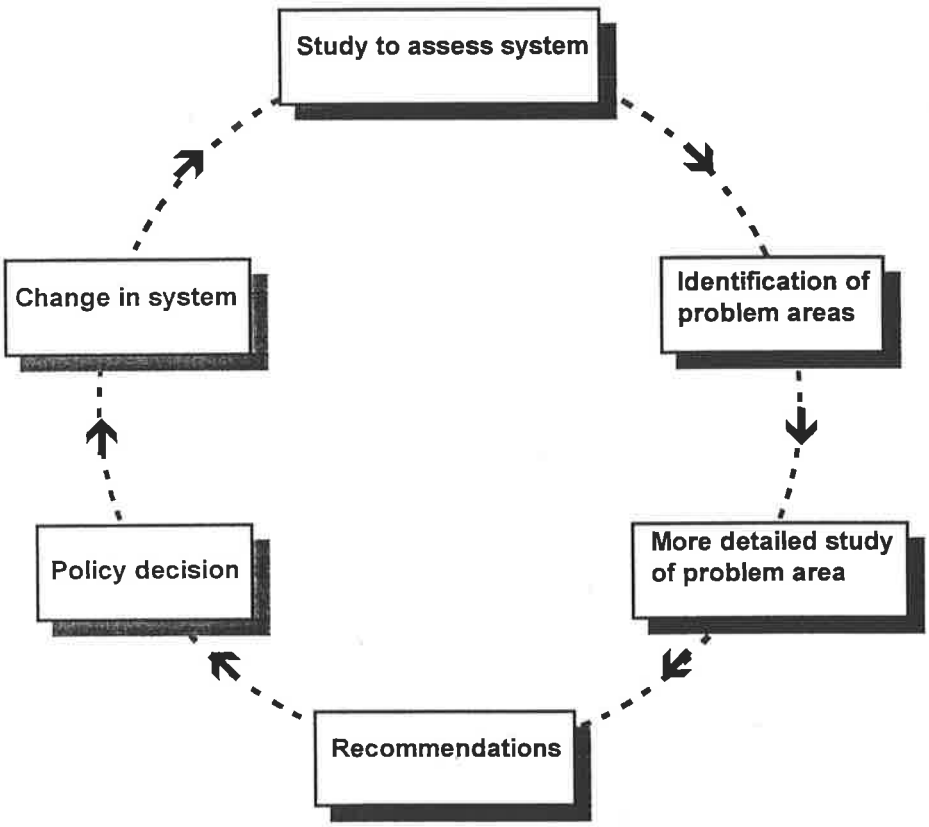
INTRODUCTION

Quality assurance and utilisation review provide the foundation for the discipline of drug utilisation review (DUR)/drug usage evaluation (DUE). This chapter provides a brief description of the relationship between the practice fields and of the terminology and definitions which underpin them. A historical perspective of DUR/DUE is provided by the literature review in chapter 2.

1. QUALITY ASSURANCE

A quality assurance (QA) program is a formal, structured and cyclic process which applies the concepts of quality assurance to specified activities or services (Figure 1) (1,2). QA programs may include *peer review* activities and *patient care* audits (3) and describe the application of quality assurance principles to medical services. The term encompasses programs applied to the professional services of all providers of health care, for example, doctors, nurses, pharmacists, dietitians, physiotherapists and other allied health workers. There is almost always interaction between physicians and other groups which involves delegated or shared responsibility for aspects of care. The principles essential for proper conduct of quality assurance programs in general and in Australian hospitals have been well described (4,5):

Figure 1 Schematic representation of the cyclic process of quality assurance and DUE (adapted from Eckert et al (6))



Since drug therapy is an important component of medical care, it is reasonable to expect that reviews of drug use should be conducted as part of the overall audit program (7). DUE is a quality assurance activity directed specifically at drug therapy and drug therapy outcomes (6). It assesses one or more elements of drug use by comparison with criteria and standards which define an acceptable quality of practice. DUE can be performed as a free-standing activity or one which is incorporated into other patient or medical-care audit or quality assurance programs (2,8). The principles of these programs are analogous to those described for DUE programs (1-2,9-12) which should be formalised, structured, cyclic and ongoing and aimed at improving the quality of drug use (6,13).

2. UTILISATION REVIEW

When an assessment is made of the way resources are consumed in the provision of services the term *utilisation review* is used. Utilisation review in an institutional context incorporates quality assurance processes which evaluate the use of the facility in which services are provided - for example, admission eligibility, length of stay or discharge procedures. The principles that underpin utilisation review as a quality and cost control mechanism for health care can easily be extended to drug utilisation. By reference to these principles, a conceptual model for drug utilisation review can be developed. From this conceptual model, operational models can be identified and applied.

3. DRUG UTILISATION

The administration of a drug to an individual represents the culmination of a complex chain of events (Table 1). Since problems may occur at any stage of this chain, there should be an appreciation of the components of this process and of the factors which influence drug selection and clinical effect. Rational prescribing therefore requires an understanding of the complex interactions between drug, disease and patient factors which impinge on drug selection and effect. These factors are well described in the literature (14-26). Drug utilisation review can provide insight into this process and assist in the deployment of strategies to promote rational, safe and economic drug use.

Table 1 Structural, process and outcome steps in the drug use process

- marketing and promotion;
- acquisition;
- determining the need for a drug by the prescriber;
- selection of the most appropriate drug from a range of possible alternatives;
- selection of optimum dose regimen, schedule and duration of therapy;
- writing the prescription;
- drug administration and consumption;
- clinical and laboratory assessment;
- monitoring of drug effect and/or outcomes.

3.1 Determining the need for a drug

Whether or not a drug is needed at all is a fundamental question which should be asked when assessing the quality of drug use (21-22). The subsequent evaluation of process parameters - for example, whether the dose regimen or schedule were correct - is academic if the *a priori* indication for drug use is ill-founded. The subsequent adverse consequences for an individual patient (adverse

drug reactions) or for the community in (antibiotic resistance), as a result of poor prescribing may be significant.

3.2 Which drug ?

If the need for drug therapy in the management of a particular disease process is confirmed, the next step is to select the most suitable drug from the variety of potential alternatives. The factors which should determine appropriate drug selection are listed in Table 2. For drug utilisation review purposes, criteria should be developed which assist in the evaluation of some or all of these elements.

Table 2 Some factors influencing the selection of drugs
Disease / organism factors • diagnostic procedures available; • other laboratory procedures available (eg. therapeutic drug monitoring); • evidence of therapeutic failure.
Patient factors • clinical signs and symptoms; • patient history of allergy or adverse drug reactions; • age; • genetic or metabolic abnormalities; • renal or hepatic function; • other drugs; • underlying diseases.
Drug factors • pharmacology / clinical pharmacology; • antimicrobial spectrum; • efficacy; • pharmacodynamics / pharmacokinetics; • dose form; • adverse effect profile; • relative cost; • investigations.
Other factors • prescriber education / support networks; • drug usage guidelines; • drug availability (eg. formulary); • reimbursement, copayment policies; • pharmaceutical industry activities.

3.3 The drug regimen

After choosing the correct drug, the next step in the prescribing process is selection of an appropriate drug regimen. Factors which may be examined include the daily dosage, minimum or maximum doses, frequency of dosing, route of administration and duration of therapy. Audit criteria for these aspects of drug use are easily constructed. Data are readily obtainable from the prescriptions or the patient notes and are easy to record and review. When audit criteria are absolute (ie. no variation from a criterion is acceptable), screening for compliance with criteria can be performed by non-professional staff or in some cases by computer systems.

3.4 The prescription

Assessment of the quality of prescription writing may also be the subject of review. Poor ordering practices may lead to errors in dispensing or administration, and in subsequent adverse medication events. For example, audit criteria might declare that all prescriptions:

- be legible;
- clearly indicate the generic name of the drug;
- clearly describe the drug dosage, route, and frequency of administration;
- avoid the use of Latin or other abbreviations for drug directions;
- specify the number of dosage units or strength of preparation;
- use standard units for weights and measures; and
- be signed by a registered medical officer.

3.5 Pharmacy aspects

Review of pharmacy dispensing and/or supply activities should also be undertaken as part of a DUE program. Issues including sub-optimal prescription processing, dispensing, packaging, primary and secondary labelling, or dispatch, should be reviewed. Problems in these areas may result in dispensing errors, administration errors, patient misunderstanding, delays in obtaining drugs and unintentional duplication of drug doses. The correct application of pharmacy procedures in relation to recording of certain drugs - for example, investigational and trial drugs - may also be the subject of audit.

3.6 Drug administration and consumption

Drug review efforts directed at administration and consumption include audit of the number of missed doses of drug therapy which occur over a specified time period. They may also review the appropriateness of administration times in relation to food or to other drugs. Concordance with recommendations for reconstitution, dilution and administration times for intravenous medications may also be assessed. Compliance with prescriber instructions, for example, intended frequency of dosing, have also been the subject of review (22).

3.7 Outcome assessment

Absent from early drug utilisation review literature were attempts to assess or monitor the outcomes of drug therapy. Few outcome criteria or data collecting procedures have been described (22). Although comparative or placebo controlled drug trials often describe and measure the expected endpoints of treatment, little attempt is made to monitor treatment outcomes outside this context. Some groups have monitored the effect of therapeutic drug monitoring on prescribing and the incidence of admission and re-admission rates for drug related disease (4,27-29). Some of my research has attempted to assess the outcomes of various treatment regimens (30). These have included clinical and microbiological outcomes of anti-infective treatment, occurrence of adverse drug reactions and the incidence of post-operative infection rates following changes to surgical antibiotic prophylaxis regimens.

4. DRUG UTILISATION REVIEW OR DRUG USAGE EVALUATION ?

Thus drug utilisation review (DUR) (more properly referred to as drug usage evaluation (DUE)) is a quality assurance activity for drug therapy. It measures patterns of drug use by reviewing rate, cost and/or expenditure trends and quality by comparing drug use and outcomes with predetermined criteria and standards which describe optimal use. DUE serves as a basis for more specific drug or procedure directed quality assurance activities and for the implementation of educational programs and/or other strategies directed at improving the quality of drug use.

4.1 Terminology

4.1.1 Drug utilisation review or drug usage evaluation ?

Close reading of the pharmacy and medical DUR literature indicates confusion in the terminology and nomenclature surrounding this topic. This is further confounded by the related literature on medical audit, quality assurance, utilisation review and peer review. Some of the confusion arises from the subtle differences in conceptual definitions, but most confusion stems from the variety of contexts, practice settings, organisational structures and regulatory pronouncements which have influenced the conduct of DUR over the years (9,22,31-32). Difficulties in distinguishing between DUR *studies*, and DUR *programs* have also been partly responsible (33).

The term DUR has assumed a double meaning in the current literature. *Generically*, it is used to describe an isolated, short term, local, drug use study (9):

> "... a one time project without lasting impact which provides minimal feedback and is usually not an integral part of an overall patient-care review (2,33)."

Often such studies are referred to as a *drug utilisation review.* Inherent in this description is that activities are usually undertaken for limited purposes, are of short duration, are conducted on an *ad-hoc* basis independent of formal quality assurance programs, and that the information is utilised only by the person or group performing the review.

The term has also been used more *specifically* to describe the *application* of DUR principles to a health care service as a method of controlling drug use and expenditure. This type of activity is also referred to as *drug utilisation review.*

The confusion stems from this duality of terminology. Therefore, it is necessary for journal editors and readers alike to review and understand DUR nomenclature and to differentiate between the terminology used by authors and the actual or implied activities described.

I think the concept of evaluation as opposed to assessment of utilisation in quantitative terms is the point at which one should consider that the terms drug utilisation review and drug usage evaluation differ conceptually. The terms *drug use review* and *drug utilisation review* refer to processes that identify usage problems but do not necessarily assess the effectiveness of remedial actions or outcomes. When evaluation components are incorporated, the term *drug usage evaluation* applies (34).

Table 3 Schematic representation of components of a DUR studies and DUR program - (adapted from Stolar (33))

	Inputs	Operation and description	Primary outputs	Secondary outputs
Quantitative DUE	• rate & cost data	• collection & reporting of quantitative data • isolated or continuous activity • usually pharmacy only activity	• data on amounts and patterns of drug use	
Qualitative DUE	• rate & cost data • criteria and standards	• qualitative analysis of data using criteria and standards • isolated or continuous activity • multi-disciplinary	• knowledge about the quality of drug use	• data on amounts and patterns of drug use
DUE programs	• rate & cost data • criteria and standards • education, correction and re-evaluation	• continuous, cyclic process of data collection, analysis, and evaluation • combined with actions to alter behaviour • multi-disciplinary	• evaluation & maintenance of the qualitative of drug use • improved drug use • improved patient care	• data on amounts and patterns of drug use • knowledge about the quality of drug use

DUR/DUE studies generally consist of one of two distinct types - *quantitative* or *qualitative* studies. When the emphasis of a study is on drug utilisation, observations of rates and costs are most relevant. Descriptions of trends and variability should be used to produce estimates of the medical and social qualitative consequences of drug use. If the emphasis is on drug monitoring and the effects or outcomes of drug utilisation, the focus should be on the qualitative components of drug use and observations made at the point of prescribing and therapy outcomes (3).

Perhaps the easiest way of understanding the interrelationships between the different DUE nomenclature is to review the early postulates promulgated by Stolar and summarised in Table 3. The raw materials for each element of DUE activities are considered as '*inputs*', the basic operations as '*processes*' and the objectives or product of the system as '*outputs*'. In essence, DUE programs are comprised of the basic elements of qualitative DUE studies, which in turn are based on the more simple quantitative DUE study structure.

The inputs for quantitative studies are data about amounts and costs of drugs; the outputs are information about rates and trends of drug use. In turn, qualitative studies draw on the quantitative review outputs and add inputs about how and why drugs are used, together with criteria describing optimal drug use. Correspondingly, the inputs for DUE programs are the outputs of qualitative reviews, to which correctional, educational, feedback and re-evaluation components have been added. The outputs of the DUE programs are the cyclic nature of the program, quality drug use and improved patient care (33).

4.2 My recommended definitions

As a solution to the confusing issue of terminology, I firstly recommend that DUE be used in preference to DUR. DUE implies an evaluation component for both quantitative and qualitative studies and is, I believe, the more correct term. DUE provides an umbrella term for the discipline and embodies quantitative and qualitative methods. It makes provision for methods to be applied on an *ad-*

hoc basis or as part of a formal program of review. In addition, I propose the following definitions be used to encompass other elements of DUE previously described (10,35):

4.2.1 Quantitative DUE

The quantitative study of drug utilisation figures from which patterns of drug acquisition, prescribing, dispensing, distribution and consumption may be determined.

4.2.2 Qualitative DUE

The qualitative evaluation of drug therapy and drug therapy outcomes by comparison of practice with predetermined criteria and standards.

4.2.3 A DUE program

An authoritative, cyclical, quality assurance activity for improving the quality and economy of drug use. A DUE program incorporates quantitative review of utilisation and qualitative evaluation of the indication, appropriateness, efficacy, and safety of drug use. Mechanisms for correcting drug misuse, for measuring the effectiveness of corrective actions, and of the overall program should be incorporated.

4.3 The complete definition

A program of drug usage evaluation is one way of assuring the quality of drug use in an institutional setting. The program itself is the system which quantifies and interprets drug utilisation patterns, defines the projects which require investigation, defines quality, measures it, corrects problems and measures the effectiveness of the corrective actions. Such programs should form part of a more universal strategy for promoting rational prescribing including formulary controls, treatment guidelines, prospective monitoring (eg. by clinical pharmacists), peer review, medical audit and continuing drug education (36-40).

As a complete definition of drug usage evaluation and in an effort to encapsulate all of the preceding sentiments I offer the following.

"Drug usage evaluation (DUE) is a quality assurance activity for drug therapy which improves patient care (or drug therapy outcomes) by systematic review of drug use to achieve rational, safe and economical drug therapy (or quality use of medicines). DUE comprises a continuous, structured, program operating with designated authority, in which quality assurance principles are applied to the drug use component of health service delivery. It is used to determine, analyse and interpret drug usage and cost patterns and the appropriateness of drug use. Quality (appropriateness) is measured by comparing drug use and drug therapy outcomes against predetermined criteria and standards. Education and other corrective strategies are implemented when drug misuse is observed. Prescriber feedback of program findings is a key feature as is periodic re-evaluation to assess the effectiveness of corrective actions and the overall effectiveness of the program."

5. SUMMARY

The need for a sound foundation in the principles of rational prescribing is fundamental to quality use of medicines. Among these principles, prescriber education is most important. A thorough

grounding in pharmacology, clinical pharmacology and therapeutics, is seen as an important requirement if we are to address the irrational prescribing and use of drugs.

It is however, no less necessary to educate other groups involved in drug use. These include consumers, pharmacists, nurses, the pharmaceutical industry and health authorities. Collaboration and cooperation between all groups involved in the distribution chain is necessary. DUE plays an important role in defining where drug misuse is occurring and where correctional strategies should be targeted.

However, providing education and information in isolation will be insufficient. Education programs should be conducted which produce changes in behaviour, not simply the acquisition of knowledge. A number of strategies are available to modify aspects of prescribing behaviour and drug use. These can be applied alone or in combination, at community or institutional level, or be directed at individual health professionals. Outcomes can be achieved through regulation, persuasion or educational methods.

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CHAPTER 2

LITERATURE REVIEW

1. HISTORY OF DUE

The phrase "*drug utilisation review*" (DUR) was first coined in 1968 in the final report of the US Secretary of Health, Education and Welfare's Task Force on Prescription Drugs (1). The task force was established 25 years ago by the then Secretary John Gardner, to consider and design a system of outpatient prescription benefits for *Medicare*[i].

The Task Force Report defined DUR as:

> "...a dynamic process aimed first at rational prescribing and the consequent improvement of the quality of health care and second at minimising needless expenditures."

This early definition clearly enunciated two important principles. Firstly and most importantly, DUR was concerned with improving the quality of patient care by ensuring rational prescribing. In particular it provided clear recognition that assuring quality drug use has a profound influence on patient health outcomes. The second premise was that in achieving the first objective, the unnecessary costs associated with drug misuse would be minimised. A quarter of a century later this definition still underscores the primary intent of DUE.

In its broadest context, DUR was defined as the review of physician prescribing, pharmacist dispensing and patient use of drugs (2). Other definitions have refined the nature and/or scope of the initial Task Force definition but left the original and fundamental concepts unchanged, for example this 1972 definition by Brodie (3):

> "...an authorised, structured, and continuing program that reviews, analyzes and interprets patterns (rates and costs) of drug usage in a given health care delivery system against predetermined standards."

This definition introduces the concept of DUR as consisting of an authorised, ongoing program performed in an organised delivery setting (eg. a hospital). Importantly, here we first read a definition which introduces the application of criteria and standards against which actual practice can be compared. As a process, drug utilisation encompasses drug marketing, acquisition, selection, prescription, dispensing, consumption, monitoring and effect. This description recognises that drug prescription and use results from a complex sequence of influences, personnel, and an amalgam of far reaching social and environmental factors. Therefore, by definition, DUR must include a review of the appropriateness of each of these components. All groups with an interest in drug use should be accountable for the quality of their component of the process and for ensuring that the most rational and cost effective drug use ensues.

The following WHO definition of DUR embodies this philosophy and incorporates societal as well

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i **Medicare** - a federally funded program of medical assistance for the elderly and disabled in the United States of America. The program does not cover outpatient prescription drugs despite the recommendations of the Task Force in 1968. Outpatient prescriptions did attract a benefit for a short time in 1988; these benefits were subsequently repealed.

as individual and economic considerations:

> "The marketing, distribution, prescription and use of drugs in society with special emphasis on the resulting medical, social and economic consequences."
>
> *World Health Organisation, 1988.*

2. QUANTITATIVE DUE

Quantitative review refers to the *what, how much* and *who* of drug use. Historically, specific reference to DUR implied review of rate and cost data or drug use trends. As described in chapter 1 the preferred and more modern term is '*quantitative DUE' (4)*:

> "The quantitative study of drug utilisation figures from which patterns of drug acquisition, prescribing, dispensing, distribution and consumption may be determined."

Quantitative DUE studies collect, organise and display measurements, estimates or projections of amounts of drug use. They describe absolute or relative drug utilisation data for large or defined populations of patients, prescribers, wards, departments or institutions over specified time periods.

Publications such as the Australian Statistics on Medicines and the Nordic Statistics on Medicines are excellent examples of methods and displays of quantitative DUE methodology (5,16). These publications represent a national population approach to collection, collation and exhibition of quantitative community based drug utilisation data. The standard adopted for data presentation and disaggregation are the Nordic Council of Medicines and the WHO Anatomic, Therapeutic, Chemical (ATC)[ii] code for drug and the defined daily dose (DDD)[iii] for utilisation, as previously described (4,5,18). Although these publications describe a population approach to drug utilisation, the application of DDD as a unit of measurement of drug use is equally applicable in the institutional context. Other studies have also used the DDD as a measure to demonstrate reductions in the use of hypnotic agents and antibiotics (19-21). In general, this measurement may be applied to: (i) examine general changes in drug utilisation over time; (ii) follow changes in the use of specific drugs or drug groups over time; (iii) document the relative intensity of therapies; (iv) evaluate the effect of correctional programs directed at prescribers or patients; (v) evaluate the effects of regulatory changes on drug use and; (vi) make external (and international) comparisons of drug use (7).

In the institutional environment, the collection, organisation and review of quantitative data are often the function of pharmacy departments and/or hospital drug committees. Data sources include pharmacy invoices or delivery documents, purchase, expenditure or issue figures (8,13-14). The data may be used for historical comparison of drug expenditure, for identifying alterations in drug use patterns and for preparing and monitoring drug budgets.

Quantitative data generally should not be used to make judgments concerning the quality of drug use. Except for situations of extreme or obvious misuse, quantitative information should be consid-

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ii **ATC** - anatomic, therapeutic, chemical classification system. A structured, 7-character alpha-numeric, 5 level coding system which allows drugs to be systematically grouped and aggregated according to their anatomic site of action and chemical and therapeutic class.

iii **DDD** - defined daily dose. The unit of measurement of drug utilisation which complements the WHO Anatomic, Therapeutic, Chemical (ATC) coding system. A technical unit only used for statistical comparison of differences in price, preparation and quantity per prescription. It is usually expressed as DDD / 1000 population / day to give an estimate of the prevalence of use of drugs by a defined population. See Guidelines for DDD, Second Edition. WHO Collaborating Centre for Drug Statistics Methodology, Oslo, Norway.

ered suggestive of problems which lend themselves to closer scrutiny. In practice - including my experience at the Royal Adelaide Hospital (RAH) - quantitative studies provide indicators of potential drug utilisation problems and provide the impetus for initiating more detailed quantitative and/or qualitative studies of the "problem" areas.

3. QUALITATIVE DUE

Qualitative reviews describe the "*why* and *how*" of prescribing. That the term DUE (as opposed to DUR) should be used in this context is beyond dispute. Qualitative DUE studies collect, organise and analyse information about a specific drug or drug group or a disease or procedure. The crucial difference between quantitative and qualitative DUE is that qualitative DUE includes the concept of *criteria.*

Criteria are pre-determined descriptions of optimal drug use (15-16). They may be constructed to define one, some or all of the elements of the drug use process. These include indications, contraindications, dosage and schedule, duration of therapy, and monitoring procedures. By comparing actual drug use with the criteria, judgments can be made concerning use (or misuse) of drugs. They become the measure against which quality of drug use is ascertained.

Most reviews of this type are conducted in institutional settings because the methodology is best applied to well circumscribed prescriber, patient and pharmacy services. Since the development of criteria requires input from both medical officers and pharmacists, qualitative DUE studies should be multidisciplinary exercises (1,3).

4. DUE PROGRAMS

DUE activities conducted on an *ad-hoc* basis usually have limited impact on long term prescribing practices because they are often of short duration, provide minimal feedback to prescribers and infrequently include any follow-up or re-evaluation of educational or other correctional efforts. Moreover, studies which are essentially perceived as medical audit activities and which appear to be conducted in isolation from coordinated quality assurance efforts and without the authority of medical practitioners, are likely to suffer credibility and acceptance problems.

Conversely, a DUE program as defined by Brodie is (1):

> "… an authorised, structured, ongoing system for improving the quality of drug use within a health care organisation by evaluating it using predetermined standards and initiating efforts to correct patterns of drug use which are not consistent with these standards. It includes a mechanism for measuring the effectiveness of these corrective actions."

This definition remains relevant today and overcomes many of the limitations of the *ad-hoc* approach to DUE. DUE programs embody both quantitative and qualitative aspects of drug use and importantly, incorporate corrective, educational, prescriber feedback and re-evaluation components (17). This nomenclature implies an authorised, structured, combined quantitative and qualitative approach to DUE (9,13,18-22). It also provides the foundation for DUE programs mandated by the JCAH and PSRO and described under OBRA.

This is corroborated by the 1986 JCAH standards definition of DUE (15):

"... a criteria based, ongoing, planned and systematic process of monitoring and evaluating the prophylactic, empiric and therapeutic use of drugs to ensure that such uses are appropriate, safe and effective."

5. DUE - AIMS

The aims and purpose of DUE do not vary with the practice setting. DUE aims to achieve quality drug use and improve patient care. An additional benefit is that unnecessary drug use and corresponding expenditure may be reduced. Rational prescribing, supply and utilisation of drugs and pharmaceuticals are the means by which the goals will be achieved. Improvements in therapy will result from the increased use of some drugs and the decreased use of others (16,23).

The need for DUE stems from our knowledge of problems associated with drug use in our hospitals and in the community. More importantly DUE is necessary to address our lack of knowledge about where precisely in the drug use process problems are occurring. The more we know about how drugs are being used, the better we are able to determine how their use may be improved. Armed with this knowledge, corrective programs can be developed and educational efforts targeted.

5.1 Cost benefits

The primary objective of DUE is not to restrict drug use or to control the level of prescribing. Minimising unnecessary drug expenditure does not necessarily result in reductions of gross prescription expenditures. This is because in instances where patients are under- or sub-optimally treated, appropriate and necessary treatment may be more expensive than the mistreatment. Thus, expenditure reduction, although an important management consideration should not be the overriding basis for DUE programs.

Misconceptions about this issue seem to have originated from the traditional objective of utilisation review, as opposed to DUE, by third party insurance companies in America. Utilisation review was a process which studied the frequency of service and charges in order to determine the service patterns or charges raised. This *traditional view* held that the purpose of insurance was to pay bills only for legitimate prescription services incurred by the insured. It was used as a management activity focused towards apprehension of clients (doctors, patients and pharmacists) who were or were perceived to be defrauding insurance programs. Claims which did not meet the criteria determined by the fund were not paid (24).

In opposition to this traditional approach, the aims of DUE should stem from a *patient health approach* to utilisation review (25). This alternative system recognises that the traditional preoccupation with cost should not be allowed to detract from important considerations of quality. Importantly, DUE should not be accepted solely as a method of controlling costs because by restricting drug use, neither improved patient care nor lower overall costs are likely to result (26). The health care approach accepted that drug use flowed from prescribing, which in turn was the result of the incidence of disease and the rational selection of drugs needed to treat them. The net changes from well designed DUE programs are efficient use of drugs and more efficient use of drug dollars through better patient health, decreased wastage, and reduced remedial medical care. These savings may or may not be offset by savings in the utilisation of pharmaceuticals in pursuit of such care, but may be realised at other levels within the health system (27).

5.2 Educational opportunities

Another important aim of a DUE program is the establishment of an educational process to promote rational prescribing. This should be a continuous educative process, requiring the ongoing presentation of relevant drug/disease data feedback to prescribers and other professionals (28-29). Involvement of all members of the health care team is important (27,30-32).

Prescribers can be offered opportunities to improve prescribing even while their practices are being monitored. In this way the educative process can be offered concurrently with the DUE process. For example, prescribers could be advised that their prescribing will be audited and the criteria upon which assessments will be made promulgated from the outset in the hope that drug use will improve, even while it is being measured. The findings of such reviews may not be entirely reflective of actual (ie. pre-DUE prescribing habits) but if prescribing does change as a result of this facilitative approach then the DUE program will have achieved its objectives.

This philosophy was supported by Eckert *et al* when they described the Hawthorne effect as representing a potentially useful intervention tool for the modification of drug use (8,13). This principle underscores the function of DUE as an educational exercise and as a means to achieving quality use of medicines. In the ideal environment, staff should welcome vigilance over their prescribing and be receptive to constructive intervention.

6. DUE - JUSTIFICATION

There is a large body of evidence describing sub-optimal drug use in the community including Australia and the medical literature is replete with drug usage statistics and evidence of irrational prescribing (33-35). The need for DUE stems from several sources. These include the need to minimise the use of inappropriate drugs, drug over- and under-use, unclear labelling, therapeutic duplication, adverse drug reactions and drug-drug interactions (36). Also important are calls by professional, community and consumer groups for better education about drug use and demands for greater accountability for adverse drug outcomes (24).

In Australia such concerns were articulated in the late 1980's, with most interest focused on the benzodiazepine group of drugs in the elderly. These concerns provided impetus for the development of a national medicinal drug policy and other initiatives for Australia to provide the necessary framework to address the problem of the quality use of medicines (37-42).

Inappropriate drug use may be more prevalent in certain sections of the community than others. In the US it has been stated that the average nursing home patient receives from 4-7 different drugs at any one time and that between 20-40% may be administered in error (43). Australian studies of drug use in hospitals, nursing homes and the community show that even after correct diagnoses, drug treatments are prescribed incorrectly for 2 - 5% of the 160 million prescriptions written each year (44). In a comprehensive record linkage study conducted by the Western Australian Department of Health, poisoning was found to be responsible for 1.5% of hospital admissions and 1% of all deaths (45). A similar but smaller study in Victoria found that 1.6% of hospital admissions were due to poisoning. It was estimated from this study that this equates to 30,000 hospital admissions in Australia per year (46). Results reported from the US estimate that up to 1 in 7 hospital beds are occupied by patients receiving treatment for adverse drug reactions (47-48).

Morbidity and mortality from adverse drug reactions (ADRs) in hospitals are also of concern, reported in up to 20% and 0.44% of inpatients, respectively (13). Although many ADRs are not related to drug misuse these figures underlie the importance of monitoring and assessing the quality of drug use to prevent those reactions which are avoidable.

Accurate figures for the scale of economic and social costs associated with the misuse-use of medications in Australia are not available. As an example, there are estimates that up to 46% of patients prescribed antibiotics in hospital do not have infections recorded among their final diagnoses (49), although poor discharge documentation may be partly responsible for this high figure. Other studies have reported an average inappropriate drug utilisation rate of 42.7%, indicating a significant problem with drug therapy (50-51).

Patient medication compliance (or lack thereof), particularly outside of hospitals, is also a major contributor to unnecessary health costs (52). Many patients fail to have prescriptions filled and even when doctors make the right diagnosis and select the correct drug, patient compliance with the intended directions may be suspect (44,53). The social costs of non-compliance have been estimated to be between $530 - $700 million dollars each year (42). Although medication compliance is not a major issue in hospitals, DUE may assist in quantifying the impacts of non-compliance on hospital admission rates.

Another need for DUE stems from increasing expenditure on drugs within the community. For example, the Australian public spends at least $3 billion dollars on PBS and over-the-counter medication annually (54). The Commonwealth government has introduced a variety of arrangements with little effect in an attempt to stem PBS expenditure. These arrangements may be to the detriment of community health as similar policies introduced in the US were shown to have an adverse effect on health outcomes because disadvantaged socio-economic groups were dissuaded from obtaining necessary drugs (55-56). The impact of such arrangements has not been investigated in Australia (54).

Philosophically, increased drug expenditure does not represent a problem if there is evidence that this expenditure is associated with rational prescribing and demonstrable improvement in health and well being. However, the association between increased health expenditure and better health is not clear. The United States for example, spends approximately 10% of gross domestic product on health care (32) (including drugs) compared with Australia's 7.8% (114). The US however, has a higher rate of infant mortality, communicable diseases and other health problems, than Australia.

The increasing expenditure on the PBS for example, has not been associated with clear demonstrations of increased health benefits. Much of the PBS increase represents use of new drugs to reduce cardiovascular morbidity and mortality such as angiotensin converting enzyme inhibitors, calcium channel blockers, and HMG-CoA reductase inhibitors. It is too early to judge improvement in cardiovascular disease risk which can be attributed to the use of these drugs.

Negative effects associated with increased drug expenditure have however been demonstrated. For example, the other major group of drugs responsible for the increased in PBS expenditure are broad spectrum quinolone, third generation cephalosporin and carbapenem antibiotics. The widespread use of these antibiotics has resulted in the emergence of multi-resistant bacteria which have been shown to compromise health outcomes (57-58).

Table 1 ***Factors contributing to need and therefore justification for DUE in hospital settings (51) -*** *with permission*

Patient/Clinical factors:
• evidence of under- or over treatment;
• concerns about antibiotic resistance;
• concerns over adverse drug reactions and other iatrogenic disease;
• patient and clinician demands for new drugs or new uses for old drugs, which cannot be funded within operating budgets unless savings can be identified elsewhere.
Economic factors:
• need to minimise drug expenditure in the context of limited budgets and demands for new and often expensive therapy initiatives as described above;
• recognition of and a need to reduce unnecessary drug use and wastage;
• identifying opportunities for minimising direct and indirect related expenditure;
• a requirement to identify sources for funding of new drug therapy initiatives.
Pharmacy factors:
• administrative or auditors demands to demonstrate accountability for drug use;
• professional requirements to demonstrate quality assurance programs which target drug usage;
• concerns over anecdotal evidence of drug misuse for which objective documentation of the nature and extent is required before recommendations can be made to improve such use;
• concerns about drug induced illness as a contributor to prolongation of inpatient stay, admission and readmission rates;
• educational opportunities;
• achievement of compliance with accreditation guidelines relating to drug therapy (eg. Clinical Indicators);
• the need to participate in quality assurance and quality management activities;
• demonstrating cost benefit of pharmacy services;
• a desire to contribute to Quality use of Medicines (QUM) and other State or Commonwealth policy initiatives, directed at improving drug use.

These and other factors (Table 1) provide reasons for the establishment of DUE programs for hospitals. For example, DUE may improve various aspects of drug use and/or result in direct or indirect cost savings. In the closed economic environment of the hospital such savings may be redirected or used to promote other clinical services.

7. DUE - OPERATIONAL ASPECTS

The basic principles upon which a DUE program should be based were originally described by Brodie (1,3). These pronouncements were later expanded by the American Society of Hospital Pharmacists (ASHP) and culminated in the development of the ASHP guidelines (Table 2) in the early 1980's (59). These principles, their practical implementation and the settings in which they have been applied - which include hospitals, skilled nursing facilities, ambulatory care settings and community pharmacy - are well described (9,17,22,24,33,43-44,56,60,65-77). They have since been promulgated by the US JCAH[iv] (27) and legislated under OBRA[v]. (16). In 1996, similar recommendations for the establishment of DUE programs in Australian hospitals were published under the auspices of a national committee chaired by me (4). To date however, the need for DUE programs has not been legislated in Australia or adopted by Australian health care standards organisations.

iv **JCAH** - Joint Commission for Accreditation of Hospitals, US Department of Health and Welfare.

v **OBRA** - US, Omnibus Reconciliation Act, 1990

Table 2 ASHP principles for conduct of a DUE program (59)	
1.	authority for the program;
2.	adequate data bases for study;
3.	use of appropriate audit methodology in data retrieval;
4.	data analysis;
5.	education or corrective action;
6.	re-evaluation;
7.	documentation and report of activities and results.

7.1 Describing the institutional and drug profiles

7.1.1 The institutional profile

Each institution must also define its own operational and demographic characteristics and those of the population which it services. Such data will assist in explaining particular usage patterns and in determining priorities for DUE programs. Parochial factors which may influence prescribing or the range of drugs used should be understood when determining criteria and standards for drug use. For example, prescribing patterns may be influenced by prescriber age, medical specialty, hospital affiliation and place of undergraduate, graduate or continuing education; professional training programs; and formularies and other hospital drug policies. Drug utilisation patterns will also be influenced by the institutional setting (eg. private or public hospital), university affiliations; teaching and research philosophies; the nature of the range of medical services provided; the nature of patient encounters (inpatient, outpatient, day-patient) and the average length of stay; the casemix (DRG mix); and the age-sex distribution, socioeconomic status and the morbidity characteristics of the catchment area (27). Descriptions of these characteristics will provide useful base lines for comparison of the characteristics of study populations observed during later individual reviews. This profile had not been described for the RAH prior to my research.

7.1.2 The drug profile

For each institution there are rates and costs of utilisation that constitute the existing profile of drug use. The purpose of describing this profile is to quantify drug usage over a given period of time. Without this description, the impact of continuing education or of other remedial programs cannot be assessed, and judgments cannot be made on the level of care being provided.

A minimum data set should be developed for all drug groups and a more detailed profile should be developed for selected drugs (78):

- expensive drugs - high per unit cost or low cost but high volume;
- drugs with high rate of inappropriate use - from local or literature experience;
- drugs with potential for drug interactions and adverse drug reactions.

More detailed information may describe individual drugs within drug classes, costs, user groups and variances over time (79).

Drug utilisation is best expressed as doses administered rather than as dollar expenditure since measures of drug purchase or issues are too far removed from patient consumption to accurately reflect utilisation (78). In the US this facility is primarily motivated by the need to raise patient charges for drugs or to satisfy reimbursement requirements from third party insurance providers. In

Australia, without unit-dose drug distribution systems, expressing utilisation rates in terms as doses administered requires manually recording doses from medication charts. This is too labour intensive for general application. As a result, less accurate indicators are used, for example from drug issue figures (in dollars), followed by purchase and then expenditure data. The defined daily dose has been used for expression of hospital drug utilisation in some centres overseas (13) but is not used in Australia other than for reporting PBS usage data. My research in 1995 applied this method of measuring utilisation to a sample of public hospitals on a trial basis. Integral to the DUE program implemented at the RAH, the minimum data set described drug classes and costs in descending order of frequency of use or expenditure.

Table 3 Steps for constructing the existing drug utilisation profile. Adapted from (78)

1. Develop rank order of drugs and drug groups with corresponding costs for the period.
2. Select most frequently used drugs and drug groups for further analysis.
3. Develop a rank order of expensive drugs and select key drugs for further study.
4. Compile pharmacy charges (product and service) for:
   - the cost per patient stay, per patient type, per year;
   - the cost per patient day, per patient type, per year;
   - relate above to age, sex, clinic, prescriber and diagnosis.
5. Determine the percentage of inpatients who are actually prescribed or receive drugs.
6. Determine the average number of drug orders prescribed/received per patient per hospitalisation.
7. Match the amounts prescribed and the prescriber with the prescribed drugs.
8. Match diagnosis with the medical condition and the prescriber with the prescribing of selected key drugs.
9. Determine the frequency of apparent concurrent use of 2 or more drugs from the same class.
10. Determine the origins and incidence of medication errors.
11. Determine the frequency of concurrent use of drugs with potential for drug interactions or adverse drug reactions.
12. Develop rank order of drugs with potential for adverse drug reactions.
13. Develop the rank order of drugs frequently identified for inappropriate use and relate to patient types.
14. Determine adverse drug reactions.
15. Determine the incidence of drug induced illness as cause of admission.

A number of steps for the development of a drug utilisation profile for an institution (Table 3) have been described (78). In practice most are difficult to achieve except in small institutions with small patient numbers. In an institution the size of the RAH, with relatively unsophisticated information systems, the ability to achieve all of the above steps is limited. The move towards 'case-mix' funding and the increased level of detail required for inpatient records - to allocate DRGs and thence derive casemix information - will increase the ability to generate and obtain the required information. The future potential to then explore the relationships between these data bases and to draw some hypotheses which can be objectively investigated is exciting (80-81).

7.1.3 Other useful data bases

Essential to the success of a DUE program is the establishment of the scientific basis for relating drug therapy to the medical status and health outcomes of patients (82). We can speculate on the basis of anecdotal reports or from literature evidence that particular drugs are 'risky' or that certain patients are 'at-risk', but collecting objective evidence of actual widespread problems (as opposed to potential problems) is more difficult. The balance between resources required to obtain the information and the ability of such information to improve the quality of drug use has been problematic.

Historically, matching of drug use data with patient information has been performed manually and has been labour intensive but nevertheless, will be helpful in certain situations. These include determining the incidence of adverse drug reactions or drug interactions, the frequency of drug induced admissions or re-admissions, and post-operative and nosocomial infection rates.

With the increasing computerisation of pharmacy departments and of the systems of other health service providers, the ability to link drug data with other medical service data is now a reality. However, implementation of these technologies at the RAH is several years away. Automatic matching of patient, DRG, pathology and drug profile information will enhance screening processes aimed at identifying potential problem areas; improve the ability to target DUE activities to 'at-risk' patients; and enable the assessment of the effectiveness of the actions taken to correct problems that occur in a more timely fashion. The sophistication of pharmacy and other information systems together with the availability of personnel with expertise to undertake the data linkage will be the limiting factors for gathering, collating and analysing such information, particularly for large institutions. The design requirements for such information systems have been described elsewhere (83).

8. DUE - IMPLEMENTATION

The specific choice of DUE projects will be determined according to the priorities and resources available to programs. Reviews may include those for individual drugs, drug groups, the drug components of clinical procedures or management of particular disease states. Some reasons for selecting drugs or drug groups for review are listed in Table 4 and have been well described in the literature (14,19,32,43,84-85).

Priorities may be influenced by the medical literature, incident and adverse drug reaction reporting, therapeutic drug level monitoring services, clinical pharmacists, drug information service inquiries, drug purchase, expenditure or issue data (19,84-85). Some elements which may be considered in assessing drug therapy are summarised in Table 5 (27,86).

Table 4 Determinants of subjects for DUE (14,19,32,43,84-85)

Patient factors	• age; • polypharmacy; • impaired organ function; • coexistent disease.	**Cost factors**	• high unit drug cost; • high volume turnover; • high cost of monitoring; • changes in cost or expenditure trends.
Drug factors	• antibiotics; • narrow therapeutic index; • high potential for adverse drug reactions; • high risk of drug interactions; • high risk of drug - disease interactions; • new drug product or indication; • drug has narrow range of indications.	**Other; factors**	• literature evidence of misuse; • anecdotal local evidence of misuse; • inquiries to drug information centre or clinical pharmacists; • request for study by appropriate group.

Table 5 Considerations for assessing the quality of drug use (27)
1. Did the drug used match the diagnosis ?
2. Was the drug prescribed the drug of choice from available alternatives ?
3. Was drug dispensed in accordance with best packaging and labelling and distribution practice and in the correct dose form to ensure best result under clinical circumstances ?
4. Was the dosage regimen adjusted accordingly ?
5. Was the duration of therapy appropriate ?
6. Was supplemental therapy provided when indicated ?
7. Was appropriate laboratory and other monitoring performed ?
8. Were the results of the above interpreted correctly and acted upon correctly ?
9. Was concurrent use of other drugs of same pharmacological class avoided ?
10. Were drug interactions or adverse drug reactions noted ?.
11. Were expected clinical outcomes achieved ?

8.1 Norms, criteria and standards

The currently accepted nomenclature for DUE criteria was defined in 1973 by the US Professional Standards Review Organisation (PSRO) (15,87-88). A clear understanding of their application is necessary before commencing DUE.

8.1.1 Norms

Common to DUE and other utilisation review activities is calculation of the average of a series of observations. In quality assurance nomenclature, measures of central tendency (eg. means or medians) are defined as *norms*. Thus norms are *"numerical or statistical measures of usual observed performance"*. They represent actual practice in the real world; and thus describe practice as it is, but not necessarily as it should be (15,36).

8.1.2 Criteria

In contrast to norms, *criteria* are statements of "what should be". They are a descriptions of optimal performance, the "gold standard" by which norms are judged. Thus criteria are defined as *"predetermined elements of health-care, based on professional expertise, prior experience and the professional literature, with which the quality, medical necessity and appropriateness of health-care services may be compared*" (15,16). By comparing actual drug utilisation with criteria a drug process or outcome event will be described as either (89-90) :

- not meeting the criterion;
- meeting a criterion exception;
- an acceptable variation of established practice;
- a documentation variation - ie. insufficient information is available to make an assessment; (Note: this deficiency may be a structural criterion violation);
- meeting the criterion.

The criteria set in any DUE are vital to its success. They should be (86,91-92):

- predetermined
- explicit
- valid
- relevant
- practical
- measurable
- outcome orientated
- relevant to patient care

- readily obtainable
- up-to-date
- not repetitious
- scientifically based

Several criteria classification systems have been described (28,60,86,91,115). Criteria may describe one or more elements of drug use (Table 6) (23,86, 93). A comprehensive DUE may incorporate criteria for each step. Three to five criteria will usually suffice as the application of too many criteria may result in loss of focus of a study (62). Also, criteria should not be so narrowly defined that they exclude most cases which are reviewed, nor should they be so broad that they become all encompassing (65).

Table 6 Steps involved in the drug use process for which criteria and standards should be developed

1. ***Determining the need for a drug.*** Drug therapy is not always indicated, and identification of the need for a drug at all in the treatment process is an important consideration in itself.
2. ***Selecting a specific drug.*** Criteria for this step may include acceptable indications, the requirement for culture and sensitivity tests, the absence of conflicting patient conditions, allergies or interacting drugs or cost of comparable drugs.
3. ***Selecting an appropriate drug regimen.*** Criteria should describe the dosage form, strength, dosing interval and duration of therapy for each patient.
4. ***Dispensing the drug to the patient.*** Criteria should assure proper preparation and delivery of prescriptions to patients, with adequate ancillary information.
5. ***Administration and consumption.*** Criteria might describe nursing requirements assuring that the right drug is delivered to the right patient in the right dose at the right time.

Development of criteria should be a joint activity, for example, involving pharmacists and expert clinicians, and following review of the medical literature (92,94). Previously published criteria - for example, those from the American Society of Hospital Pharmacists - or peer reviewed consensus statements may be used as the basis for local criteria (95-96). At the RAH, guidelines for drug use must be submitted when a request is made for a drug to be considered for addition to the hospital formulary (97). These guidelines then form the basis of criteria for subsequent DUE studies.

Criteria can be rigid and mutually exclusive (65), requiring little if any subjectivity in their application. This may enable data acquisition to be undertaken by non-professional staff or by automated systems. Alternatively, criteria may be such that data can only be interpreted by skilled professional staff.

Both criteria approaches can be streamlined by providing a "yes" or "no" response to specific statements or questions. This facilitates data acquisition by reducing the task of data collection to simply annotating a series of 'check-boxes', which then simplifies the collation, analysis and interpretation of recorded data. The questions the review is attempting to answer are those which should appear on the data collection sheet; not the information required to determine the answer (2,18,43,65,86,89-90,98-100).

Table 7 Criterion types

CRITERION TYPE	DESCRIPTION	EXAMPLE or APPLICATION
absolute	these function as precise boundaries to practice and function as thresholds or limits; a datum either meets or fails the threshold	"...the dose of ceftriaxone did not exceed 2G daily"
relative (or statistical)	describe judgments as to where to set the boundaries of acceptance and rejection; may be established in relation to the distribution of measurements about a threshold.	"...the daily dose of captopril in patients with normal renal function was between 50-150mg"
combined	scope for individualisation, but an absolute exception for certain types of patients	"...no patient with a creatinine clearance of less than 10ml per minute should receive a captopril dose in excess of 75 mg"
pragmatic	describe what is considered clinically valid or practical	"...ceftriaxone was given as a single daily dose or as 2 divided doses"
subjective (implicit)	unstructured and exist only in the mind of the assessor.	different investigators reviewing the same data may reach different conclusions as to the nature of the service, according to their perspective and experience.
objective (explicit)	Explicitly defined	any investigator reviewing the same set of data will arrive at the same conclusion
Note: subjective and objective criteria may be used in combination with absolute, relative or pragmatic criteria.		a prescriber may decide on a particular drug from a range of equally effective alternatives, but knows not to exceed a certain dose or blood concentration for an individual
structural	are the facilities, equipment, administrative organisation and personnel characteristics involved in providing the services and products being reviewed	the elements required for development of a medication chart or the need for written procedures or treatment protocols
process	the procedures and activities which utilise these structures	"...procedures which should be performed before a decision is made to prescribe a particular drug"
outcome[vi]	the expected net results, impacts or end products of the structures and processes	include findings such as the incidence of medication errors or adverse drug reactions, post-operative infection rates as well as clinical or microbiological outcomes
screening[vii]	the few critical elements of a procedure, or service whose absence or deficiency indicates a the need for more thorough investigation of the data set or population	"...all patients undergoing colorectal surgery procedures have received antibiotic prophylaxis"

8.1.3 Standards

It is a difficult task to be purely objective and explicit with any aspect of medical care, including drug therapy. Explicit criteria will not cover all circumstances. Provision for this uncertainty is accommodated through the application of *standards* to criteria.

Standards (also referred to as *thresholds*) have been defined as *"professionally developed expres-*

vi Assigning causality to a clinical outcome is difficult because the correlation between drug administration and clinical effect is not always clear. Many non-drug factors affect patient outcome and in some cases, things go wrong even when drugs are used correctly. In addition, outcome assessments are usually made retrospectively. For hospital patients, the logistic difficulty this represents (eg. after discharge) explains why outcome measurements for inpatient populations are not well described in the DUE literature. Nevertheless, measurement of health outcomes is desirable and should be attempted where possible.

vii Screening criteria may also be used to identify 'at-risk' patients or drugs or perhaps dose ranges or frequency of administration. They may be applied by non-professional staff or computerised systems. The dimensions and scaling of the criteria and standards determine the fineness of the screen. Review of cases meeting criteria should also be undertaken as a check for validity of the screen.

sions of the range of acceptable variation from a norm or criterion" (15). Standards should be based on data from clinical trials or review articles and should describe exceptions under which divergence from criteria is acceptable. If a standard is not met then a focused evaluation of the problem may be warranted (20,84). Internal standards - developed to satisfy the practices of a particular institution - combined with uniform criteria used by a number of institutions, can facilitate inter-hospital comparisons (92).

8.2 DUE Methodology

8.2.1 The timetable

The overall time frame for a DUE study will depend on the type, scope and complexity of the review. A comprehensive qualitative review can be performed by one reviewer in about 8-10 weeks depending on the speed of patient recruitment. This allows for literature review and criteria development, development and field testing of the data collection instruments, data collection, data collation, analysis and report writing. It may be possible to undertake several reviews concurrently, particularly if a mix of quantitative, simple qualitative and a more comprehensive DUEs can be well coordinated and a number of reviewers are available.

8.2.2 Timing

Assessments of drug use may be conducted *retrospectively, concurrently* or *prospectively.* Retrospective review is conducted after the course of therapy has been completed, usually well after the patient has been discharged. Concurrent review is conducted while the patient is receiving therapy, usually within the first 48-72 hours. This is typically an active process to recommend alterations to therapy which are found to be inappropriate or unnecessary. Prospective review evaluates drug therapy before it commences, that is before the patient receives the first dose of the drug.

8.2.2.1 Retrospective review

Retrospective review is the most common timing used for DUE because (9,57,90,101-102):

- it is the easiest to implement;
- it can be planned to cause the least disruption to other activities;
- patient records can be reviewed at a time most convenient to the reviewer;
- it poses the least threatening environment to prescribers.

Retrospective review has a historic focus and thus is of no immediate benefit to the patients reviewed. However, retrospective reviews can determine problematic utilisation and result in strategies to improve prescribing for future patients (22,101).

Traditionally, retrospective review targeted primary medical insurance coverage and charge parameters, emphasising cost-containment and the detection of gross abuses by care providers. More advanced systems, assessed 'quantity' standards of dosage, amount supplied and therapeutic class (102-103). Retrospective review is also used to establish base line data for concurrent or prospective reviews and to facilitate comparisons within or between hospitals (22-93).

Retrospective review is now mandated under OBRA in the US. This requires intermittent examination of drug claims to identify drug use patterns, problems relating to under- or over-use or therapeutic effectiveness in the community setting (22). Physicians and pharmacists are then targeted for intervention through written or electronic 'reminders' containing patient or drug specific informa-

tion, including suggestions for changes to prescribing or dispensing (16). The effectiveness of program interventions remain unsubstantiated (9). No similar formal program is mandated by Australian regulatory authorities.

The greatest limitation of retrospective review is that data acquisition relies on the quality of information documented in the patient record, which is often illegible, incomplete or difficult to interpret. Some programs address this by performing assessments a few days or weeks following patient discharge and rapidly communicating with prescribers about questionable prescribing, still leaving time to alter maintenance treatments when necessary (63,99).

8.2.2.2 Concurrent and prospective review

Concurrent and prospective review provide the opportunity for education and intervention during the course of a patient's drug therapy. Review criteria may include drug choice, dose form and regimen as well as the appropriate ordering and response to results of laboratory tests, or adverse drug reactions. The 'real-time' monitoring associated with *concurrent* review:

- can minimise preventable adverse effects;
- reduce unnecessary drug and related expenditure;
- facilitate prescriber, pharmacist, nursing and patient education; and
- demonstrate cost savings.

However, since interventions associated with concurrent review may not occur until several drug doses have been administered to the patient, some inappropriate drug use may still occur. The objective is to prevent future occurrences through intervention and education.

The advantage of *prospective* DUE over other methods is that sub-optimum drug use can be corrected before drugs are administered to the patient. This has more immediate patient and cost benefits, and prevents drug misuse. Similar criteria to those described for concurrent review can be applied. When the order satisfies the criteria, it may be forwarded for processing and supply. If the order fails the screen, appropriate actions should be instigated.

Concurrent and prospective review are labour intensive and more disruptive to daily activities than retrospective reviews. To be effective, the evaluators require immediate access to the prescriber and patient clinical data. In addition the reviewers must have a good background therapeutics knowledge to be able to quickly and effectively assess the therapy request. Good personal communication skills are also required and personnel must be willing and able to endure the occasional confrontation with doctors over aspects of drug therapy (23).

Prospective review should not be undertaken lightly. It should be reserved for drugs which have a narrow therapeutic index, are expensive, which require special administration or preparation, are effective for only a narrow range of indications or which require specialist knowledge for their use or monitoring (33,93).A concern of prospective DUE is that patient care will be interrupted while therapy review takes place, particularly if requests occur after hours. This can be avoided with careful planning. For example, criteria which describe the indication for use, dosage regimen, exceptions, contraindications and patient monitoring procedures, should be readily available to reviewers and senior clinical staff who may be needed for consultation should be clearly identified.

In the US, OBRA statutes require that prospective DUE programs be established in community and

hospital settings and that review of each prescription filled or delivered to a Medicaid patient at the point of sale or distribution be performed. The guidelines require prescriptions to be screened for therapeutic duplication, drug-disease contraindications, drug-drug interactions, incorrect dosage or duration of treatment, drug-allergy interactions and clinical abuse or misuse (16).

8.3 Scope of reviews

Individual DUE studies can be undertaken as screening, modular or comprehensive review projects. *Screening* projects usually involve the cursory review by manual, semi-automated or fully computerised methods of prescriptions or orders to determine compliance with one or two specific criteria. These might include the prescription of a particular drug, dose form, dose, dose schedule or duration of therapy. Screens may operate with positive or negative intent. Positive screens eliminate orders which meet the review criteria and which describe positive or acceptable practice. Negative screens identify orders which meet negative or screening criteria defining unacceptable events. Drug orders may be screened by non-professional staff or by automated systems to identify orders which require review by skilled professional staff. This method is the most resource efficient and results in the least implementation cost of all the methods described (28,65).

Modular reviews assess one or two major components of the use of a particular drug. This allows detailed review of a specific aspect of use without having to collect information on all aspects of drug utilisation. Correspondingly the number of criteria required and the cost of the review is minimised when compared with a more detailed study. For example, a review of gentamicin might specifically focus on drug concentration monitoring processes rather than aspects relating to indication for use, the dose or method of administration.

Comprehensive or expansive reviews assess all elements of the drug use process, from determining the need for a drug through to patient administration and assessment of effect. These reviews require a large number of criteria to be developed, and generally require effort for data acquisition, analysis and reporting.

8.4 Sampling

Assessing the therapy of every patient during a review is not always desirable or feasible. Also, the expense may be prohibitive. Appropriate sampling methodology should be determined before commencing reviews and will be dependent on the individual circumstances of the review and the drug or drug group chosen for the study (23).

Complete sampling (also called total patient sampling or census based review) involves every patient prescribed a particular agent, for example, when drugs have limited use. This approach gives the best indication of prescribing practices because it reviews all patients receiving a particular drug.

For drugs which are widely used it will not be possible to review all treatment courses. For these reviews, systematic or random sampling may be used. A different approach is a '*snapshot*' (also called 'cross sectional') sampling process, for example, the selection of all patients receiving gentamicin for the month of November. Another approach might be to select one ward each day for review and screen prescriptions for the drug under study; different wards may be selected on different days to provide a progressive, cumulative and representative picture of drug prescribing over a fixed period.

Data collection may also be *selective* or *targeted*. This approach may be used where a particular drug or procedure is of interest; for example, the use of warfarin or surgical antibiotic prophylaxis. The patient groups in this example could be further defined by targeting only patients anticoagulated for valvular heart disease or having antibiotic prophylaxis for colorectal procedures. A disease or procedure may be targeted instead of a drug itself; for example, the treatment of pneumonia or the impact of blood culture results on antibiotic prescribing. By targeting the procedure or diagnostic group, it is possible to observe overall trends in prescribing which might go unnoticed if only the drug thought to be used for that procedure was targeted.

8.5 Corrective strategies

An appropriate plan of corrective actions is mandatory to the success of a DUE program. When inappropriate drug use is found, the reviewers must make recommendations to the body responsible for the program on how to correct problems. The nature of remedial strategies will be dictated by the deficiencies detected by the reviews (67). Since the factors influencing prescribing decisions are multifactorial, so will be the strategies to combat poor prescribing and drug misuse (13). The actions should be kept simple and directed at one or more specific and correctable problems (23). Interventions which are not precisely targeted show little effect when compared with interventions which focus on individual prescribers or practices (8,13).

Various methods have been identified (Table 8). A combination of methods will probably be required for best effect (8-9,20,33,104-106). Corrective strategies should be:

- acceptable to the hospital and prescribers;
- cost efficient in implementation;
- specific in impact for both drugs and prescribers;
- provide educational benefits for staff, and
- should be broadly applicable and transportable to other settings.

Published studies describing the results of successful interventions should be regarded cautiously. Many studies contain methodological and statistical flaws and lack controlled populations for proper assessment of the effectiveness of the corrective actions (50).

The success of strategies will depend on the features of the hospital concerned, a supportive medical and hospital administration, an ameliorative environment, and the availability and commitment of staff and other resources. Clinical pharmacists, clinical pharmacologists and clinical microbiologists have been most frequently recruited to assist with educational efforts (33).

Corrective actions should be outcome focused and be designed to promote rational prescribing and improve patient care. They should not embarrass, intimidate or castigate. Measures which offer the opportunity for modification of therapy based on availability of unbiased information are preferred. Communication may be accomplished 'face-to-face', by telephone or in writing (eg. letters or reports of results) and should be conciliatory, constructive and educational. Prescriber feedback may be provided as a summary of study findings, comparisons of the prescriber's pattern with that of other users, advice about a particular patient or problem, advice on alternative treatments, or as educational materials including therapeutic guidelines. A reasonable time should be allowed for changes to occur, except in situations where the patient may be at risk (8,13,33).

Table 8 Remedial strategies for improving prescribing and drug utilisation	
1. Education	• clinical meetings, seminars, conferences; • drug committee or pharmacy newsletters/bulletins; • reports, summaries, memoranda; • letters to prescribers, or heads of departments; • formulary, guidelines, protocols; • prescriber feedback; • academic detailing; • clinical literature.
2. Drug restriction	• removal of drug from formulary or inventory; • formulary controls; • prescriber restrictions; • required consultation before prescribing; • automatic stop orders.
3. System changes	• additional personnel - eg. pharmacists, pharmacologists, • microbiologists; • additional plant and equipment - eg. computers; • revision/updating of criteria, policies, procedures, protocols; • implement new services - eg. TDM, antibiotic monitoring; • alteration of reporting systems - eg. antibiotic susceptibility test results.
4. Interventions	• prospective or concurrent drug monitoring programs; • clinical pharmacists, clinical pharmacologists; • required peer or expert consultations; • administrative action.

8.6 Documentation

8.6.1 Documentation of DUE study results

Education or feedback programs are an essential component of DUE programs; improvement in prescribing will not occur if users are not presented with objective evidence of what they are doing wrong and with recommendations for acceptable drug use. Feedback should not only be reserved for advising prescribers of drug misuse; it should also be used when practices are found to be favourable.

Documenting the results of individual DUE activities is therefore an important task. The most efficient way of completing this exercise is simply to write-up activities in report form as they are completed and store them in some form of compendium or filing system. Copies of approved criteria and standards, data collection sheets, memoranda and correspondence, tabulated data and reports, committee minutes and corrective action plans should also be kept on file (23). The preferred format would be one similar to a research publication, describing the study background, aims and hypothesis, patients and methods, results, discussion and conclusions. The report may conclude that drug utilisation is acceptable, or include recommendations for corrective actions and plans for further study. Dissemination of study results may take the form of summaries to the drug committee or hospital administration or to the medical service under review. They may also be circulated as administrative memorandum, communicated as therapeutic guidelines and treatment protocols, presented at clinical and other meetings or incorporated as guidelines into hospital formularies. Articles

may also be prepared for drug committee bulletins or other hospital publications, or for publication in scientific journals.

8.6.2 Program documentation

An important principle of all quality assurance programs is that results of activities are documented for future reference (84). This is no less important for DUE programs as it is for DUE individual studies. Procedure manuals should be developed which describe the program for a particular institution (Table 9).

Table 9 Proposed structure of DUE resource manual

1. Program overview - including lines of authority and reporting relationships.
2. Definitions of DUE.
3. Program goals and objectives.
4. Program framework and hierarchy.
5. Sample review questions.
6. Description of data elements and data sources.
7. Description of methods used for development of criteria.
8. Time frames for assessment.
9. Example data collection sheets.
10. Methods for data analysis and reporting.
11. Description of educational programs and other corrective actions.
12. Description of human, computing and other resource requirements.

8.7 Program evaluation

Evaluation of the effectiveness of DUE studies or the DUE program after corrective actions have been implemented will provide information on the process itself, the impact of the review on drug utilisation rates and of the cost of review against benefits achieved. Short and long-term effects should be measured and hospital as well as department and individual performances reported. All interventions and intervention methods should be tested for effectiveness, for positive or negative effects on clinical or other outcomes, and for duration of effect (9,13,23,67,107-108). Assessment may be based on:

- changes in utilisation, for example, rate and cost data or DDDs;
- changes in apparent quality of patient care as evidenced by alterations in adverse drug reactions;
- changes in cost of patient care as evidenced by drug inventory, patient or third party expenditure for drugs or DRGs, and
- changes in attitudes of prescribers, nurses and administrators towards the program.

Continual or intermittent *macro* review of pharmacy purchase or issue patterns may be sufficient to detect positive or negative changes in drug utilisation. In some cases comprehensive reviews to properly assess continued compliance with criteria and standards will be required.

Threshold or exception analysis may be applied. Any increase in purchases or issues over time which approach or exceed the threshold will be indicative of increasing use and signal a need for some action. Thresholds should be set low enough to signal that action is required before the need

becomes urgent. Actions include identification and discussion of the increased use with prescribers, reiteration or reinforcement of the corrective action, or further detailed study.

Exception analysis applies similar principles. Tests can be applied to reports which describe monthly, annual or year-to-date variances in drug utilisation. When items demonstrate movements outside certain predetermined limits, (that is they are *exceptions* to the limits), then they may draw further scrutiny. Dollar threshold, or dollar or percentage variances may be used to identify changes at which consideration should be given to further study. The use of percentage threshold is of particular use in situations where expenditure for a drug or drug group is relatively small.

8.8 Cost-benefit of DUE

Considerable thought and planning should occur before embarking on DUE programs if demonstration of their cost-effectiveness will be required. If program effectiveness assessment is to be based on these or other categories, then baseline profile data must be obtained against which program outcomes may be judged. The fiscal impact of DUE *per se* may be positive or negative. Neither of these outcomes are interpretable indicators of the net benefit (or loss) of the program in the absence of information regarding net changes in the overall health status of the population concerned. A comprehensive analysis of the fiscal impact of DUE should include an analysis of total health-care expenditure, since improvements in health should be linked to decreases in other types of health service utilisation. Thus, the cost effectiveness of drug utilisation should be measured in terms other than cost savings to the drug budget. The overall impact of the program on the institutions operating costs should be included (28). This may mean reviewing the impact of the program on reducing the length of hospital stay, nursing time, investigations and monitoring procedures, and reduction in adverse drug reactions or drug induced hospital admissions. In practice such opportunities prove difficult to quantify, let alone assign primary causality exclusively to improved drug utilisation.

8.9 The Role of the Pharmacist

Table 10 Opportunities for pharmacists in DUE and DUE programs (1,19,59,105)

1. Preparation of submissions for program justification.
2. Program development, supervision and coordination.
3. Education of hospital staff about DUE in conceptual and practical terms.
4. Recommendation and promotion of the goals and objectives of DUE.
5. Development/review of audit criteria, guidelines, study protocols and other educational material.
6. Development of data collection instruments, field testing, data collection, analysis and report writing.
7. Documentation of program outcome, effectiveness and cost benefit.
8. Prospective/concurrent monitoring of drug usage.
9. Participating as a member of hospital committees concerned with quality assurance in general and DUE in particular.
10. Presentation of DUE results at meetings and conferences.

Drugs play an integral role in patient management and pharmacists play a central role in their distribution and utilisation. It behoves pharmacists to understand and participate in quality assurance and DUE programs if they are to contribute to the continual and increasing emphasis on patient care evaluation processes (109). A comprehensive DUE program coordinated through a network of motivated pharmacists, in association with prescribers, pharmacologists and other stake-holders, will provide patient benefits, prescriber education, documentation of outcomes and an opportunity for

development of a pharmacy practice research program (Table 10). These will all have demonstrable cost and/or efficiency benefits.

The required attributes for a DUE personnel have been described by various authors and include (85,105):

- an extensive clinical and therapeutic drug knowledge base;
- literature retrieval and interpretation skills;
- excellent verbal and written communication skills;
- good interpersonal, committee and management skills;
- computer skills;
- self-motivation and initiative;
- assertiveness;
- comfortable in confrontation situations.

Pharmacists are well qualified to undertake this role. Pharmacist vigilance over quality use of medicines provides benefits for both the patient and the hospital. This applies particularly to concurrent or prospective activities. These are best performed at the bedside but can also be undertaken remotely. For example, the use of unit dose or individual patient supply drug distribution systems in association with computerised ordering and dispensing, may offer the ability to review current or even past patient drug profiles and intervene as necessary, from the dispensary (13). Computerised screening for dose, therapeutic duplicates or drug-drug interactions may enable pharmacists to concentrate on examining in more detail prescriptions which fall outside screening thresholds rather than necessarily scrutinise each prescription or drug order (13).

Thus, DUE simply represents a structured approach to what is currently defined as the practice of clinical pharmacy[viii]. Formalised DUE programs therefore present a useful avenue for initiating or expanding clinical pharmacy services. Clinical pharmacists who review patient medication profiles on a regular basis using subjective (implicit) criteria, are really performing concurrent or prospective DUE. If these activities were modified to utilise explicit criteria and to document the findings and results of interventions, they would become the basis of a formal DUE program (84,110-111). The results of these activities would be easily documented and provide substantiation of the clinical and cost benefit of clinical pharmacy services (24,31,61,85,112).

DUE programs also integrate clinical pharmacy practice with the present health service management objectives of cost minimisation, quality assurance and improved service efficiency. Responsibility for financial management is being increasingly decentralised with health services becoming more patient focused and team approaches to patient management becoming commonplace (44,54,113). Clinical managers are becoming increasingly receptive to strategies which minimise unnecessary expenditure and/or encourage more efficient use of limited resources.

viii The application by pharmacists in the clinical setting of accepted scientific, pharmacological, pharmacokinetic and therapeutic knowledge, principles and information for the optimal management of patient drug therapy.

9. SUMMARY

DUE was first described in the US in 1968. Conceptually, DUE is a quality assurance activity for drug therapy. It describes the application of quantitative and/or qualitative methods to determine both the pattern and quality of drug use. Operationally, it involves the evaluation of the nature and pattern of drug use. This is most easily done in an institutional setting. In practical terms this involves establishing criteria which describe the optimum use of drugs, comparison of actual use with these criteria, identification of problem practices, formulation and implementation of recommendations to remedy such practices and finally evaluation of the effectiveness of corrective actions. DUE combines quantitative and/or qualitative reviews of drug use and ranges in scope from cursory screening activities to expansive reviews of drug therapy. Studies may be retrospective, concurrent or prospective and may be conducted as isolated reviews or as part of a formal DUE program.

DUE is a multidisciplinary activity, with an educational focus. The key players in program implementation are medical practitioners and pharmacists. The need for DUE stems from the adverse outcomes of drug misuse and the need to identify at which points in the drug use process problems are occurring. DUE aims to improve patient care by promoting rational, safe and economic drug therapy. In so doing, unnecessary or inappropriate drug use and their associated cost are minimised.

10. AIM/HYPOTHESIS

It is clear from the foregoing that literature on the implementation or effectiveness of DUE programs in Australian hospitals is lacking. In addition, although there are good drug utilisation statistics for PBS and private prescriptions in Australia, there are few data for the public hospital system. Therefore, my research project and this thesis had 2 main aims:

1. to describe the implementation of a DUE program in an Australian hospital setting, principally the Royal Adelaide Hospital (RAH).
2. to research the feasibility of collecting quantitative drug utilisation data from Australian public hospitals in an effort to provide baseline data from which to commence national DUE activities.

My hypothesis was that DUE was an effective tool for measuring the pattern and quality of drug use in a hospital environment and for promoting the quality use of medicines in that setting.

The research commenced in 1988 and was undertaken in part during an appointment as project pharmacist to the Royal Adelaide Hospital Drug Committee.

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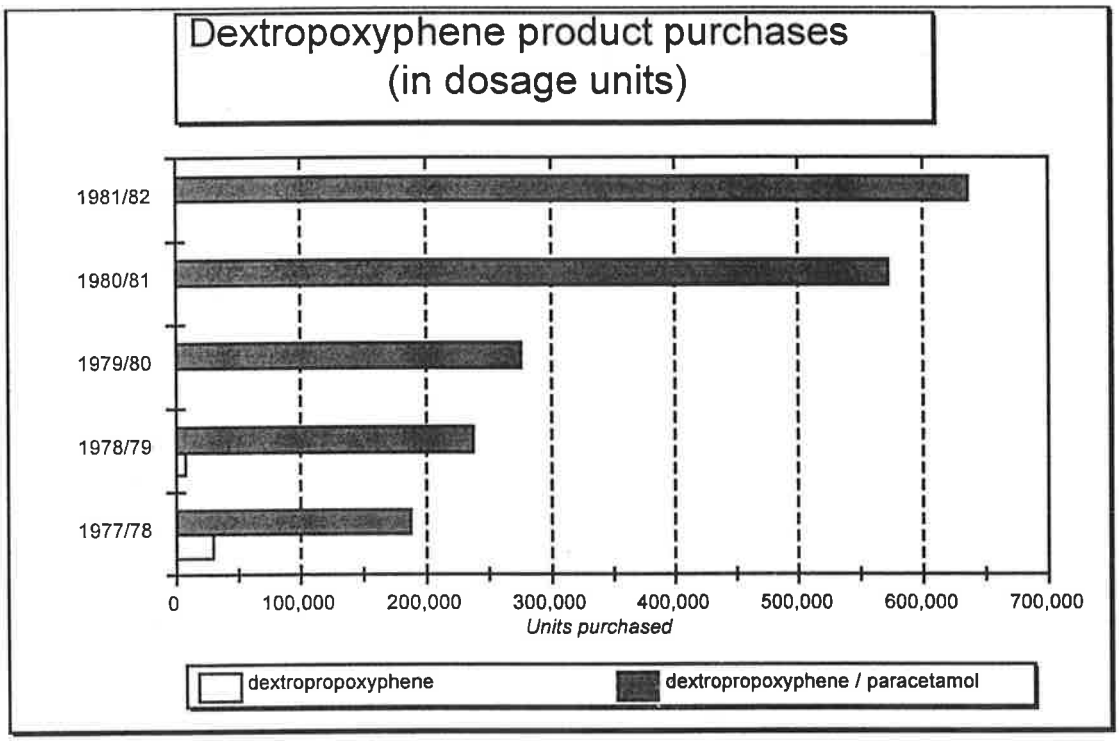
CHAPTER 3

EVOLUTION OF THE RAH DUE PROGRAM

Intermittent quantitative and qualitative DUE studies were conducted at the RAH during the early 1980's. These early reviews were undertaken by persons[i] other than myself. They provided early experience in DUE methods and assisted the Drug Committee in determining the need for a more formal program of review.

1. HISTORY AND RESULTS OF PRELIMINARY STUDIES

1.1 Dextropropoxyphene



Graph 1 Graph of dextropropoxyphene product usage.

A review of purchases and issues of dextropropoxyphene preparations was undertaken in 1982. The review was prompted by concern over a 234% increase in usage of the combination product over 5 years (Graph 1). A one month, quantitative review of inpatient and outpatient use of a dextropropoxyphene only preparation (Doloxene™) and a combination product containing dextropropoxyphene with paracetamol (Capadex™), was performed. The survey demonstrated that inpatient prescriptions accounted for 36.3%, discharge prescriptions for 22.5% and outpatient prescriptions for 41.2%. The clinics with the highest use were cardiothoracic surgery (inpatient and discharge prescriptions), and rheumatology (outpatient prescriptions). The information was presented to the Drug Committee and the user groups in the hope that usage would be curtailed. Some reductions

[i] Members of the Pharmacy Department, Royal Adelaide Hospital

were noted shortly after the review was completed. However, usage soon reverted to pre-review levels. This demonstrated the need for ongoing monitoring of usage patterns.

1.2 Ophthalmic preparations

An extensive review of purchases of ophthalmic agents from 1979/80 to 1981/82 was undertaken in 1983. The Drug Committee noted an 81% increase in purchases of this class of drugs over the period. Price increases accounted for only 10% of this growth. A review of individual items within the ophthalmic group[ii] attributed increases principally to prescribing of new products (eg dipivefrine eye drops for glaucoma; $4.67 compared with phenylephrine eye drops, $1.07 (average cost)) and a trend to prescribing more expensive products in preference to older, cheaper agents (eg Liquifilm Tears™ (Polvinyl alcohol; $1.59) eye drops instead of hypromellose eye drops ($0.55). The Ophthalmology Department was interested in the information provided but felt the figures provided did not indicate inappropriate or unnecessary usage. No changes in practice resulted.

Of interest from this example is the difficulty in effecting change in prescribing practices without objective qualitative data indicating inappropriate drug utilisation. The development of criteria delineating appropriate use is problematic. For example, except in instances where individual patients exhibit intolerance of a particular ocular lubricant, there would seem little justification to support the routine use of Liquifilm Tears™ over hypromellose eye drops. However, there are few supporting data to indicate the relative efficacy or differences between the two preparations. Without such evidence, product selection or assessment of appropriateness becomes subjective and one of personal preference.

To properly resolve such matters would require a randomised controlled clinical trial. However, the cost and overall impact on clinical management in this instance, prevents this. Thus the only option open to the Drug Committee would have been to delete one product from the Formulary on the basis of cost. In 1983, the fiscal, administrative and ethical atmosphere which prevailed would not have tolerated the Drug Committee forcing this issue. Accusations of bureaucratic interference with the prescribing rights of doctors and compromise of the doctor-patient contract would have resulted. The result was to maintain the status quo and retain both products.

This case exemplifies some of the difficulties faced by the Drug Committee and the DUE pharmacist over such matters. Effecting change for even minor issues was sometimes difficult. We quickly learned that promoting rational therapy was not simply a matter of considering and promoting scientific evidence. A range of other factors including clinical ego, power brokering and internal politics also had to be considered.

1.3 Doxorubicin

Two reviews of the anthracycline antibiotic doxorubicin were conducted in the period before 1988. Doxorubicin satisfied many of the characteristics required for a DUE study:

- it had a narrow therapeutic index[iii] and was associated with significant morbidity;
- misadventure was associated with potential mortality;

[ii] see Appendix 1., Section 52:00 Eye Preparations

[iii] ECG changes including non-specific ST-T wave changes, sinus tachycardia, premature atrial and ventricular contractions, low voltage QRS complex; dose and schedule related congestive cardiomyopathy

- it had high unit cost (in 1984, expenditure for doxorubicin was more than for any other drug at the hospital.)

A protocol was developed for both studies which described background information, patient selection and study methods, anticipated patient numbers, drug audit criteria, and a sample data collection sheet. A preliminary study was conducted during a six week period in 1984 and a second review was conducted in 1986.

Concerns determined from the initial review were that liver function tests were not available for up to 40% of patients who had received doxorubicin for the first time. In 74% of patients, gated blood pool studies to assess left ventricular function were not performed according to drug audit criteria. In up to 30% of patients, no effort was made to assess the efficacy and thus the risk-benefit ratio. The study did find that all patients had pretreatment blood examinations performed and that treatment flow charts were used in the majority of patients.

The second review involved a survey of 100 occasions of doxorubicin administration over a two month period. Drug usage was reviewed to assess compliance with the following criteria: indication for use, pretreatment liver function tests, assessment of cardiac function, appropriate dosage adjustment, re-assessment of treatment response, use of treatment flow charts. The indications for doxorubicin usage in all cases was found to be appropriate. Compared with the initial review, 80% of patients had pretreatment liver function tests performed. Only small numbers of patients had adequate pre- and posttreatment cardiac assessment and a recommendation was made for all future patients to have baseline ECG. The ECG was to be repeated at a cumulative dose of 400-500 mg/m^2 BSA (body surface area). Similarly it was recommended that all patients have base line testing of left ventricular ejection fraction and that studies be repeated depending on base line findings. Clinicians were encouraged to clearly define and document expected response criteria and continue to make use of flow charts in the management and follow-up of patients administered cytotoxic chemotherapy. To date there has been no further follow-up of these recommendations. In fairness however, it should also be stated that no gross evidence of problem use has been described.

1.4 Other reviews

Several other quantitative reviews were undertaken and referred to relevant clinical experts in the hope that some rationalisation of the range of agents available on the Formulary may occur. These included the use of alginic acid preparations (Gaviscon™, Meracote™) for non-ulcer dyspepsia and oesophagitis. In this case Meracote, a preparation combining alginic acid and aluminum hydroxide, was deleted from the Formulary in favour of the Gaviscon preparation. The cost savings achieved were minimal.

Comments were also sought on the range of hospital vitamin preparations. Of the 22 different single and multivitamin preparations available the review resulted in the removal of 3 items (riboflavin, menaphthone and dihydrotachysterol). The usage of these items had been progressively decreasing over time and deletion from the Formulary had minimal clinical or cost impact.

An attempt was made to interest the Department of Otorhinolaryngology in rationalising the range of Ear, Nose and Throat (ENT) preparations on the Formulary. This resulted in Waxsol™, an agent used to assist in the removal of wax from the ears, being offered as the token 'sacrificial lamb' - from a 'flock' of over 90 different ENT drug products - to the Drug Committee.

2. A DUE LIGHT AT THE END OF THE TUNNEL

In summary, the Royal Adelaide Hospital Pharmacy and Drug Committee had attempted a non-coordinated program of quantitative drug utilisation review. The results were limited by lack of qualitative data, and poor appreciation or understanding of the intent of the program. Outside a small and dedicated group within the pharmacy and Drug Committee there was little support for the concept from hospital clinicians. In addition, there was a general distrust of any quality assurance activity within the hospital, let alone one which questioned the prescribing by doctors. The program also suffered from lack of administration support and therefore authority to implement corrective actions. Human and other resources were limited.

The experiences culminated in 1984 with the preparation and circulation of a draft document outlining the nature and structure of a possible drug utilisation review program for the hospital. Specifically the document defined the objectives of DUE as a quality assurance program for drug therapy. Authority for the program would rest with the medical staff and its basic elements were to:

1. identify important or potential problems;
2. determine priorities for investigating and resolving problems;
3. objectively assess the cause (s) and scope of problems using clinically valid criteria;
4. plan and implement actions to correct and eliminate problems;
5. monitor problem resolution and effectiveness.

The corrective actions proposed included education, restriction, system changes and prospective intervention. Importantly, the proposal described the need for specific human and other resources to properly implement and sustain the program. As described in Chapter 2, these elements mirror those described by Brodie, Knapp, Stolar and other pioneers of the DUE concept.

The Drug Committee sought comments from senior clinicians concerning the implementation of such program. The document was reviewed by the hospital's Post Graduate Education and Peer Review Committee and was given general, 'in principle', support. This Committee believed that such studies were an important aspect of peer review within a teaching hospital and recognised the potential implications for cost containment. The Committee was strongly in favour of a DUE program forming part of the hospital's overall quality assurance activities but was not able to provide tangible financial support, practical assistance or authority for the program. From that time until late-1987 the idea of establishing a DUE program for the hospital remained firmly on the agenda of the Drug Committee and Pharmacy. In late 1987, the idea became reality.

3. PROJECT PHARMACIST, DRUG COMMITTEE

In October 1987, following a joint submission by the Hospital Drug Committee and Pharmacy Department, a senior pharmacist[iv] was seconded from the Pharmacy to the newly created position of Project Pharmacist, Drug Committee. The support of the RAH administration for this position followed advice from the Drug Committee that administrative mechanisms to contain drug costs had been exhausted. Further, neither the Drug Committee nor the Pharmacy had the resources to develop and implement a comprehensive DUE policy, which both local and overseas experience had demon-

[iv] Gary Misan, the author of this thesis, was the pharmacist seconded from the Pharmacy.

strated was an effective method for improving prescribing standards and curtailing drug expenditure.

The project pharmacist was responsible to the Chairman of the Drug Committee. His principal function was to plan and implement a DUE program at the RAH. Other duties included administrative functions associated with the Drug Committee and allied sub-committees, monitoring of Formulary control procedures and editing of the Pharmacy/Drug Committee bulletin. Funding for the position was made available from the hospital drug budget. A 3 year appointment subject to annual review was established. Continuity of tenure was subject to the demonstration of savings on drug expenditure at least equivalent to the Project Officer's salary.

The DUE program was conducted under the authority of the RAH Drug Committee. A DUE subcommittee was established to direct and review the Project Pharmacist's activities. The DUE program was modelled on similar work described in the medical and pharmacy literature. The scope and implementation of the RAH program was necessarily modified to accommodate differences between the Australian and overseas health systems and the more limited computer resources of the RAH. Desktop computer systems were developed by the author to enable the rapid review of pharmacy purchase patterns, the analysis of financial information for Drug Committee reporting purposes and for the performance and evaluation of individual DUE projects.

4. DUE PROGRAM STRUCTURE

The program has a 3 tiered structure commencing with routine quantitative reviews of rate, cost and expenditure data. The second level includes determination of user groups and review of usage patterns. The third level incorporates qualitative studies of drug use. DUE methodology has been applied to drugs alone, to drug management of particular disease states and to the drug aspects of medical procedures. Projects have included retrospective, concurrent and prospective reviews. They have ranged in complexity from simple reviews of one aspect of drug use to comprehensive studies of every aspect of the use of a particular drug. This may include evaluation of clinical, biochemical, microbiological data as well as details of drug dosage, schedule and monitoring parameters. Structure, process and outcome indicators have been studied.

Audit criteria are reviewed by relevant experts before reviews are undertaken to ensure that criteria are practical, relevant, reproducible and clinically valid. In most cases, collected data are also reviewed by a clinician before final assessments of appropriateness are made. This not only ensures that a medical perspective is applied to data but also maintains program credibility and increases overall clinician acceptance of DUE results. DUE findings are reported to the Drug Committee and published in the Pharmacy/Drug Committee bulletin or as Medical Director's Memoranda.

5. HUMAN RESOURCES

In addition to the Project Pharmacist, DUE projects have involved clinical pharmacists, pharmacy trainees, medical students and medical practitioners. The author was successful in attracting external funding[v] for a part-time research officer which enabled a concentration of effort on some of the

[v] 1990 - Rousell Uclaf Australia Pty. Ltd. donated $13,000 to assist in purchase of a new 386SX and printer and for support of a part-time research assistant for the author. For the period 1991-1993 - Roche Australia Pty. Ltd. donated $5,000 per year to assist with continuing salary costs for the research assistant.

more recently marketed antibiotics. Over 25 drugs, drug groups or procedures have been evaluated over the period including antibiotics, antiemetics, intravenous fluids, sustained release morphine, anti-ulcer drugs, anaesthetic agents, laxatives and mouth-care preparations.

The DUE program has also become a useful basis for teaching and development of basic research skills for graduate and undergraduate students. Graduate pharmacists and medical students have conducted DUEs as research electives under the supervision of the author[vi]. The aim of the research project was to encourage students to develop skills in independent learning, inquiry, observation, analysis and application of research methods. Projects were undertaken in one term of the 4th year of medical undergraduate training; 5 afternoons per week for 12 weeks. Under the direction of a supervisor, students were required to conduct literature surveys, plan, describe and prepare the research proposal, undertake data collection and analysis, interpret results, prepare a written report and present a seminar. Students worked singly or in pairs. I personally designed, directed and supervised 11 research projects for 14 medical students, as part of this program.

Projects were drawn from the hospital's drug usage evaluation program and included reviews of acyclovir, metronidazole, aminoglycosides, laxatives, Augmentin™, antiemetics, blood cultures, community acquired pneumonia, intravenous fluids, sustained release morphine, and ceftriaxone. Project results contributed to formulation of hospital drug policy. The projects have provided valuable, clinically relevant research experience for students and an opportunity to study practical aspects of drug therapy. They have improved the pharmacy-medical interface and fostered an understanding of the role and resources of the pharmacy department and of the pharmacists contribution to patient care. They have also demonstrated the ability of pharmacists to contribute positively to undergraduate medical education.

Overall, the DUE program has achieved the support of both senior clinicians and hospital administrators. This is exemplified by general cooperation of hospital medical staff with the recommendations of the Drug Committee following the results of various DUEs and the recent conversion of the Project Pharmacist from a temporary position to one of permanent tenure.

6. SUMMARY

DUE at the RAH dates back to the early 1980's during which a number of 'ad-hoc' reviews were undertaken by the Pharmacy in association with the Drug Committee. These included qualitative reviews of doxorubicin and quantitative reviews of dextropropoxyphene, opthalmic preparations, alginic acid preparations, multivitamins and ENT preparations. The impact of these activities was limited. Administrative support, staff and other were also restricted.

In 1987 approval was given to implement an authorised DUE program with a full time project pharmacist. The pharmacist was responsible to the Chairman of the Drug Committee. The position was to be funded from savings generated by the program.

[vi] In 1990 the University of Adelaide introduced an assessable research project as a key component of the 4th year medical student curriculum.

The program has a 3 tiered structure:

- routine quantitative reviews of rate, cost and expenditure data.
- determination of user groups and review of usage patterns.
- qualitative studies of drug use.

Retrospective, concurrent and prospective reviews of drugs, drug management of particular disease states and the drug aspects of medical procedures were undertaken. Reviews ranged from simple studies to expansive reviews of drug use.

Audit criteria were reviewed by relevant experts to ensure that criteria were practical, relevant, reproducible and clinically valid. Clinicians also assisted in the review process.

DUE projects involved clinical pharmacists, pharmacy trainees, medical students and medical practitioners. A part-time research officer was also recruited. Over 25 drugs, drug groups or procedures have been evaluated.

The program has also become a useful basis for teaching and development of basic research skills and has received support from senior clinicians and hospital administrators.

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CHAPTER 4

RAH DUE INFORMATION SOURCES AND SYSTEMS

1. INTRODUCTION

An understanding of information sources and systems is fundamental to the establishment and conduct of a DUE program. This chapter describes the RAH pharmacy information systems and their relevance and application to the DUE program at the hospital.

2. INFORMATION SYSTEMS

The drug use profile of any institution, including the RAH, is simply an organised display of whichever measure of drug utilisation is appropriate or possible for the health unit. The format of drug profiles is determined by the degree of automation and sophistication of information systems used to collect, aggregate, and report the data, and the objectives or recipients of the information (Table 1).

Up to the end of the 1992/93[i] financial year, drug utilisation reporting at the RAH comprised purchase and issue data derived by the Finance department from the computerised Pharmacy purchasing system and expenditure (payment) data derived from the Finance department general ledgers.

Table 1 Display formats used to describe the RAH quantitative drug use profile

Report type	Possible descriptors (example)	Sorted by
Reports for a specified time period describing: • Drug purchase • Drug expenditure • Drug issues (eg. aggregate issues, ward stock, imprest, discharge, outpatients, individual patient supply, unit dose) • Drug consumption • (ie. administration)	• ***Level 1*** - Therapeutic class (eg. antiinfectives) • ***Level 2*** - Pharmacological group (eg. antibiotics) • ***Level 3*** - Drug class (eg. cephalosporins) • ***Level 4*** - Drug (eg. ceftriaxone) • Dose form, strength, brand name pack size • $ - daily, weekly, monthly, month-to-date, yearly, year-to-date • Mass units (eg. grams), dosage units, DDD • user group (eg. prescribers, clinics, patient types)	• $ - daily, weekly, monthly, month-to-date, yearly, year-to-date • Top 10 (or other number) • Variance -% and/or $; from budget or compared with some other time period (eg. last year year-to-date) • exceptions - display items which exceed predetermined $,% or variance thresholds

The system was initially developed as a purchase/order system[ii] used to track and report on orders placed with hospital suppliers for drugs and pharmaceuticals and to provide information to the hos-

i The new Pharmacy computerised dispensing system RxVision™ (Health Systems (Canada) Pty. Ltd.) captures individual patient prescription data for some inpatient areas of the hospital. The system also captures individual patient prescription data for outpatients and discharge patients. This system has a flexible report generator which is able to manipulate the captured data and produce reports including drug utilisation information in a variety of formats. The limitation of this system at present is that it caters for less than one third of hospital patients. Hardware limitations restrict the volume of reports which can be generated and PC interface programming is in evolutionary stages only.

ii FMCS - Financial Management Computer System™, McDonnell Douglas Corporation, Pty. , Ltd..

pital income and expenditure ledgers. It was later modified to accommodate retrospective recording of drug issue data by pharmacy and other staff. Data processing personnel and pharmacy support staff entered issue location, drug name, dose form, drug strength and issue quantity data obtained from prescriptions and drug orders into computer terminals after the drugs had been supplied. The value of entries was calculated automatically by the system, through matching of the drug catalogue number with the last purchase price of that item described in the purchase module of the data base. Utilisation data were allocated to geographical cost centres.

Computer programmers were commissioned to develop in-house reporting modules which generated utilisation reports from the drug issue data. Reports were "hard-coded" within these modules and were not amenable to modification except by special request and by system programming staff. This limited the flexibility of utilisation reporting.

Data were usually entered into the system within a week of processing but occasionally backlogs of several months occurred due to system or line failure, and staff shortages. Data were logged by the system according to the data entry date rather than the issue date. There was no capacity within the system to adjust dates when backlogs occurred. Thus, an order issued in January but keyed in March would appear in utilisation reports as having been issued in March. Correspondingly, monthly utilisation reports did not always represent true trends in drug issues to hospital wards and departments.

Purchase and issue data were reported in one of four levels of detail which corresponded with the formulary classification system described in Appendix 1. In contrast, expenditure data were extracted as a line item only[iii] from the hospital ledgers with no reference to formulary classification or drug codes.

System limitations included lack of internal integrity checks and error capture facilities. Errors due to discrepancies between drug issue and purchase size and price modules occurred with regular frequency. Limitations for data reporting also applied to inpatient and outpatient prescription issues. For example, utilisation reports could indicate which medical clinics (outpatients) or geographic cost centres (inpatients) drugs were issued to, but could not identify prescriber or patient details. These data could only be obtained by manually transcribing data from drug charts or patient case notes.

Over the years, DUE personnel acquired a thorough understanding of system functionality and limitations, and fine tuned reporting processes to aid the DUE program. PC application software was applied to data down loaded from the hospital mainframes to provide better control and flexibility over reporting processes. This information provided the basis for the DUE program at the hospital and greatly assisted in determining and monitoring drug policy and drug utilisation.

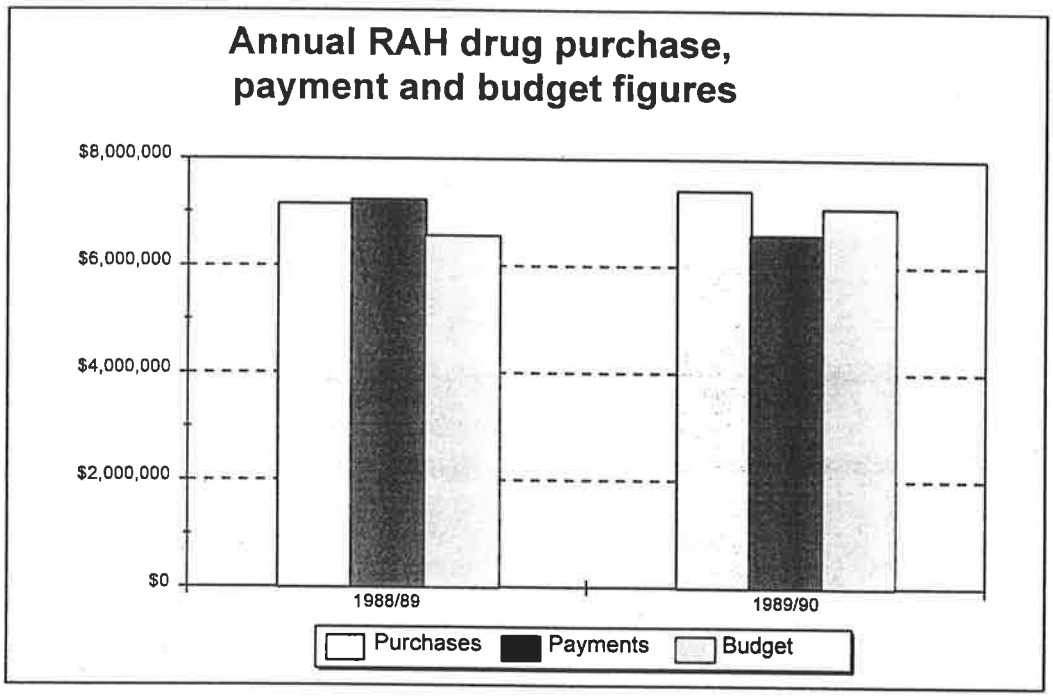
2.1 Measures of drug utilisation

Drug *purchase* data refers to the value of drug orders placed by the pharmacy with the various wholesalers and other suppliers. *Expenditure* (or payments) data refer to the amount of money paid by the hospital over a defined period for goods purchased. *Issue* data describe the drugs distributed by the pharmacy on receipt of a drug order or prescription to: wards and departments; outpatients;

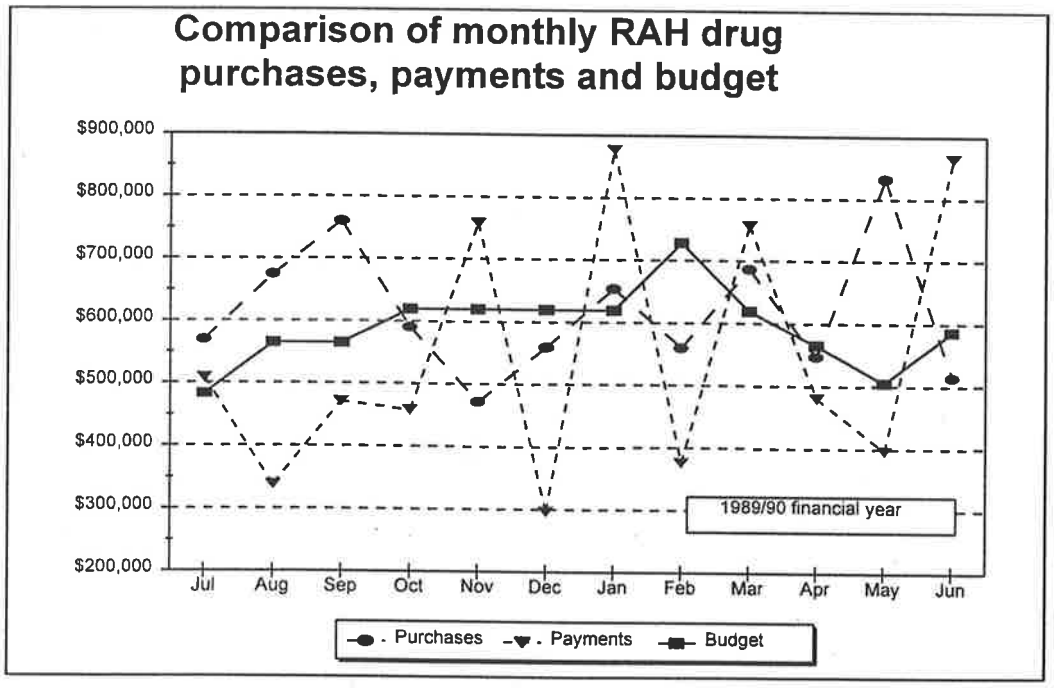
iii Line item - a single cumulative dollar figure representing total payments for the period.

patients being discharged from hospital; and patients treated in the Accident and Emergency Department.

Graph 1 ***Graph showing relationship between annual drug purchase, payment and budget figures for financial years 19988/89 - 1989/90***



Graph 2 ***Graph showing discordance between monthly drug purchase, payment and budget figures for Royal Adelaide Hospital 1989/90 financial year***



If purchase, issue or payment figures were closely and reliably interrelated, data types could be used interchangeably to reflect utilisation patterns. Figures could be used alone or in combination to confidently express quantitative institutional drug utilisation information. Such concordance is apparent at the end of each financial year (Graph 1) but not during the year (Graph 2).

2.1.1 Purchase data

Drug purchase information is available daily, weekly, monthly and annually from the purchasing computer system. Purchase data are reported for the combined hospital campuses. Daily and weekly purchase data assist the Director, Drug Distribution and other pharmacy staff in the management of the pharmacy inventory. The Drug Committee viewed monthly, year-to-date and annual figures.

Purchase data are available as dollars only. Information about the pack size of the individual line items purchased is readily available from pharmacy stock/buying cards, but there is no simple method for converting monthly dollar purchase figures into reports of dosage (DDD) or mass units for the 700 drugs and over 2,500 lines currently listed on the pharmacy catalogue. Continual price changes for drugs compound the problem. To convert annual purchase figures to dosage units for utilisation reports, an average unit price for the year would have to be calculated. Comprehensive reporting on changes in drug prices over time is difficult, partly because of the large numbers of orders placed and also price changes which occur for more than half of the items purchased each month.

2.1.2 Drug Inventory

The hospital drug inventory is comprised of all drugs held in the main pharmacy and its satellites, together with drugs held by wards and departments. The pharmacy inventory comprises drugs held in the main pharmacy plus its satellites. A manual stock take of the pharmacy inventory is carried out at the end of each financial year. The value of purchase orders placed less the stock-take figure, provides an estimate of the cost of drugs issued to wards, departments, outpatients and as discharge drugs. No stock-take of inventory external to the Pharmacy is undertaken. Calculation of the value of drugs held on ward imprest and as ward stock in drug trolleys provides the only estimate of the inventory beyond the pharmacy department. This figure is not readily available.

Table 2 Number of drug lines in A, B, C Model for Drug Inventory Control - 1990/91 and 1993/94

		1990/91		1993/94	
Inventory Category	% of total payments	No. (%)	$ x 1000	No. (%)	$ x 1000
A	70%	165 (7.6)	$5,245	136 (6.5)	$7,520
B	20%	342 (15.6)	$1,499	313 (15)	$2,149
C	10%	1679 (76.8)	$749	1636 (78.5)	$1,075
Total	**100%**	**2186 (100)**	**$7,494**	**1985 (100)**	**$10,746**

The department operates an A, B, C purchasing and inventory control system. High cost or high turnover items are accorded category A status. Category A items are those lines which are included in the range of drugs which account for 70% of the total payments for drugs (Table 2). Category B and C drugs are those which account for the next 20% and 10% of the drug payments respectively. The aim is to turn over category A lines 12 or more times per annum and B and C lines 8 and 2

times per annum, respectively. This frequency of turnover ensures high cost inventory stock levels are minimised and that purchase quantities are regularly reviewed.

The drug lines within each category are determined at the beginning of the financial year according to expenditure figures from the previous year. The eventual purchase/inventory category is influenced by one or other of unit cost, usage and buying patterns. For example, category A items range from high unit cost items such as tissue plasminogen activator ($1000 per unit) which are used intermittently, medium cost drugs such as ceftriaxone ($20/unit) which have relatively large usage (5-10,000 units per year) to low cost items such as sodium chloride 0.9% injection, 1000 mL ($1.20 per unit) which is consumed in vast quantities (200,000 units per year). Some items which are purchased in bulk or forward purchased for the next financial year may shift up a category even though their usage for that year would not satisfy the category definition.

As of July 1994, for a drug to be classified as category A[iv], individual yearly expenditure for 1993/94 must have exceeded $15,000 or 0.15% of the total drug expenditure. The corresponding expenditure for category B and C lines were $3300 - $15,000 and less than $3300 respectively.

A review of pharmacy inventory control procedures completed in August 1991 for the financial year ending 1990/91 showed that the average stock turn for all drug lines was between 5 - 6.5 times per annum. The stock turns for A, B, and C category items were 12.5, 7.6 and 2 times per year respectively.

What is the significance of the above observations to drug utilisation research? If the main aim of such research is to reduce unnecessary expenditure, then efforts should be directed at the drugs which consume the most significant component of the hospital budget. The A, B, C inventory model provides a method of identifying these agents. Identifying and correcting unnecessary use of one or more of these agents will have a significantly greater impact on drug expenditure than correcting inappropriate use of a large number of category B or C drugs. Similarly, the return resources invested into minimising inappropriate use of Category A agents will be greater and be realised more quickly than would efforts for the less costly categories.

Limitations with this practice are that A, B, C categorisation is only performed annually so that some drugs may go unchecked for many years, particularly if they are at the lower end or do not feature in the category A list. Also, if selection of drugs for review is based purely on expenditure, investigation of category B and C drugs may never occur.

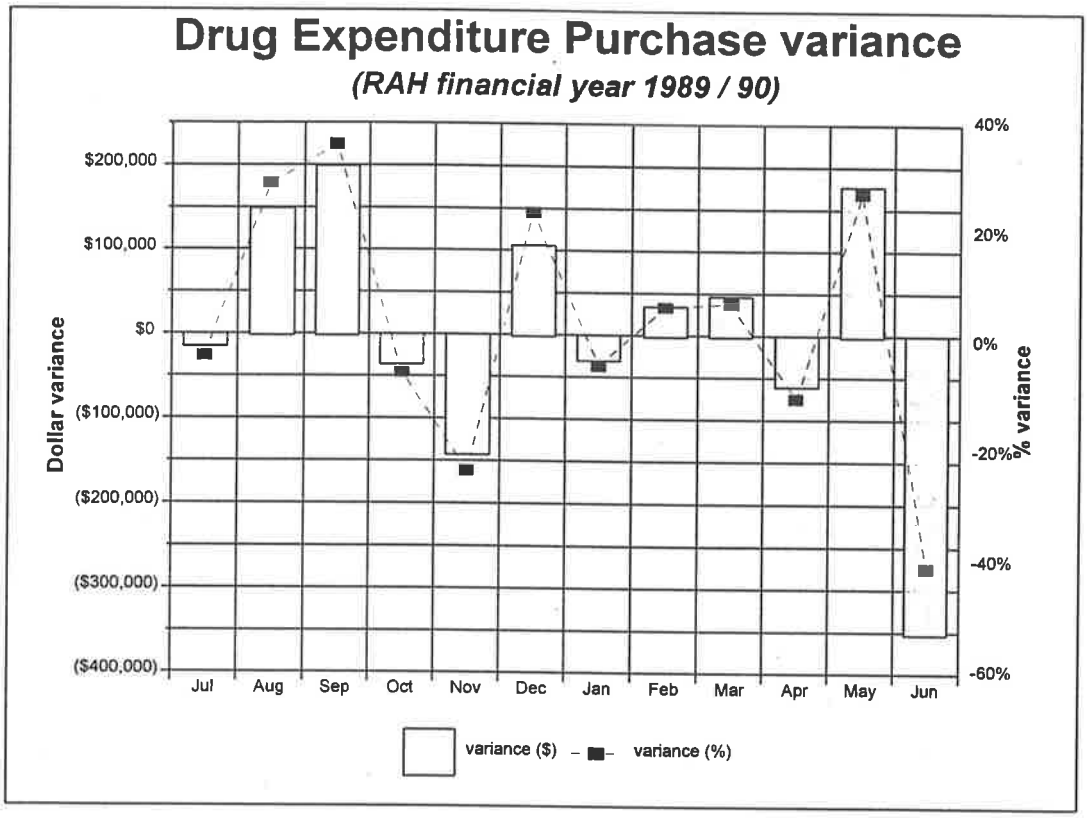
2.1.3 Drug Payments (expenditure)

The use of payment data as a measure of drug utilisation suffers from several limitations which diminish their utility for DUE reporting. The hospital's general ledger lists payments for 'drugs' as a single line (expenditure category) under Goods and Services payments; individual drugs or drug groups are not listed. Even though there is an audit trail which links purchases, supplier invoices and payment cheques for invoices, information linking payments to the individual items purchased is not available. This is because payment details relate to the invoice rather than the items on the invoice.

iv The Category A group comprised cyclosporin; a range of anti-infectives; inhalational anaesthetics; muscle relaxants and other drugs used in operating theatres; radiographic contrast media; growth factors including filgrastim and erythropoeitin; thrombolytic agents; antineoplastics; and large volume intravenous replacement fluids/colloids.

Individual items can only be identified by manually tracing back through the purchase order numbering system. This is time consuming and impractical for routine reporting purposes.

Graph 3 Graph showing variability in difference between purchase (orders placed) and expenditure (bills paid) as both dollar and % variance



Another limitation of expenditure figures is that use of monthly expenditure figures (which represent invoices paid) as measures of drug utilisation, is marred by factors including manipulation of cash flow. For example, the finance department determines in advance what the anticipated cash flow should be for a particular month and effects payment for invoices according to the cash flow rather than what has actually been purchased. In any given month, purchases may exceed expenditure by $200,000 or expenditure may exceed purchases by a similar amount and payments for outstanding invoices may range from $1,300 - $40,000 (30 day invoices) to $58,000 - $248,000[v] (60 day invoices) (Graph 3)

Some of the difficulty arises because cash, rather than accrual accounting methods are used. This means that drug purchase figures are reported for the month in which they are purchased even though the purchase may represent several months usage. High cost items are particularly problematic as they have a marked negative impact on cash flow. For example, a 3 monthly purchase of cyclosporin A capsules - which would cost approximately $300,000 - places a significant strain on the monthly cash flow figure of $800,000 which is supposed to account for all drugs. In addition, if this purchase figure was used to indicate utilisation of cyclosporin for the month of purchase then it would be clearly erroneous. By using an accrual accounting system, purchases could be amortised over the period of use. This would more reliably reflect cash flow and utilisation.

v Ranges derived from review of Royal Adelaide Hospital Drug Committee Finance reports 1988/89 - 1993/94

2.1.4 Drug Issues (utilisation)

The RAH operated primarily as a floor stock site up to mid-1995. In a floor stock system, a predetermined range of drugs are stocked at each patient unit and are maintained at a threshold level. Standard packs or quantities of selected medications are supplied following receipt of an order from the patient area to replace the drugs consumed at ward level. Patient drug requirements outside this predetermined range are provided following receipt of an order from the ward detailing patient requirements. Prescription and ward issue data were entered into the department's computer system within 72 hours of dispatch. Data were reported according to date of entry rather than date of dispatch which sometimes resulted in artifactual reporting errors. For example, during 1992, there was a period where no issue data were entered for several months due to staff shortages in both the Pharmacy and Finance departments. Issue reports indicated nil issues for those months. A similar situation occurred in early-1994 when a cable linking the Pharmacy data entry terminals with the Finance Department mainframe was severed for several months resulting in a backlog of data which was not entered until the following financial year.

The new computerised drug distribution system overcomes such limitations. With this system, data entry occurs when prescriptions/orders are processed. There are no delays for data entry. All data are reported for the month of issue for all prescription/order and patient types. Issues recorded through the new system however still represent only an indirect measurement of drug utilisation. For example, issues are recorded in dollars or dosage units rather than doses administered to patient and no adjustments are made for drugs issued and not used. Also, there are still a number of drugs available on wards as floor stock or imprest items. Issues of these drugs are tracked to geographical locations and not to patients. Examples include inexpensive drugs such as atropine, frusemide, potassium chloride, temazepam, paracetamol, paracetamol with codeine, paracetamol with dextropropoxyphene, metoclopramide, oral laxatives, large volume parenteral fluids, various creams and emolients, antiseptic solutions, irrigations and reagent strips. The cost for these items are allocated to wards rather than patients. The percentage of total issues in dollars which can be tracked to individual patients is approximately 60%.

Drug issue data are available in all 4 levels of the formulary classification system. Level 4 data are of most practical use. These data are usually presented as drug issue data per ward or as reports of all drugs issued to a particular ward over a defined time period. Patient report data are not used routinely except for troubleshooting report anomalies.

2.1.5 Inpatient, outpatient and discharge drugs

Although the RAH has maintained activity statistics for inpatient, outpatient, discharge and other patient types for many years, the ability to similarly differentiate drug costs has only been possible since 1994. Differential patient costs are only available for the main hospital campus. Data which became available in January 1995 for the period September to December 1994 identified the value of issues among inpatient, outpatient and discharge patients as 64%, 31% and 5% of prescription charges respectively. These figures were applied to the pre-1993 drug payment figures to provide an estimate of the split of total costs per patient among patient types.

Table 3 and Graphs 3 and 4 show the result of this modelling. Figures for 1994 onwards have not been presented as they reflect system funding and policy changes rather than changes in utilisation.

For example, differentiation of patient types occurred incrementally[vi] during a period when the way drugs were funded also changed. Some drugs which were previously unavailable to outpatients at the hospital due to funding constraints (eg. interferon, colony stimulating growth factors, foscarnet) became freely available after 1993 because of altered funding arrangements between the State and Commonwealth governments [vii]. This resulted in a disproportionate increase in outpatient drug costs. Also, the quantity of drugs issued to discharge patients was reduced from 14 days to 7 days supply in October 1994. This effectively halved the cost of drugs supplied to discharge patients. As a result, 1994 figures are not comparable with those for previous years.

The rates of change of per patient cost and per occupied bed day costs over the period 1987/88 through 1992/93 did not change markedly. The magnitude of change for inpatient costs seems to be affected little by removing the outpatient and discharge components. This demonstrates that inpatient drug costs account for most of the hospital drug costs.

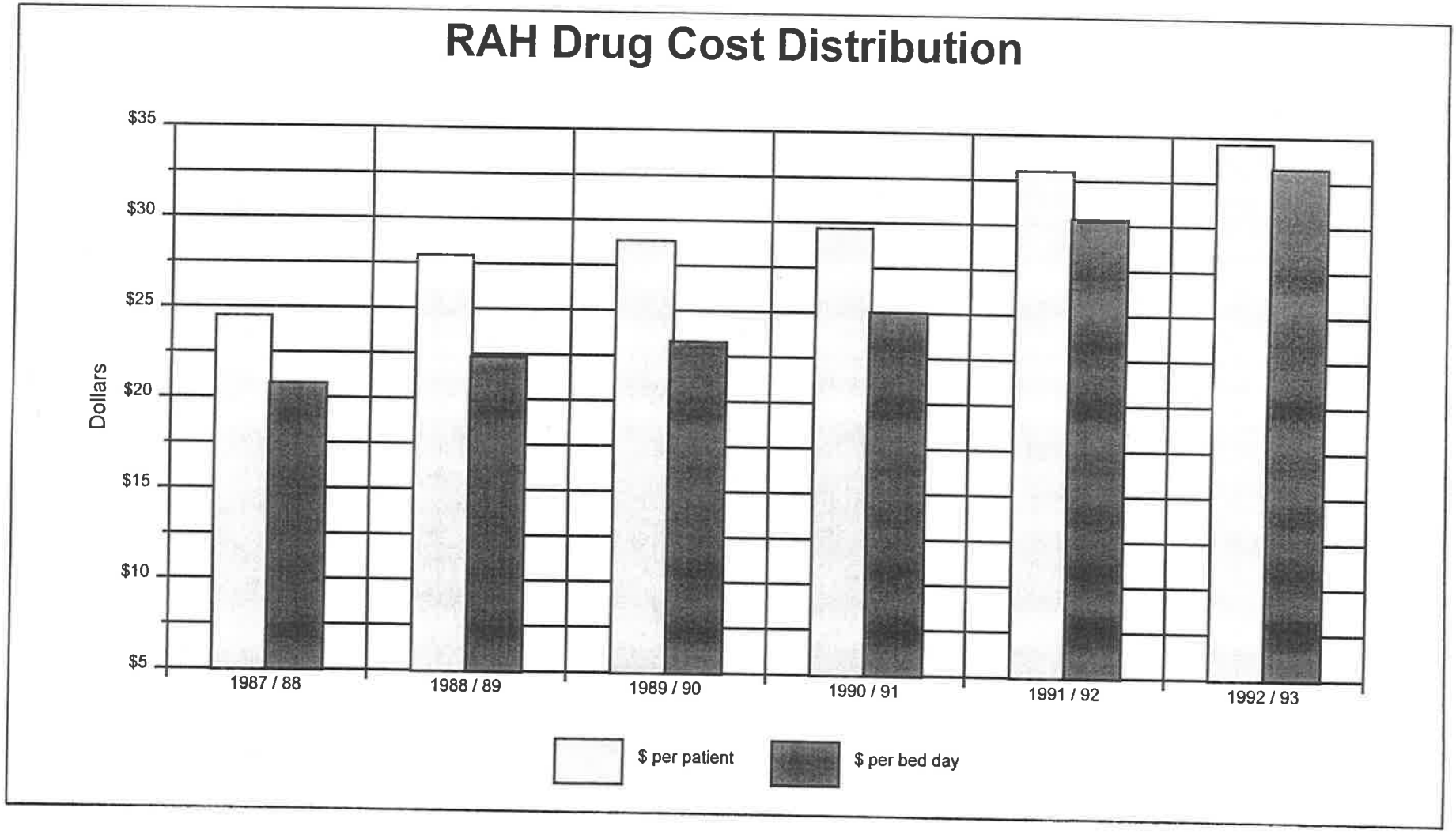
vi Discharge prescription data was computerised in February 1994, and outpatient data in September 1994. The full computerisation of inpatient data (RAH campus only) was not complete until June 1995.

vii The Highly Specialised Drugs Program (Section 100, Pharmaceutical Benefits Scheme) is a federally funded scheme administered by the Highly Specialised Drugs Working Party of the then Commonwealth Department of Health, Housing, Community Services and Local Government. The scheme provides funding to public hospitals for a selected range of specialised drugs prescribed for specified indications.

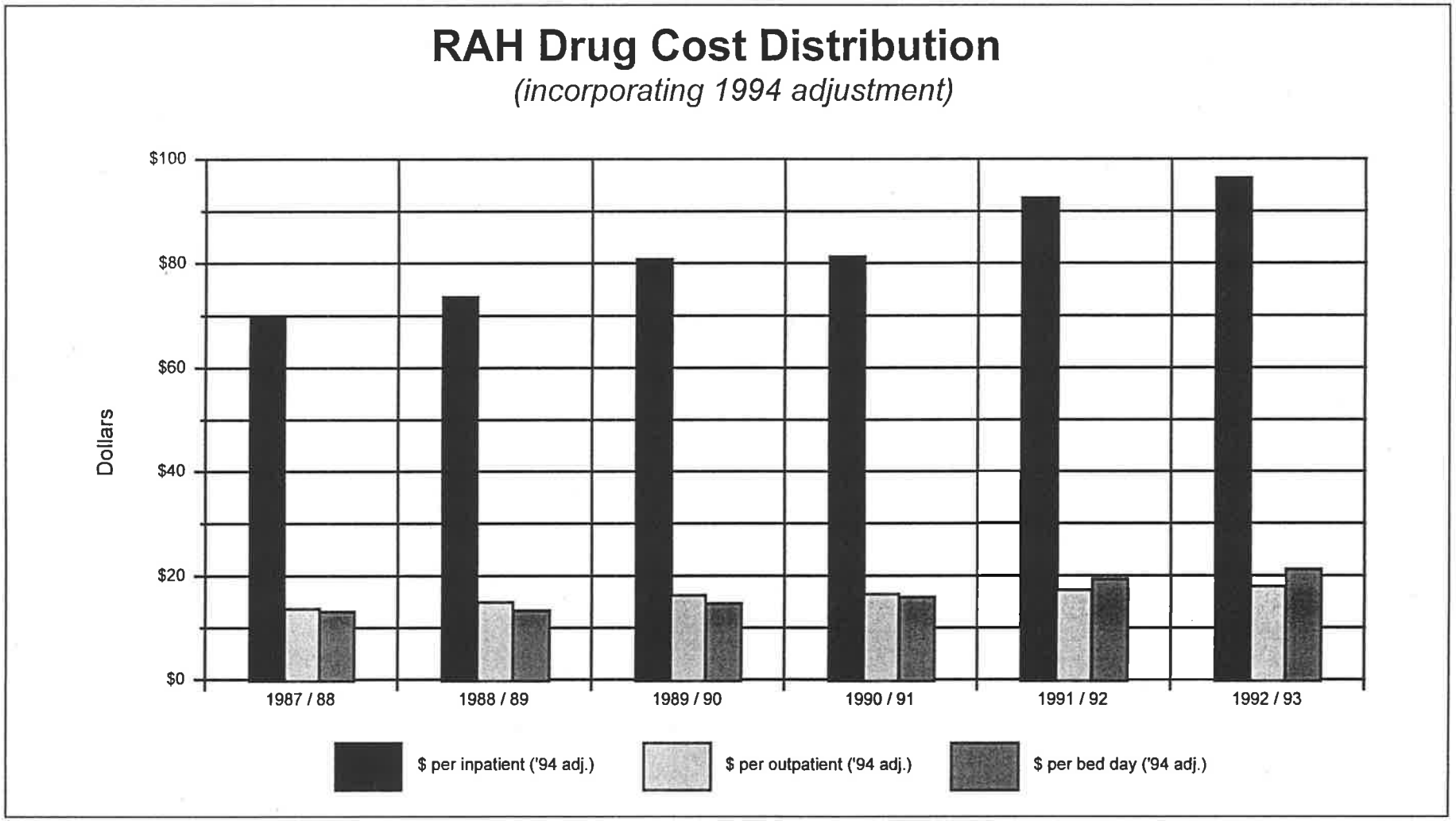
Table 3 Estimates of per patient and per occupied bed costs following incorporation of 1994 figures for distribution of drug costs per patient type

	1987 / 88	1988 / 89	1989 / 90	1990 / 91	1991 / 92	1992 / 93	Average
Drug payments	$6,059,000	$6,576,000	$7,229,000	$7,494,000	$8,775,000	$9,411,000	$7,590,667
Total No. of patients	247,741	249,852	250,411	252,713	265,945	271,741	256,401
inpatients	55,311	57,001	57,139	58,834	60,539	62,361	58,531
outpatients	135,139	134,886	136,622	140,413	155,801	160,653	143,919
No. of bed days	291,848	312,184	310,467	299,680	288,905	282,696	297,630
$ for each patient typ							
inpatients - 64 %	$3,877,760	$4,208,640	$4,626,560	$4,796,160	$5,616,000	$6,023,040	$4,858,027
outpatients - 31 %	$1,878,290	$2,038,560	$2,240,990	$2,323,140	$2,720,250	$2,917,410	$2,353,107
discharges - 5 %	$302,950	$328,800	$361,450	$374,700	$438,750	$470,550	$379,533
Per patient cost							
inpatients	$70.11	$73.83	$80.97	$81.52	$92.77	$96.58	$82.63
outpatients	$13.90	$15.11	$16.40	$16.55	$17.46	$18.16	$16.26
% change from 1987/8							
inpatients	N/A	5.3%	15.5%	16.3%	32.3%	37.8%	17.9%
outpatients	N/A	8.7%	18.0%	19.0%	25.6%	30.7%	17.0%
$ per occupied bed da							
(inpatient component only)	$13.29	$13.48	$14.90	$16.00	$19.44	$21.31	$16.40
% change from 1987/8							
inpatients	N/A	1.5%	12.2%	20.5%	46.3%	60.4%	23.5%

Graph 4 Sample per patient and per occupied bed day costs before adjustments for patient types



Graph 5 Per patient and per occupied bed day costs after adjustment for patient types



3. SUMMARY

An understanding of information sources and systems is fundamental to the establishment and conduct of a DUE program. Data sources include drug purchase, issue and expenditure data. Traditionally drug purchase data have been most useful for analysis utilisation trends. With the advent of the computerised distribution system, drug issue data will become predominant as the source of utilisation and cost data. Drug payment data are less useful because they arc too far removed from the distribution system to adequately reflect utilisation trends. Drug purchase and issue data can be used to describe utilisation by major category, class and sub-class and by individual drug or drug product for month or year-to-date. Issue data can also be used to describe user groups.

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CHAPTER 5

THE RAH: A GROSS UTILISATION PROFILE

1. INTRODUCTION

This chapter provides introductory information about the Royal Adelaide Hospital (RAH) - service characteristics, staff demographics, drug policy, and Drug Committee operations. These provide the relevant background to my DUE research described in later chapters. The findings described in my gross analysis of general and drug expenditure trends had not been undertaken previously at the RAH. These data served as a foundation for more detailed quantitative and qualitative methods and results which follow in subsequent chapters.

2. THE HOSPITAL PROFILE

The RAH was established in 1840. It is a university affiliated teaching hospital, a major tertiary referral centre for South Australia (SA), a state centre for selected services[i] and the largest hospital in South Australia. In 1988, when my research commenced, the RAH comprised 800 beds on the Adelaide campus, and 118 specialist rehabilitation and 31 nursing home beds at the Hampstead Centre campus[ii]. The hospital provided a broad range of specialist and sub-specialist medical and surgical services including Cardiovascular, Gastroenterology, Orthopaedic, Trauma, Internal Medicine, General Surgery, Cancer Services, Radiology, and Nuclear Medicine. The hospital employed approximately 4,700 people in the equivalent of 3,500 full-time positions including nursing, medical, allied health, hotelling and support staff.

3. ACTIVITY MEASUREMENTS

The activity statistics of the RAH are impressive (Table 1). Over the six years to 1992/93 over 1.54 million patients attended the RAH Of these 860,000 patients attended outpatient clinics, 323,700 the Accident and Emergency Department, 282,000 people were admitted as in- patients[iii] and 68,800 as day patients. Inpatient activity remained relatively static over the period (an increase of 3.2%) compared with outpatient attendances which increased by almost 19%. The most dramatic increase was for same day patient activity which increased by 62% over the period, reflecting a growing trend for managing minor surgical and diagnostic cases as day cases. Correspondingly, the average length of inpatient stay for the hospital, excluding same day patients, increased by 28% from 6.3 in 1987/88 to 8.1 days in 1992/93, perhaps reflecting greater illness severity of inpatients.

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i State Services include spinal injuries, radiation oncology, adult cranio-facial surgery, hyperbaric medicine, tuberculosis and adult burns.

ii ex Royal Adelaide Hospital Strategic Plan, 1994-1998

iii An inpatient was defined as a patient requiring a period of stay in hospital longer than 1 day

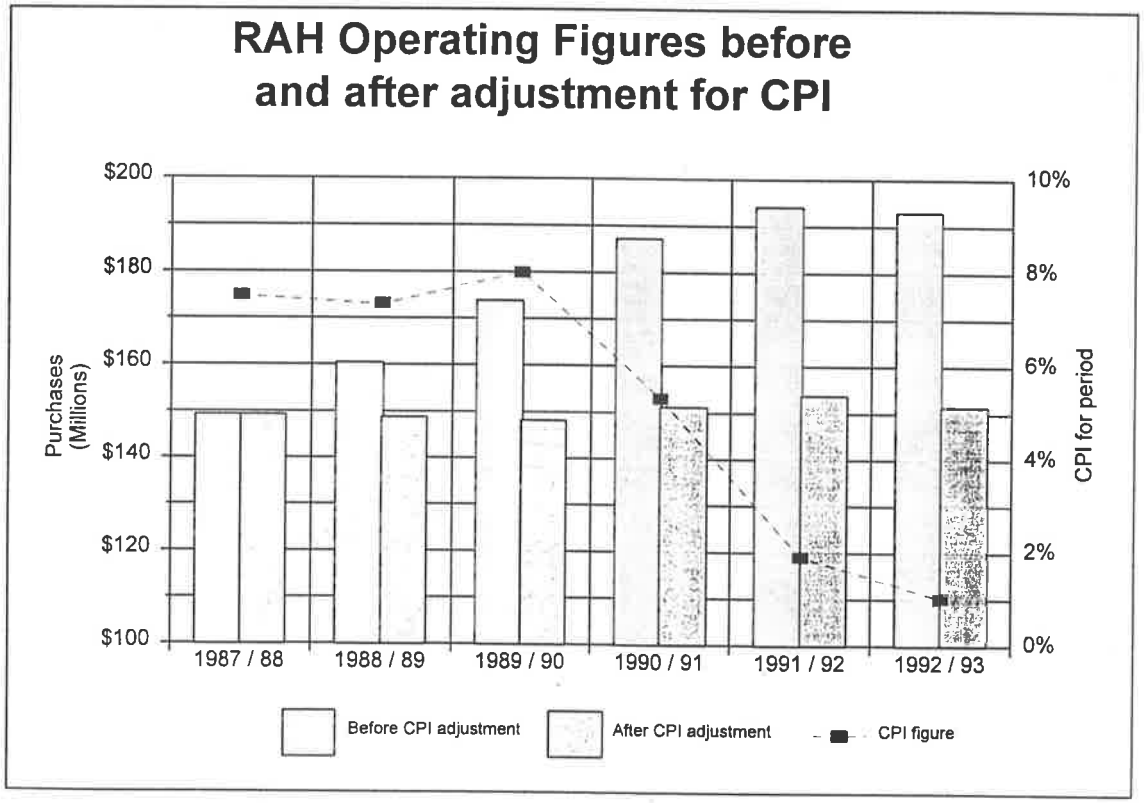
Table 1 Royal Adelaide Hospital activity demographics [iv]

Fiscal year / Patient statistic	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
No. of in- patients	46316	47030	46651	47215	47419	47760
No. of outpatient attendances	135139	134886	136622	140413	155801	160653
No. to accident & emergency	57291	57965	56650	53466	49605	48727
No. of same day patients	8995	9971	10488	11619	13120	14601
Total bed days (excluding same day beds)	282853	302213	299979	288061	275785	268095
Average length of stay	6.3	6.6	6.6	8.1	8	8.1

4. GROSS OPERATING COSTS

Between 1987/88 to 1992/93 the RAH spent between $150 - 190 million per annum (in unadjusted figures[v]), on health care and related services (Graph 1). The major expenditure was for salaries and wages which accounted for an average 73.6% (range: 72.2-74.9%) of operating costs. Approximately 41% of this cost was for nursing salaries, 22% for medical and the remainder for scientific, allied health, hotelling and support service staff. The Goods and Services category, which includes drugs, comprised an average of 13.6% (range: 13.1-15.5%) of total operating costs. This was followed by Administrative Services (average 6.4%, range: 5.1- 8.1%), Equipment and Services (average 6.4%, range: 3-3.7%), and fuel, light and power (average 1.2%, range: 1.1-1.3%). A range of miscellaneous service costs accounted for a further 8.2% (range: 4.9 - 10.5%)[vi].

Graph 1 Royal Adelaide Hospital operating costs - actual and adjusted for inflation.

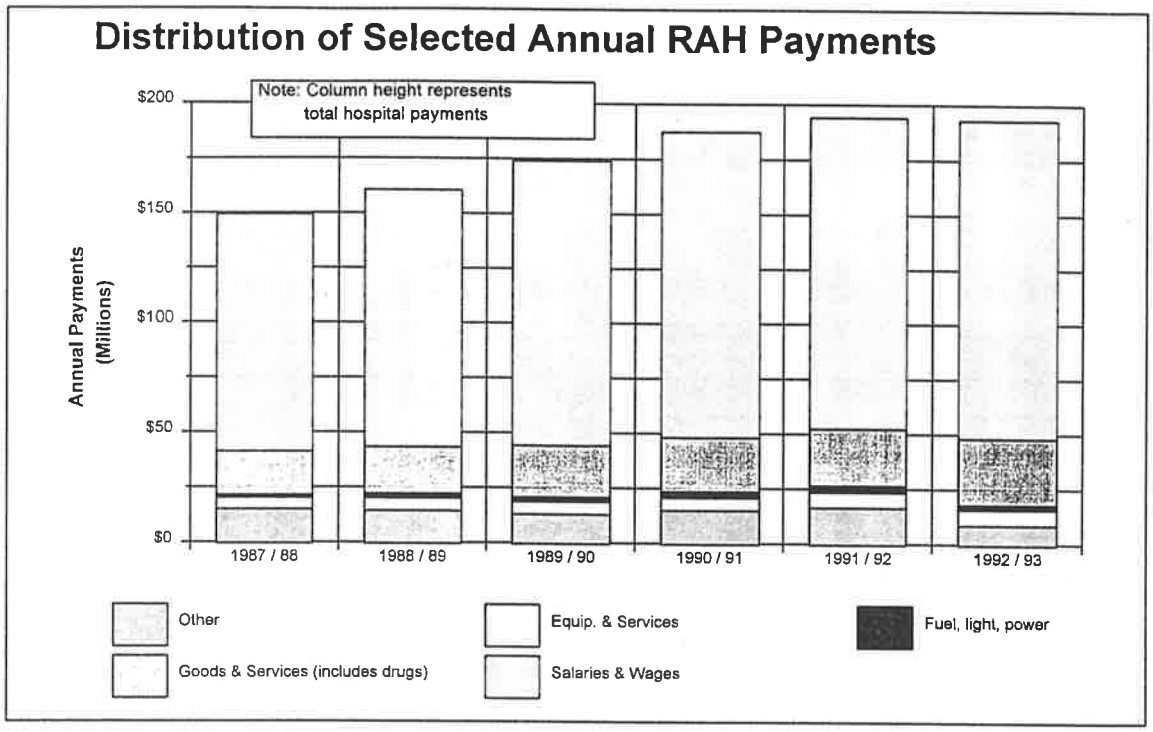


iv Information obtained from Royal Adelaide Hospital Annual Reports 1987 / 88 through 1992 / 93.

v Not adjusted for CPI.

vi Figures from RAH Annual Reports 1987/88 to 1992/93.

Graph 2 Graph depicting distribution of hospital operating costs



Using unadjusted figures, the hospital operating budget increased by almost 30% from approximately $149 million dollars to about $193 million dollars over the period. However, when these figures are adjusted for inflation[vii], the annual budget shows little movement in *real* terms, changing from $149 million to $151 million or only 1.4% over the period (Graph 1). At the same time the hospital managed an increasing patient throughput in all areas apart from Accident and Emergency (Table 1).

5. GOODS AND SERVICE COSTS

Accounting definitions used in RAH annual reports over the years have differed slightly in the composition of expenditure categories used to describe Goods and Services[viii]. This means that figures are not exactly comparable. Goods and Services include food supplies, drugs, hotelling services (including linen supplies), medical and surgical supplies, and purchase/hire/repair of plant and equipment associated with patient treatment or diagnosis. They comprise consumable items or services used directly in the delivery of patient care, as opposed to the general non-patient specific services associated with administration, or maintenance of buildings, plant and equipment.

The figures show that drugs followed expenditure for Medical and Surgical Supplies as the major Goods and Services (47 - 54% of category) cost for the hospital. Drugs comprised 30 - 34% of goods and services payments for the RAH between 1987/88 and 1992/93 and were almost double the payments for food supplies and other consumable items. Drug expenditure varied from slightly

vii Inflation adjustments were made by decreasing the budget figure for each year by the increase in CPI for each of the preceding years back to the base year of 1987/88. For example, the figure for 1989/90 was multiplied by (1-CPI(1989/90))*(1-CPI(1988/89)) to arrive at a figure expressed in terms equivalent to the value of the dollar in 1987/88.

viii The composition of the Goods and Service category changed in 1992/93 and again in the 1993/94 financial year. Comparisons were possible between 1992/93 and previous years by making adjustments to figures in the 1992/93 report from additional detail provided in that report. The changes in 1993/94 however were not accompanied by sufficient detail to confidently track expenditure categories back to those used in previous years.

over $6 million to almost $9.5 million over the period. Drugs accounted for only a small portion (between 4.0 and 4.9%) of total hospital operating costs (Table 2).

Table 2 Table showing value of Goods and Services payments for the RAH for years 1987/88 to 1992/93.

FINANCIAL YEAR	1987/88 000s	1988/89 000s	1989/90 000s	1990/91 000s	1991/92 000s	1992/93 000s
ITEM						
Food Supplies	$2,449	$2,570,	$2,765,	$2,906,	$2,684,	$2,298
Drugs	$6,059	$6,576	$7,229	$7,494	$8,775	$9,411
Medical & Surgical	$10,170	$10,932	$12,421	$13,349	$14,632	$14,138
Other[ix]	$812	$1,057	$841	$851	-	$4,114
Total Goods & Services	$19,490	$21,135	$23,256	$24,600	$26,091	$29,961
Total operating costs	$149,256	$160,471	$173,767	$187,261	$194,124	$193,013

6. GROSS PER PATIENT AND PER BED DAY COST

Another measure of efficiency in management of operating costs over the years was ascertained by dividing the total dollars spent by the total number of patients managed, and/or the total number of occupied bed days for each of the relevant years (Table 3). When *actual* figures are used, the per patient cost of treatment shows an average increase of 16.8% (SD ± 6.4%; range: 6.6 - 23%) over the period suggesting that treatment costs are increasing. A number of factors are responsible for this observation including changes in patient mix, together with changes in cost of procedures, drugs and new technology and increases in wage, salary and other costs. The same arguments apply when figures for the hospital cost for each occupied bed day (Table 3) are examined. These figures show an average increase over the period of 19.4% (SD ± 14.2%; range: 0.51 - 33.5%) with the minimal increases in 1988 - 1990 not being sufficient to offset the large increases in subsequent years.

Conversely, when figures for years following 1987/88 are adjusted for CPI a different pattern emerges. The average of CPI adjusted per patient costs for the period was $587. This figure was 3% less than the average figure of $602 for 1987/88. Similarly the average of the cost per occupied bed day showed a decrease of 1.2% when compared with the 1987/88 figure (SD ± 5.6%; range: - 6.8 - 4.7%).

[ix] The composition of this figure varied in Annual Reports depending on accounting definitions.

Table 3 Royal Adelaide Hospital operating costs per patient and per occupied bed day

Fiscal year Patient statistic	1987/88 *($ x 1000)*	1988/89 *($ x 1000)*	1989/90 *($ x 1000)*	1990/91 *($ x 1000)*	1991/92 *($ x 1000)*	1992/93 *($ x 1000)*	Average
Hospital payments *(a)*	$149,256	$160,471	$173,767	$187,261	$194,124	$193,013	$176,315
Adjusted payments *(b)*	$149,256	$148,756	$148,209	$151,253,	$153,819	$151,370	$150,444
Number of patient (c)	247741	249852	250411	252713	265945	271741	256400
Actual per patient cost *(a)*	$602	$642	$694	$741	$730	$710	$687
Adjusted per patient cost *(b)*	$602	$595	$592	$599	$578	$557	$587
Actual % change in per patient cost from base year 1987/88 *(a)*	N/A	6.6%	15.2%	23%	21.2%	17.9%	16.8%
% change in per patient cost from adjusted base year - 1987/88 *(b)*	N/A	-1.2%	-1.8%	-0.66%	-4%	-7.5%	-3.03%
Total bed days *including* same day bed days	291848	312184	310467	299680	288905	282696	297630
Actual cost per occupied bed day *(a)*	$511	$514	$560	$625	$672	$683	$594
Adjusted cost per occupied bed day *(b)*	$511	$477	$477	$505	$532	$535	$506
Actual % in cost change per occupied bed day from base year 1987/88 *(a)*	N/A	0.51%	9.44%	22.18%	31.39%	33.50%	19.4%
% change in cost per occupied bed day from adjusted base year - 1987/88 *(b)*	N/A	-6.83%	-6.66%	-1.31%	4.11%	4.70%	-1.2%

Legend: a - actual, b - adjusted for inflation; c - Figures are derived from RAH annual reports and include inpatients, outpatient attendances, same day patients and Accident Emergency patients. Figures do not include patients seen by Allied Health professionals.

7. SUMMARY

The RAH , established in 1840, is the largest hospital in SA. The hospital combines a substantial teaching and research base with an extensive range of general and specialised medical services. The hospital employs the equivalent of 3000 full time medical, nursing, scientific and support staff and has an average per annum operating budget in excess of $180 million. The major expenditure is for salaries and wages (74%) followed by Goods and Services (14%) which includes drugs.

Over the six years to 1992/93, over 1.54 million patients attended the hospital, over half of whom presented as outpatients. Over the period inpatient activity remained relatively static, while outpatient activity increased by 19%, and same-day patient activity by 62%.

Analysis of gross cost per patient and per occupied bed day costs showed that real (ie. adjusted for inflation) costs decreased slightly over the period. These figures confirm the efficiency of the hospital in treating an increasing number of patients at the same or less cost in 1992/93 compared with 1987/88. This was despite the introduction of new medical technology and drugs over the period.

Hospital drug policy is determined by the Drug Committee and administered by the Pharmacy Department. Drug distribution services include, ward stock, imprest and more recently individual patient supply systems. The hospital operates a Formulary, the objective of which is to promote rational and economic drug use.

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CHAPTER 6

THE RAH: A GROSS DRUG UTILISATION PROFILE

1. INTRODUCTION

Before identifying which aspects of drug use would be targeted for my DUE studies, it was necessary to research drug utilisation at the RAH in its broadest sense. This required acquiring knowledge of the environment in which drug use was occurring, and of the magnitude of drug utilisation in the context of overall hospital resource consumption. Historical analyses of this type had not been undertaken previously. My findings are described below.

2. HOSPITAL DRUG POLICY

2.1 The Drug Committee and Drug formulary

The RAH Drug Committee comprises senior clinicians, pharmacists, administration and nursing representatives and is responsible to the Medical Committee of the hospital. The Drug Committee reports through the Medical Director to the hospital Executive and Board of Management. The terms of reference of the Committee are to:

1. serve in an advisory capacity on all matters pertaining to the safe use of drugs;
2. develop a formulary of drugs accepted for use in the hospital on the basis of scientific and professional standards and to provide for its constant revision;
3. ensure the cost-effective use of drugs and make recommendations to the Drug Finance Committee regarding drug availability;
4. initiate and/or direct drug use review programs and studies;
5. establish or plan suitable educational programs for the hospital's professional staff on matters related to drug use;
6. ensure review and documentation of the hospital position in relation to accreditation standards;
7. liaise with other hospital committees as appropriate.

Following consultation with senior Medical Staff of the hospital, the Drug Committee selects and includes in the hospital Drug formulary those drug products which are considered the best available for the prophylaxis and management of disease. The role of the Drug Committee is not to establish or dictate therapy, but to provide prescribers with a range of medications which, according to the present state of medical knowledge, meets clinical needs and avoids duplication of therapeutic effect.

The RAH Formulary is published every 2 years. Its objective is to ensure that patients receive the best of the wide range of drugs available to the community, at the most economic cost to the hospital. The formulary is reviewed regularly and drugs which are rarely used or which have been supplanted by more effective agents are deleted and new agents included when appropriate. Approximately 700 drugs and over 3000 individual items are listed in the formulary. Formulary drug listings

are divided into pharmacological or therapeutic classifications. The classifications are based on the American Hospital formulary Service, Drug Information (AHFS)[i] (Appendix 1). This system not only defines the order of the drugs listed in the formulary but also provides the basis for DUE drug purchase and utilisation reports.

Drugs may only be included on the formulary if they have received marketing approval by the Commonwealth; non-marketed drugs, investigational agents or trial drugs cannot be included. Some formulary drugs may be restricted to individual prescribers or units or for treatment of patients with specific disease states. Non formulary drugs are drugs which are not included in the formulary and are thus not available for routine use within the hospital. The Drug Committee may approve supply of a non-formulary drug for treatment of an individual patient following submission of an application.

Non formulary drugs include Special Access Scheme (SAS) drugs, Individual Patient Use (IPU - RAH) drugs, Investigational and Trial Drugs. IPU - RAH drugs are drugs which have received marketing approval but are not included in the formulary. They are being considered for ultimate inclusion in the RAH Formulary and may be made available for evaluation purposes to certain prescribers following application to the Drug Committee. Investigational drugs are drugs which have not received general marketing approval from the Commonwealth but are undergoing clinical investigation according to a protocol approved by the Human Ethics Committee of the Hospital.

2.2 Drug prescribing, administration and supply

The hospital requires that all drugs with the exception of combination products are prescribed using the approved generic name. Compound preparations may be ordered by brand name. Only approved abbreviations are acceptable for expression of dosage. Except in emergency cases, drugs may only be administered following a doctor's written order on any one of a number of RAH drug charts or prescription forms. All medications provided to hospital patients are dispensed through the hospital Pharmacy. Importantly, drugs provided by pharmaceutical companies as samples or drugs for clinical trials may not be issued or administered to patients unless the drug is dispensed through the Pharmacy in response to a doctor's order. Also, for reasons of efficiency and economy only one brand of a drug is stocked.

Between 1993 and 1995, the hospital was in transition from an aggregate system to an individual patient supply (IPS) system. Under the aggregate system, drugs were issued as bulk units to wards for use by any patient prescribed the particular drug. Under IPS, patients were supplied with individualised drug containers for sole use. Full implementation of individual patient supply was completed in June 1995 and was supplemented by coincident implementation of a computerised dispensing and inventory system.

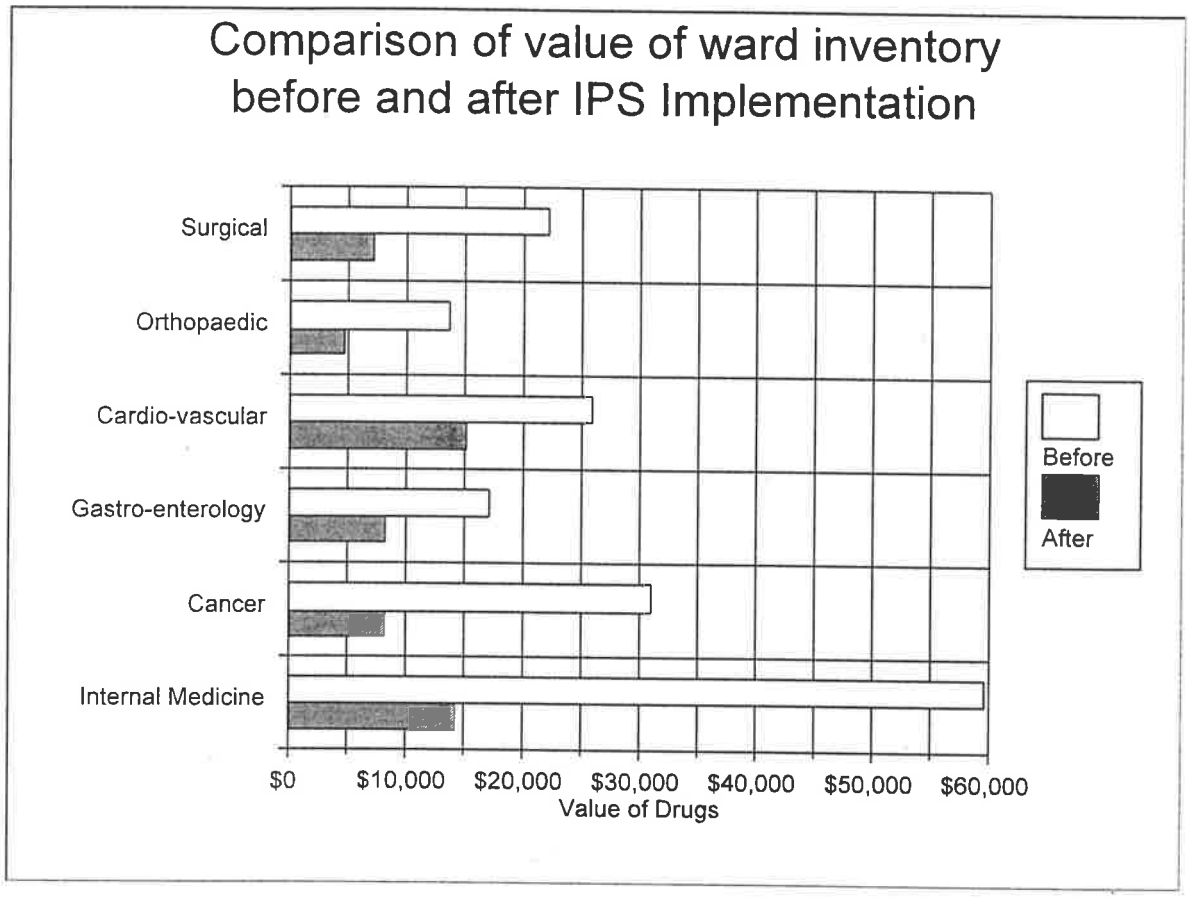
The advantages of IPS (for DUE) compared with the previous aggregate distribution system include:

- supply of drugs to individual patients;
- improved accountability for drug usage within the hospital;
- improved safety and efficiency of drug administration;

i Published by the American Society of Health System Pharmacists Inc., 4630 Montgomery Avenue, Bethesda, MD 20814. USA.

- reduction of ward drug inventory and wastage (Graph 1);
- improved management information;
- ability to differentiate between inpatient, outpatient, ward, imprest and discharge drug issues.

Graph 1 Effect of IPS Implementation on Ward/Service Inventory



The availability of this information facilitates review of drug usage and identification of potential problems requiring more detailed scrutiny. Computerisation also provides for hitherto unexplored potential of automated screening for DUE.

3. THE RAH DRUG PROFILE

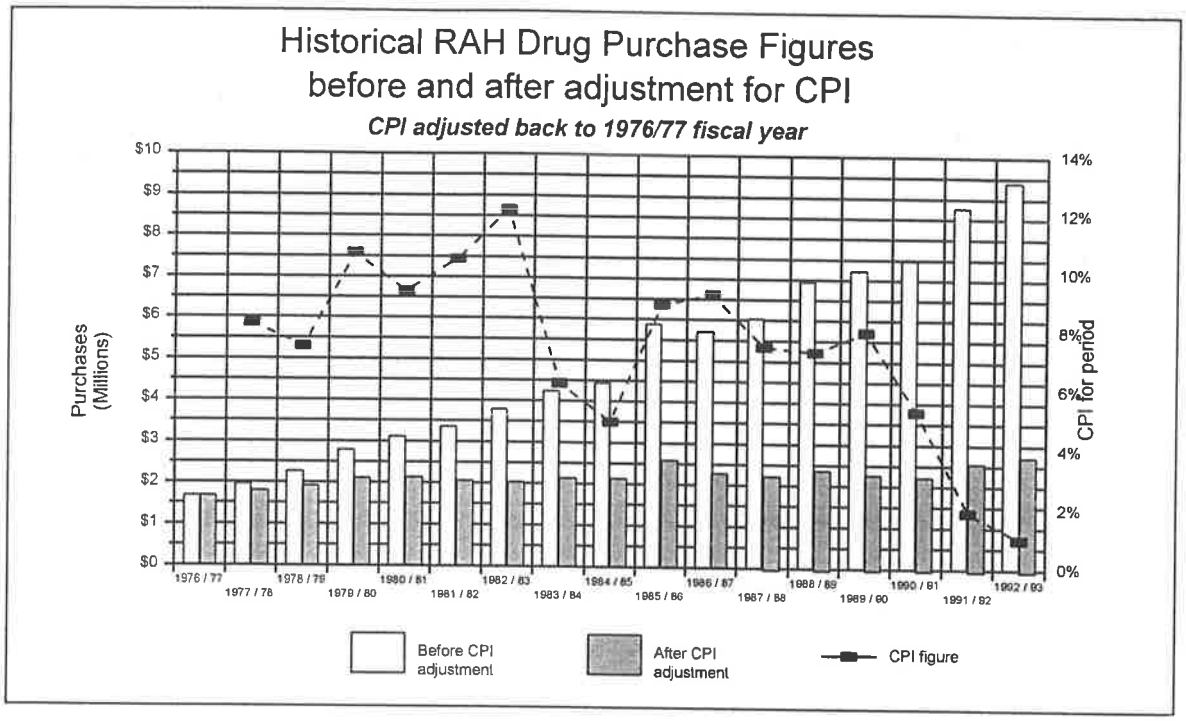
The highest level of drug utilisation reporting at the RAH was for total hospital drug purchase or expenditure. Longitudinal data provided the best representation of general utilisation trends. Annual figures, both actual (real) and those calculated after making adjustments for inflation, were used to make assessments of utilisation trends. Adjusted figures were used to apply inflation adjustments to annual figures back to a benchmark year.

Drug costs 'per patient' and 'per occupied bed day' were also helpful in understanding drug use trends over time. These were calculated by combining 'macro' (gross) drug expenditure and patient activity data with real or adjusted figures.

The next level of reporting was for major drug classifications. Reports were developed to display or highlight particular utilisation trends. Comparisons with notional budgets, or the previous year's expenditure, were made. More detailed reports described utilisation of major drug classes within drug classifications or sub-classes for the major classes. The most detailed reports were those which

described individual drugs and/or drug products.

Graph 2 17 years of Royal Adelaide Hospital drug payments before and after inflation adjustments.



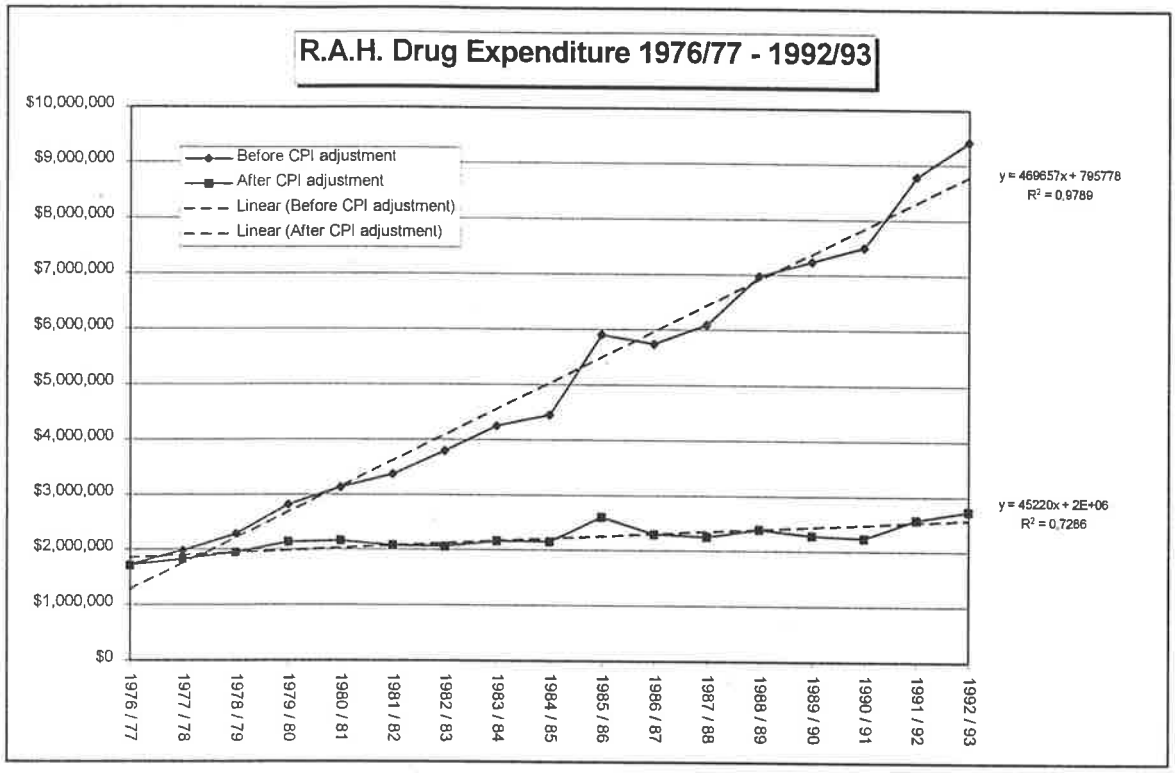
Between 1976/77 and 1992/93, expenditure for drugs increased 450% from $1.7 million to $9.4 million (Graph 2). The corresponding cumulative increase in CPI for the period was 120.1%[ii]. Thus, drug payments outstripped inflation 3.75 fold. However when figures were adjusted for inflation, the drug payments for 1992/93 (when expressed in 1976/77 terms), were only $2.7 million. This represented an increase of only 60%, which was half of the corresponding CPI increase for the period.

Unexpected movements in annual drug expenditure were assessed by plotting the line of best fit (ie. a linear regression) for payment data over the period, and by assessing the degree of correlation between predicted and actual data points. Concordance between the actual data and the regression line was indicative of the variability of the data (Graph 3). The R^2 values for the lines, particularly for unadjusted payments ($R^2 = 0.98$) indicate reasonable correlation between actual and predicted figures. The average annual change in expenditure of 3.2% also compared favourably with the average CPI increase for the period[iii]. These findings confirmed that movements in expenditure could be predicted with reasonable certainty from growth over previous years.

[ii] CPI figures obtained from the Australian Bureau of Statistics.

[iii] The average annual increase in CPI for the period 1987/88 - 1992/93 was 5.2 ± 3% which corresponded with a cumulative increase of 31% during the same time.

Graph 3 Graph showing predicted drug expenditure before and after CPI adjustment between 1976/77 and 1992/93



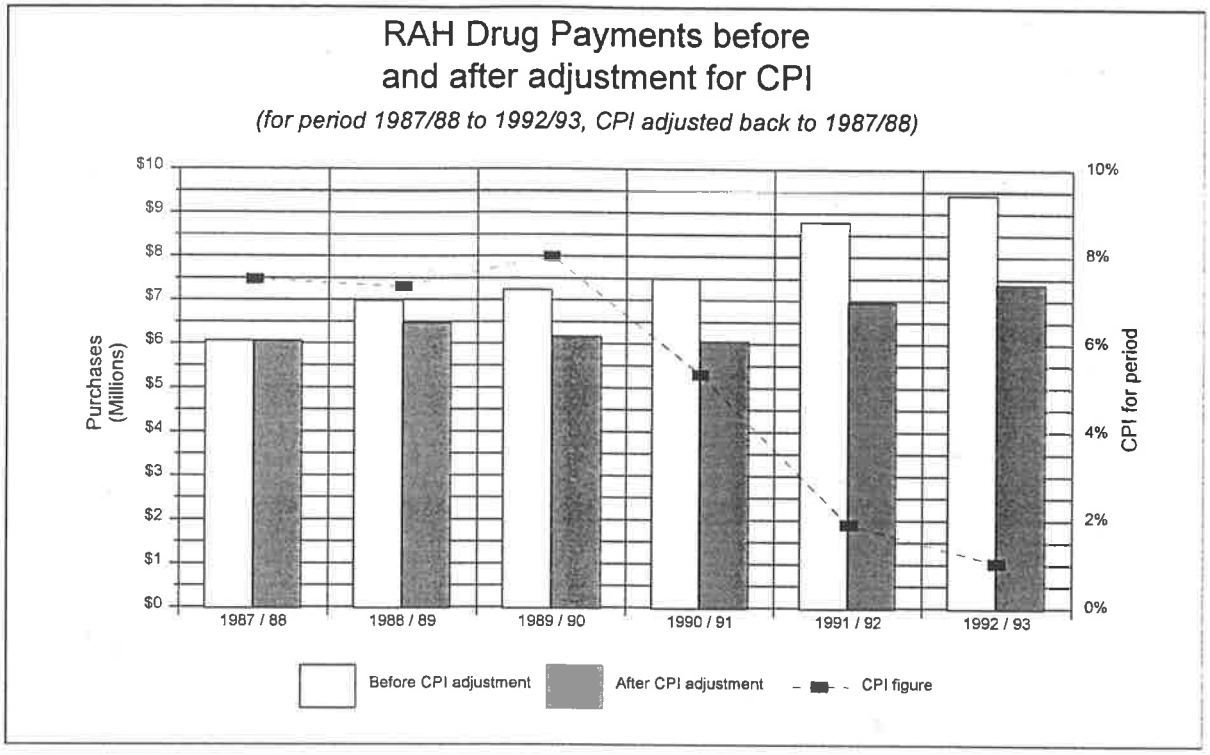
3.1 Drug budgets/payments

For the period 1987/88 to 1992/93, drug expenditure increased from $6 million (1987/88) to $9.4 million (1992/93); an increase of 55% (Graph 4). The corresponding cumulative inflation rate was 31%. The average annual increase in payments of about 3.2% per year was again less than the average increase in CPI[iv] for the period. However, during this period (as compared with 1976/77-1992/93), percentage increases in drug payments ran closer to percentage increases in inflation between years. The increased expenditure may be explained, in part, by the advent of new and expensive, high technology drug products.

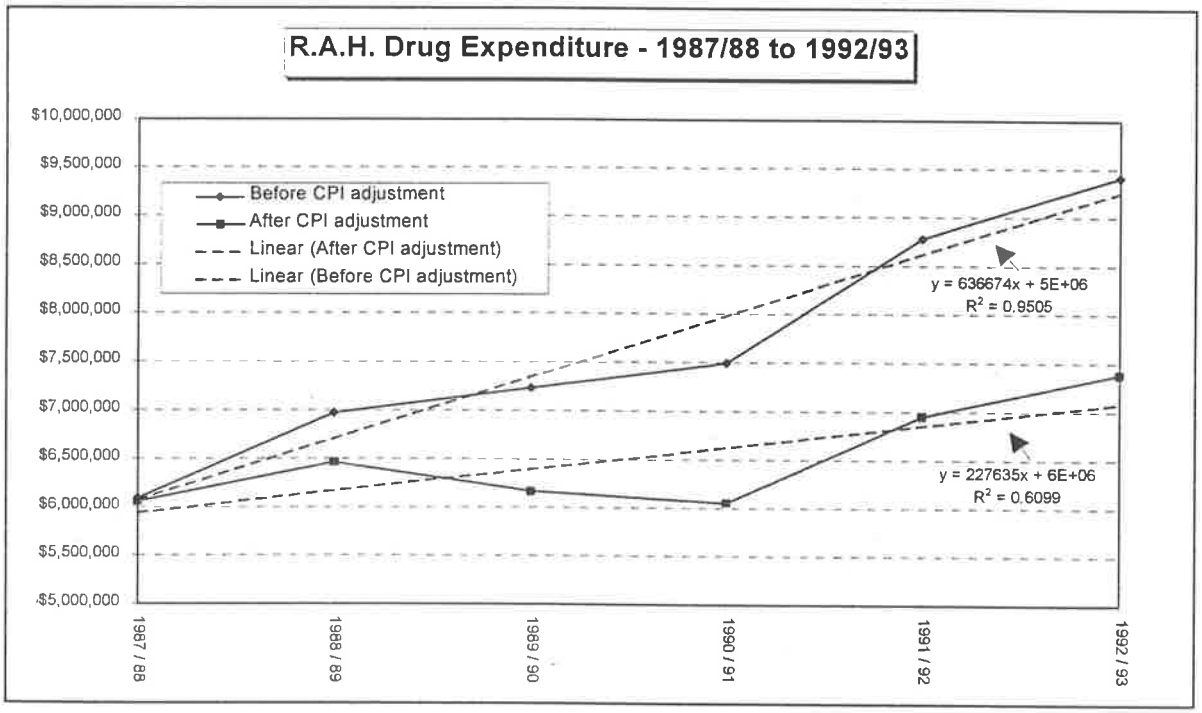
After CPI adjustment, the corresponding expenditure for 1992/93 (expressed as 1987/88 dollars), was $7.4 million, which represented an increase of 21.8% over 1987/88 (Graph 4). Linear regression of these data also demonstrated excellent correlation ($R^2 = 0.95$) between actual figures and statistical predictions of payments (Graph 5). Furthermore, expenditure figures for 1989/90 and 1990/91 showed negative growth. This means that in real terms (ie compared with 1988/89), the hospital spent less money on drugs for those years than in 1988/89 (Graph 6).

[iv] The average annual increase in CPI for the period 1976/77 - 1992/93 was 5.1 ± 3% which corresponded with a cumulative increase of 31% over the same time.

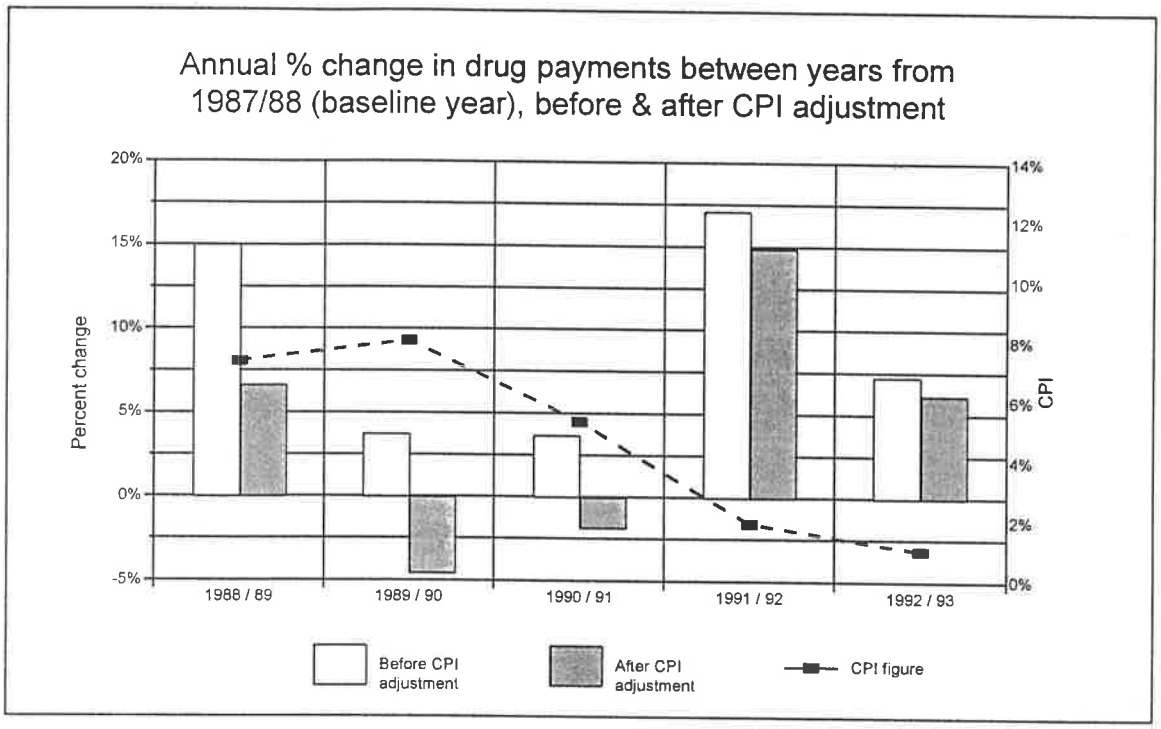
Graph 4 Drug expenditure for 6 years between 1987/88 and 1992/93



Graph 5 Graph showing predicted drug payments before and after CPI adjustment between 1987/88 - 1992/93



Graph 6 Change in drug payments from 1987/88 compared with CPI



3.3 Drug costs 'per patient' and 'per occupied bed day'

Analysis of the drug payment figures for actual and adjusted per patient and per occupied bed day costs (Table 1) showed results with trends similar to those for total hospital payments described in Chapter 5. However, unlike total payment figures, drug expenditure per patient or per occupied bed day did not show a fall in real terms. Increases however, were still less than the corresponding increases in inflation for the period studied.

The overall *per patient expenditure* (before adjustment for inflation) increased by 41% from $24.50 to $34.60 over the period, compared with an increase of 11% when figures were adjusted for inflation. The latter figure was less than one third the cumulative inflation figure of 31% for the period (see Chapter 5). The average, unadjusted per patient percent change in cost for the period was 26% compared with 4.5% after CPI adjustment. This adjusted figure was 12% less than the average CPI figure of 5.1%.

The drug costs *per occupied bed day* were also less than the corresponding inflation figures for the period. The overall, unadjusted, drug cost per occupied bed day rose 60% compared with 26% for the adjusted cost. The latter figure again compares favourably with the CPI figure of 31% described above. The average increase in the drug cost per occupied bed day were 29% and 7% for adjusted and unadjusted figures respectively, compared with the average CPI increase of 5.1%. Similarly percentage increases in adjusted payments for 1989/90 and 1990/91 were less than the corresponding CPI movements. In contrast to unadjusted figures, payments for these years showed negative growth in real terms, compared to each of the preceding years. However, like the unadjusted figures described above, the large increase in payments for 1991/92 and 1992/93 offset these decreases by exceeding the corresponding CPI movements.

Table 1 Royal Adelaide Hospital drug costs per patient and per occupied bed day

Fiscal year **Patient statistic**	**1987/88** *($ x 1000)*	**1988/89** *($ x 1000)*	**1989/90** *($ x 1000)*	**1990/91** *($ x 1000)*	**1991/92** *($ x 1000)*	**1992/93** *($ x 1000)*	**Average**
Drug payments *(a)*	$6060	$6971	$7229	$7494	$8775	$9411	7656
Adjusted drug payments *(b)*	$6060	$6462	$6166	$6053	$6953	$7384	6512
Number of patients[v]	247741	249852	250411	252713	265945	271741	256400
Actual per patient cost *(a)*	$24.46	$27.90	$28.87	$29.65	$33.000	$34.63	$29.75
Adjusted per patient cost *(b)*	$24.46	$25.86	$24.62	$23.95	$26.14	$27.16	$25.37
Actual % change in per patient cost from base year 1987/88 *(a)*	N/A	14.1%	18.0%	21.2%	34.9%	41.6%	26%
% change in per patient cost from adjusted base year - 1987/88 *(b)*	N/A	5.7%	0.7%	-2.1%	6.9%	11%	4.45%
Total bed days *including* same day bed days	291848	312184	310467	299680	288905	282696	297630
Actual cost per occupied bed day *(a)*	$20.76	$22.33	$23.28	$25.01	$30.37	$33.29	$25.84
Adjusted cost per occupied bed day *(b)*	$20.76	$20.70	$19.86	$20.20	$24.07	$26.11	$21.95
Actual % in cost change per occupied bed day from base year 1987/88 *(a)*	N/A	7.5%	12.1%	20.4%	46.3%	60.3%	29.4%
% change in cost per occupied bed from adjusted base year - 1987/88 *(b)*	N/A	-0.3%	-4.3%	-2.7%	15.9%	25.7%	6.9%

a - actuals, b - adjusted for inflation

The main limitation of 'per patient' and 'per bed day' analyses was that, for the period studied, it was not possible to distribute drug utilisation rates proportionally between these different patient types. This was because to the end of 1992/93, information systems were unable to separate drug costs by patient type or between hospital campuses[vi] and figures are calculated as if all drugs were used for inpatient treatment. Further confounding any interpretation is that outpatients (including A & E patients) accounted for approximately 80% of the total number of patients treated at the hospital. These patients received between 7 and 30 days supply of medication even though their encounter with the hospital may have lasted only a few minutes. In addition, a number of expensive

[v] Figures were derived from RAH annual reports. They include inpatient, outpatient, same day patient and Accident Emergency patient attendances. Figures do not include patients seen by Allied Health professionals.

[vi] The Royal Adelaide Hospital Pharmacy Department is comprised of A main Pharmacy and 3 satellites. The main Pharmacy and the outpatient satellite provide parenteral cytotoxic drug admixtures, limited general intravenous drug admixtures, non-sterile and non-sterile production, Drug Information and Clinical Pharmacy Services, discharge and outpatient drug supplies. One satellite services the extended care facility providing drugs to spinal injury, geriatric and slow stream rehabilitation inpatients. The second satellite services Thoracic Medicine and Cystic Fibrosis outpatients and patients attending the State's Sexually Transmitted Disease outpatient clinics.

drug lines were used almost exclusively by outpatients including cyclosporin, erythropoeitin, interferon, and anti-retroviral drugs. No weighting was applied for different patient types or for particular drugs and thus the analysis overestimates the per day drug cost because it underestimates the number of drug days dispensed by the pharmacy.

3.4 The 'big ticket' drugs

Table 2 High cost drugs 1993/94

	Drug	Total expenditure	% of total expenditure	Cumulative
1.	cyclosporin	$862,690	8.03	8.03
2.	zidovudine	$415,590	3.87	11.9
3.	erythropoeitin	$354,984	3.3	15.2
4.	ioversol	$292,397	2.72	17.92
5.	acyclovir	$252,976	2.35	20.27
6.	ceftriaxone	$204,716	1.9	22.17
7.	parenteral nutrition solution	$176,596	1.64	23.81
8.	isoflurane	$168,189	1.56	25.37
9.	Haemaccel™	$160,099	1.49	26.86
10.	propofol	$159,921	1.49	28.35
11.	ticarcillin/potassium clavulanate	$156,450	1.45	29.8
12.	octreotide	$147,060	1.37	31.17
13.	cephalothin	$122,688	1.14	32.31
14.	imipenem/cilastatin	$119,056	1.11	33.42
15.	filgrastim	$109,718	1.02	34.44
	TOTAL	$3,703,130	34.44	

As another example of utilisation reporting, a global view of individual drug utilisation was obtained by reviewing detailed utilisation reports for each drug group and collecting the major expenditure items to describe the 'big ticket' drugs for the hospital (Table 2). These are the drugs for which major expenditure occurred in the hospital.

This table shows that 15 drugs accounted for almost 35% of the total hospital drug expenditure. Cyclosporin and zidovudine alone accounted for 12% of the total. Overall, 50% of the total drug expenditure was consumed by only 50 products of the 2000 available at the hospital.

4. SUMMARY

Total hospital payments and drug payments have been smooth and predictable since 1977. When actual payment figures were adjusted for inflation, increases in drug expenditure in real terms were less than the corresponding rise in the CPI. Also, the more recent increases in hospital activity have not resulted in unexpected increases in drug payments compared with CPI.

There have been minimal changes in per patient drug payments or in payments per occupied bed day although the cost per occupied bed day has increased relative to the cost per patient treated. Data indicate that cost containment has occurred over a period during which there was an explosion

in the number of new and expensive drugs. Fortuitously, the impact of the introduction of these new drugs has been offset by large decreases in prices of older drugs. Increased awareness by clinical managers of the need to contain costs, and the efforts of the Drug Committee and Pharmacy Departments through the DUE program have also been contributory.

About 15 drugs from six major therapeutic classes have consistently accounted for the majority (approximately 70%) of hospital drug expenditure. Of the 400 drugs and 2000 products used at the RAH, approximately 15 account for one third of total drug expenditure.

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CHAPTER 7

QUANTITATIVE REVIEW: REPORTING

1. INTRODUCTION

In order to facilitate monthly review of drug utilisation, to provide indicators of potential problem trends and to assist in the summary and presentation of meaningful data to the Drug Committee and its sub-committees and working parties, it was necessary to develop robust methods for reporting utilisation. This chapter describes reports which I developed and their application to these ends.

2. REPORTING NEEDS

The majority of quantitative utilisation reports I prepared for the DUE program have been those intended either directly or indirectly for the Drug Committee. The Committee required information about overall drug expenditure and its pattern. In addition, the Committee required budgetary performance information for major drug groups and major cost items. Utilisation reports were provided in different forms to meet these needs and as the requirements of the Committee/Subcommittees changed over the years, so did the type of reports.

Reports ranged from comprehensive text based reports to simple executive summary type reports. Drug Committee reports usually consolidated the utilisation characteristics of individual drugs under therapeutic class headings. Additional detail or explanation was provided for individual items where utilisation patterns indicated that closer scrutiny was warranted. Thus, reports provided essential information only and were kept concise and easily interpretable.

Detailed reports were not provided to the main committee since they were often difficult to interpret and therefore not helpful in making strategic decisions for the hospital. To counter this problem, the Drug Committee established a number of smaller groups to review more detailed reports and to provide recommendations to the main Committee. These included the Drug Utilisation Review Working Party, the Antibiotic Working Party (of the Drug Committee), and the Oncology Drug Working Party. Financial information was referred to the Finance Sub-Committee and concerns over antibiotics or anti-cancer drugs to the respective clinical working parties. The records of all subcommittee meetings were tabled at Drug Committee or circulated with Drug Committee minutes.

3. REPORT TYPES

The challenge in developing reports was to deliver the information in a succinct, meaningful and visually appealing form. The reports were designed to highlight relevant points and minimise misinterpretation.

3.1 Purchase and issue data

The report formats included end-of-month/year-to-date reports and/or reports indicating utilisation for each month of the current and previous financial year. Data were reported at one of two levels and in one of two formats. The information corresponded with Level 1 and/ or Level 4 of the Formulary classification system. Level 1 data provided sufficient detail to monitor and report drug

budget activity to interested committees. Level 2 (Pharmacological group) or Level 3 (Drug class) reports, provided more detailed information. The detail to identify drugs requiring closer scrutiny or for analysis of problem trends was obtained from Level 4 (Individual drug) reports. These reports were generated/used by the project pharmacist.

3.2 Notional budgets

One way to assess purchase patterns was to describe drug use in terms of variance from projected budget figures. Notional budgets were calculated from the previous year's drug utilisation after making upward or downward adjustments for inflation and other factors. Comparisons of year-to-date purchases with notional budget figures provided some indication of whether particular purchase patterns were exceptional.

Budgets were calculated for the 4 Formulary Levels, but in practice were allocated only for therapeutic classes (Level 1) and for individual drugs (Level 4). Calculations were performed using PC based electronic spreadsheet application software (Lotus 123 ™, Version 2.02, Lotus Corporation Pty. Ltd.). These reports were used routinely for committees/working party review and analysis.

Notional budgets calculated in this way assumed that drug costs increased in line with budget increases. In many cases however, percentage movements in drug prices were quite different from budget movements. When drug prices moved in line with the budget changes then increased expenditure did not necessarily represent increased utilisation. Conversely, when prices remained unchanged or moved downwards, concordance between notional budget figures and actual utilisation rates actually indicated increased utilisation.

4. REPORT EXAMPLES

The following pages provide examples of reports commonly provided to the Drug Committee and working parties between 1988 and 1993. Reports are followed by a short commentary describing their application and limitations.

Figure 1 Month-to-date Drug Purchase Report, sorted by therapeutic classification in accordance with Level 1 descriptions of the RAH Formulary drug classification system

PHARMACY DEPARTMENT - ROYAL ADELAIDE HOSPITAL
DRUG PURCHASE STATEMENT - 1990/91

For Month Ending:- June 1991
By: G. Misan, Project Pharmacist, Drug Committee

SORTED BY THERAPEUTIC CATEGORY

Drug budget	
Current year:	$7,489,106
Previous year:	$7,090,796
Expenditure	
Year-to-date:	$7,777,400
Last-year-to-date:	$7,714,743
Last year full year:	$7,714,743

SECTION NO.	CATEGORY DESCRIPTION	ORDERS MONTH TO DATE	ORDERS YEAR TO DATE	NOTIONAL * BUDGET YEAR TO DATE	YEAR TO DATE BUDGET VARIANCE %	$
4	ANTIHISTAMINES	$1,487	$18,510	$16,639	11.2%	$1,871
8	ANTI-INFECTIVE AGENTS	$107,815	$1,287,402	$1,140,706	12.9%	$146,696
10	ANTINEOPLASTIC/IMMUNOSUPPRESSANT AGENTS	$110,257	$1,142,477	$1,088,667	4.9%	$53,811
12	AUTONOMIC DRUGS	$16,794	$237,927	$200,320	18.8%	$37,607
19	PHARMACY EQUIPMENT	$29,246	$204,500	$196,349	4.2%	$8,151
20	BLOOD FORMATION AND COAGULATION	$16,125	$234,566	$261,409	-10.3%	($26,843)
21	NUTRITION AND DIETETICS	$9,531	$139,030	$105,416	31.9%	$33,614
24	CARDIOVASCULAR DRUGS	$20,419	$259,480	$260,265	-0.3%	($785)
28	CENTRAL NERVOUS SYSTEM DRUGS	$42,061	$525,065	$441,741	18.9%	$83,323
36	DIAGNOSTIC AGENTS	$25,109	$523,367	$644,856	-18.8%	($121,490)
40	ELECTROLYTE, NUTRITION/FLUID BALANCE	$75,772	$999,808	$896,743	11.5%	$103,065
50	EAR, NOSE AND THROAT PREPARATIONS	$5,306	$50,332	$50,230	0.2%	$102
52	EYE PREPARATIONS	$7,233	$107,146	$129,271	-17.1%	($22,124)
56	GASTRO-INTESTINAL DRUGS	$35,491	$438,646	$398,822	10.0%	$39,824
60	ANTIRHEUMATIC AGENTS	$1,981	$31,216	$34,223	-8.8%	($3,007)
64	DETOXIFYING AGENTS AND ANTAGONISTS	$762	$29,509	$67,532	-56.3%	($38,023)
68	HORMONES AND SYNTHETIC SUBSTITUTES	$13,229	$237,878	$240,128	-0.9%	($2,250)
72	LOCAL ANAESTHETICS	$7,522	$83,586	$63,030	32.6%	$20,556
76	OXYTOCICS	$43	$1,083	$470	130.4%	$613
80	SERUMS, TOXOIDS, VACCINES	$1,242	$58,936	$38,664	52.4%	$20,272
84	SKIN AND MUCOUS MEMBRANE PREPARATIONS	$54,023	$713,063	$660,495	8.0%	$52,568
86	RESPIRATORY AGENTS	$8,304	$88,688	$84,634	4.8%	$4,054
88	VITAMIN PREPARATIONS	$8,296	$63,616	$55,211	15.2%	$8,405
92	UNCLASSIFIED THERAPEUTIC AGENTS	$1,082	$27,316	$15,002	82.1%	$12,314
94	TRIAL DRUGS	$23,486	$274,254	$398,284	-31.1%	($124,030)
	SUB-TOTAL	$622,616	$7,777,400	$7,489,106	3.8%	$288,294
	LESS Section 21	$9,531	$139,030	$105,416		
	ADJUSTED TOTAL	$613,085	$7,638,370	$7,383,690	3.4%	$254,680

adjusted for 12 months advance purchase of $362,120 in June 1988/89 for 1989/90.
* Notional budget calculated from previous years purchases as a % of total purchases and adjusted for current year Drug Budget

Figure 2 Month-to-date Drug Purchase Report, sorted by dollar value (descending) of purchases for month, for Level 1 descriptions of the RAH Formulary drug classification system

PHARMACY DEPARTMENT - ROYAL ADELAIDE HOSPITAL
DRUG PURCHASE STATEMENT - 1990/91

For Month Ending:- June 1991
By: G. Misan, Project Pharmacist, Drug Committee

SORTED BY $ MONTH-TO-DATE

Drug budget	
Current year:	$7,489,106
Previous year:	$7,090,796
Expenditure	
Year-to-date:	$7,777,400
Last-year-to-date:	$7,714,743
Last year full year:	$7,714,743

SECTION NO.	CATEGORY DESCRIPTION	ORDERS MONTH TO DATE	ORDERS YEAR TO DATE	NOTIONAL * BUDGET YEAR TO DATE	YEAR TO DATE BUDGET VARIANCE %	YEAR TO DATE BUDGET VARIANCE $
10	ANTINEOPLASTIC/IMMUNOSUPPRESSANT AGENTS	$110,257	$1,142,477	$1,088,667	4.9%	$53,811
8	ANTI-INFECTIVE AGENTS	$107,815	$1,287,402	$1,140,706	12.9%	$146,696
40	ELECTROLYTE, NUTRITION/FLUID BALANCE	$75,772	$999,808	$896,743	11.5%	$103,065
84	SKIN AND MUCOUS MEMBRANE PREPARATIONS	$54,023	$713,063	$660,495	8.0%	$52,568
28	CENTRAL NERVOUS SYSTEM DRUGS	$42,061	$525,065	$441,741	18.9%	$83,323
56	GASTRO-INTESTINAL DRUGS	$35,491	$438,646	$398,822	10.0%	$39,824
19	PHARMACY EQUIPMENT	$29,246	$204,500	$196,349	4.2%	$8,151
36	DIAGNOSTIC AGENTS	$25,109	$523,367	$644,856	-18.8%	($121,490)
94	TRIAL DRUGS	$23,486	$274,254	$398,284	-31.1%	($124,030)
24	CARDIOVASCULAR DRUGS	$20,419	$259,480	$260,265	-0.3%	($785)
12	AUTONOMIC DRUGS	$16,794	$237,927	$200,320	18.8%	$37,607
20	BLOOD FORMATION AND COAGULATION	$16,125	$234,566	$261,409	-10.3%	($26,843)
68	HORMONES AND SYNTHETIC SUBSTITUTES	$13,229	$237,878	$240,128	-0.9%	($2,250)
21	NUTRITION AND DIETETICS	$9,531	$139,030	$105,416	31.9%	$33,614
86	RESPIRATORY AGENTS	$8,304	$88,688	$84,634	4.8%	$4,054
88	VITAMIN PREPARATIONS	$8,296	$63,616	$55,211	15.2%	$8,405
72	LOCAL ANAESTHETICS	$7,522	$83,586	$63,030	32.6%	$20,556
52	EYE PREPARATIONS	$7,233	$107,146	$129,271	-17.1%	($22,124)
50	EAR, NOSE AND THROAT PREPARATIONS	$5,306	$50,332	$50,230	0.2%	$102
60	ANTIRHEUMATIC AGENTS	$1,981	$31,216	$34,223	-8.8%	($3,007)
4	ANTIHISTAMINES	$1,487	$18,510	$16,639	11.2%	$1,871
80	SERUMS, TOXOIDS, VACCINES	$1,242	$58,936	$38,664	52.4%	$20,272
92	UNCLASSIFIED THERAPEUTIC AGENTS	$1,082	$27,316	$15,002	82.1%	$12,314
64	DETOXIFYING AGENTS AND ANTAGONISTS	$762	$29,509	$67,532	-56.3%	($38,023)
76	OXYTOCICS	$43	$1,083	$470	130.4%	$613
	SUB-TOTAL	$622,616	$7,777,400	$7,489,106	3.8%	$288,294
	LESS Section 21	$9,531	$139,030	$105,416		
	ADJUSTED TOTAL	$613,085	$7,638,370	$7,383,690	3.4%	$254,680

adjusted for 12 months advance purchase of $362,120 in June 1988/89 for 1989/90.
* Notional budget calculated from previous years purchases as a % of total purchases and adjusted for current year Drug Budget
~ Section 21 = Dietary Formula which although purchased by the Pharmacy are not included as drug expenditure for Drug Committee reports

Figure 3 Month-to-date Drug Purchase Report, sorted by dollar variance (descending) from notional budgets (based on total purchases for group over the previous financial year), for Level 1 descriptions of the RAH Formulary drug classification system

PHARMACY DEPARTMENT - ROYAL ADELAIDE HOSPITAL
DRUG PURCHASE STATEMENT - 1990/91

For Month Ending:- June 1991
By: G. Misan, Project Pharmacist, Drug Committee

SORTED BY $ VARIANCE FROM BUDGET

Drug budget	
Current year:	$7,489,106
Previous year:	$7,090,796
Expenditure	
Year-to-date:	$7,777,400
Last-year-to-date:	$7,714,743
Last year full year:	$7,714,743

SECTION NO	CATEGORY DESCRIPTION	ORDERS MONTH TO DATE	ORDERS YEAR TO DATE	NOTIONAL * BUDGET YEAR TO DATE	YEAR TO DATE BUDGET VARIANCE %	YEAR TO DATE BUDGET VARIANCE $
8	ANTI-INFECTIVE AGENTS	$107,815	$1,287,402	$1,140,706	12.9%	$146,696
40	ELECTROLYTE, NUTRITION/FLUID BALANCE	$75,772	$999,808	$896,743	11.5%	$103,065
28	CENTRAL NERVOUS SYSTEM DRUGS	$42,061	$525,065	$441,741	18.9%	$83,323
10	ANTINEOPLASTIC/IMMUNOSUPPRESSANT AGENTS	$110,257	$1,142,477	$1,088,667	4.9%	$53,811
84	SKIN AND MUCOUS MEMBRANE PREPARATIONS	$54,023	$713,063	$660,495	8.0%	$52,568
56	GASTRO-INTESTINAL DRUGS	$35,491	$438,646	$398,822	10.0%	$39,824
12	AUTONOMIC DRUGS	$16,794	$237,927	$200,320	18.8%	$37,607
21	NUTRITION AND DIETETICS	$9,531	$139,030	$105,416	31.9%	$33,614
72	LOCAL ANAESTHETICS	$7,522	$83,586	$63,030	32.6%	$20,556
80	SERUMS, TOXOIDS, VACCINES	$1,242	$58,936	$38,664	52.4%	$20,272
92	UNCLASSIFIED THERAPEUTIC AGENTS	$1,082	$27,316	$15,002	82.1%	$12,314
88	VITAMIN PREPARATIONS	$8,296	$63,616	$55,211	15.2%	$8,405
19	PHARMACY EQUIPMENT	$29,246	$204,500	$196,349	4.2%	$8,151
86	RESPIRATORY AGENTS	$8,304	$88,688	$84,634	4.8%	$4,054
4	ANTIHISTAMINES	$1,487	$18,510	$16,639	11.2%	$1,871
76	OXYTOCICS	$43	$1,083	$470	130.4%	$613
50	EAR, NOSE AND THROAT PREPARATIONS	$5,306	$50,332	$50,230	0.2%	$102
24	CARDIOVASCULAR DRUGS	$20,419	$259,480	$260,265	-0.3%	($785)
68	HORMONES AND SYNTHETIC SUBSTITUTES	$13,229	$237,878	$240,128	-0.9%	($2,250)
60	ANTIRHEUMATIC AGENTS	$1,981	$31,216	$34,223	-8.8%	($3,007)
52	EYE PREPARATIONS	$7,233	$107,146	$129,271	-17.1%	($22,124)
20	BLOOD FORMATION AND COAGULATION	$16,125	$234,566	$261,409	-10.3%	($26,843)
64	DETOXIFYING AGENTS AND ANTAGONISTS	$762	$29,509	$67,532	-56.3%	($38,023)
36	DIAGNOSTIC AGENTS	$25,109	$523,367	$644,856	-18.8%	($121,490)
94	TRIAL DRUGS	$23,486	$274,254	$398,284	-31.1%	($124,030)
	SUB-TOTAL	$622,616	$7,777,400	$7,489,106	3.8%	$288,294
	LESS Section 21	$9,531	$139,030	$105,416		
	ADJUSTED TOTAL	$613,085	$7,638,370	$7,383,690	3.4%	$254,680

adjusted for 12 months advance purchase of $362,120 in June 1988/89 for 1989/90.
* Notional budget calculated from previous years purchases as a % of total purchases and adjusted for current year Drug Budget
~ Section 21 = Dietary Formula which although purchased by the Pharmacy are not included as drug expenditure for Drug Committee reports

Figure 4 Month-to-date Drug Purchase Report, sorted by percentage variance (descending) from budget purchases, for Level 1 descriptions of the RAH Formulary drug classification system

PHARMACY DEPARTMENT - ROYAL ADELAIDE HOSPITAL
DRUG PURCHASE STATEMENT - 1990/91

For Month Ending:- June 1991
By: G. Misan, Project Pharmacist, Drug Committee

SORTED BY % VARIANCE FROM BUDGET

Drug budget	
Current year:	$7,489,106
Previous year:	$7,090,796
Expenditure	
Year-to-date:	$7,777,400
Last-year-to-date:	$7,714,743
Last year full year:	$7,714,743

SECTION NO.	CATEGORY DESCRIPTION	ORDERS MONTH TO DATE	ORDERS YEAR TO DATE	NOTIONAL * BUDGET YEAR TO DATE	YEAR TO DATE BUDGET VARIANCE %	YEAR TO DATE BUDGET VARIANCE $
76	OXYTOCICS	$43	$1,083	$470	130.4%	$613
92	UNCLASSIFIED THERAPEUTIC AGENTS	$1,082	$27,316	$15,002	82.1%	$12,314
80	SERUMS, TOXOIDS, VACCINES	$1,242	$58,936	$38,664	52.4%	$20,272
72	LOCAL ANAESTHETICS	$7,522	$83,586	$63,030	32.6%	$20,556
21	NUTRITION AND DIETETICS	$9,531	$139,030	$105,416	31.9%	$33,614
28	CENTRAL NERVOUS SYSTEM DRUGS	$42,061	$525,065	$441,741	18.9%	$83,323
12	AUTONOMIC DRUGS	$16,794	$237,927	$200,320	18.8%	$37,607
88	VITAMIN PREPARATIONS	$8,296	$63,616	$55,211	15.2%	$8,405
8	ANTI-INFECTIVE AGENTS	$107,815	$1,287,402	$1,140,706	12.9%	$146,696
40	ELECTROLYTE, NUTRITION/FLUID BALANCE	$75,772	$999,808	$896,743	11.5%	$103,065
4	ANTIHISTAMINES	$1,487	$18,510	$16,639	11.2%	$1,871
56	GASTRO-INTESTINAL DRUGS	$35,491	$438,646	$398,822	10.0%	$39,824
84	SKIN AND MUCOUS MEMBRANE PREPARATIONS	$54,023	$713,063	$660,495	8.0%	$52,568
10	ANTINEOPLASTIC/IMMUNOSUPPRESSANT AGENTS	$110,257	$1,142,477	$1,088,667	4.9%	$53,811
86	RESPIRATORY AGENTS	$8,304	$88,688	$84,634	4.6%	$4,054
19	PHARMACY EQUIPMENT	$29,246	$204,500	$196,349	4.2%	$8,151
50	EAR, NOSE AND THROAT PREPARATIONS	$5,306	$50,332	$50,230	0.2%	$102
24	CARDIOVASCULAR DRUGS	$20,419	$259,480	$260,265	-0.3%	($785)
68	HORMONES AND SYNTHETIC SUBSTITUTES	$13,229	$237,878	$240,128	-0.9%	($2,250)
60	ANTIRHEUMATIC AGENTS	$1,981	$31,216	$34,223	-8.8%	($3,007)
20	BLOOD FORMATION AND COAGULATION	$16,125	$234,566	$261,409	-10.3%	($26,843)
52	EYE PREPARATIONS	$7,233	$107,146	$129,271	-17.1%	($22,124)
36	DIAGNOSTIC AGENTS	$25,109	$523,367	$644,856	-18.8%	($121,490)
94	TRIAL DRUGS	$23,486	$274,254	$398,284	-31.1%	($124,030)
64	DETOXIFYING AGENTS AND ANTAGONISTS	$762	$29,509	$67,532	-56.3%	($38,023)
	SUB-TOTAL	$622,616	$7,777,400	$7,489,106	3.8%	$288,294
	LESS Section 21	$9,531	$139,030	$105,416		
	ADJUSTED TOTAL	$613,085	$7,638,370	$7,383,690	3.4%	$254,680

adjusted for 12 months advance purchase of $362,120 in June 1988/89 for 1989/90.
* Notional budget calculated from previous years purchases as a % of total purchases and adjusted for current year Drug Budget
~ Section 21 = Dietary Formula which although purchased by the Pharmacy are not included as drug expenditure for Drug Committee reports

Figure 5 Year-to-date Drug Purchase Report, sorted by dollar value of purchases year-to-date

PHARMACY DEPARTMENT - ROYAL ADELAIDE HOSPITAL
DRUG PURCHASE STATEMENT - 1990/91

For Month Ending:- June 1991
By: G. Misan, Project Pharmacist, Drug Committee

SORTED BY $ PURCHASES YEAR-TO-DATE

Drug budget	
Current year:	$7,489,106
Previous year:	$7,090,796
Expenditure	
Year-to-date:	$7,777,400
Last-year-to-date:	$7,714,743
Last year full year:	$7,714,743

SECTION NO	CATEGORY DESCRIPTION	ORDERS MONTH TO DATE	ORDERS YEAR TO DATE	PREVIOUS YEAR YEAR TO DATE	YEAR TO DATE VARIANCE %	YEAR TO DATE VARIANCE $
8	ANTI-INFECTIVE AGENTS	$107,815	$1,287,402	$1,175,074	9.6%	$112,328
10	ANTINEOPLASTIC/IMMUNOSUPPRESSANT AGENTS	$110,257	$1,142,477	$1,121,467	1.9%	$21,011
40	ELECTROLYTE, NUTRITION/FLUID BALANCE	$75,772	$999,808	$923,760	8.2%	$76,047
84	SKIN AND MUCOUS MEMBRANE PREPARATIONS	$54,023	$713,063	$680,395	4.8%	$32,668
28	CENTRAL NERVOUS SYSTEM DRUGS	$42,061	$525,065	$455,051	15.4%	$70,014
36	DIAGNOSTIC AGENTS	$25,109	$523,367	$664,285	-21.2%	($140,918)
56	GASTRO-INTESTINAL DRUGS	$35,491	$438,646	$410,838	6.8%	$27,808
94	TRIAL DRUGS	$23,486	$274,254	$410,284	-33.2%	($136,030)
24	CARDIOVASCULAR DRUGS	$20,419	$259,480	$268,106	-3.2%	($8,626)
12	AUTONOMIC DRUGS	$16,794	$237,927	$206,356	15.3%	$31,571
68	HORMONES AND SYNTHETIC SUBSTITUTES	$13,229	$237,878	$247,362	-3.8%	($9,484)
20	BLOOD FORMATION AND COAGULATION	$16,125	$234,566	$269,285	-12.9%	($34,719)
19	PHARMACY EQUIPMENT	$29,246	$204,500	$202,264	1.1%	$2,236
21	NUTRITION AND DIETETICS	$9,531	$139,030	$108,592	28.0%	$30,438
52	EYE PREPARATIONS	$7,233	$107,146	$133,165	-19.5%	($26,019)
86	RESPIRATORY AGENTS	$8,304	$88,688	$87,184	1.7%	$1,504
72	LOCAL ANAESTHETICS	$7,522	$83,586	$64,929	28.7%	$18,657
88	VITAMIN PREPARATIONS	$8,296	$63,616	$56,875	11.9%	$6,741
80	SERUMS, TOXOIDS, VACCINES	$1,242	$58,936	$39,829	48.0%	$19,107
50	EAR, NOSE AND THROAT PREPARATIONS	$5,306	$50,332	$51,743	-2.7%	($1,411)
60	ANTIRHEUMATIC AGENTS	$1,981	$31,216	$35,254	-11.5%	($4,038)
64	DETOXIFYING AGENTS AND ANTAGONISTS	$762	$29,509	$69,567	-57.6%	($40,058)
92	UNCLASSIFIED THERAPEUTIC AGENTS	$1,082	$27,316	$15,454	76.8%	$11,862
4	ANTIHISTAMINES	$1,487	$18,510	$17,140	8.0%	$1,369
76	OXYTOCICS	$43	$1,083	$484	123.7%	$599
	SUB-TOTAL	$622,616	$7,777,400	$7,714,743	0.8%	$62,656
	LESS Section 21	$9,531	$139,030	$108,592		
	ADJUSTED TOTAL	$613,085	$7,638,370	$7,606,151	0.4%	$32,218

adjusted for 12 months advance purchase of $362,120 in June 1988/89 for 1989/90.
* Notional budget calculated from previous years purchases as a % of total purchases and adjusted for current year Drug Budget
~ Section 21 = Dietary Formula which although purchased by the Pharmacy are not included as drug expenditure for Drug Committee reports

Figure 6 Year-to-date Drug Purchase Report, sorted by dollar variance of purchases between years

PHARMACY DEPARTMENT - ROYAL ADELAIDE HOSPITAL
DRUG PURCHASE STATEMENT - 1990/91

For Month Ending:- June 1991
By: G. Misan, Project Pharmacist, Drug Committee

SORTED BY $ VARIANCE FROM PREVIOUS YEAR

Drug budget	
Current year:	$7,489,106
Previous year:	$7,090,796
Expenditure	
Year-to-date:	$7,777,400
Last-year-to-date:	$7,714,743
Last year full year:	$7,714,743

SECTION NO.	CATEGORY DESCRIPTION	ORDERS MONTH TO DATE	ORDERS YEAR TO DATE	PREVIOUS YEAR YEAR TO DATE	YEAR TO DATE VARIANCE %	YEAR TO DATE VARIANCE $
8	ANTI-INFECTIVE AGENTS	$107,815	$1,287,402	$1,175,074	9.6%	$112,328
40	ELECTROLYTE, NUTRITION/FLUID BALANCE	$75,772	$999,808	$923,760	8.2%	$76,047
28	CENTRAL NERVOUS SYSTEM DRUGS	$42,061	$525,065	$455,051	15.4%	$70,014
84	SKIN AND MUCOUS MEMBRANE PREPARATIONS	$54,023	$713,063	$680,395	4.8%	$32,668
12	AUTONOMIC DRUGS	$16,794	$237,927	$206,356	15.3%	$31,571
21	NUTRITION AND DIETETICS	$9,531	$139,030	$108,592	28.0%	$30,438
56	GASTRO-INTESTINAL DRUGS	$35,491	$438,646	$410,838	6.8%	$27,808
10	ANTINEOPLASTIC/IMMUNOSUPPRESSANT AGENTS	$110,257	$1,142,477	$1,121,467	1.9%	$21,011
80	SERUMS, TOXOIDS, VACCINES	$1,242	$58,936	$39,829	48.0%	$19,107
72	LOCAL ANAESTHETICS	$7,522	$83,586	$64,929	28.7%	$18,657
92	UNCLASSIFIED THERAPEUTIC AGENTS	$1,082	$27,316	$15,454	76.8%	$11,862
88	VITAMIN PREPARATIONS	$8,296	$63,616	$56,875	11.9%	$6,741
19	PHARMACY EQUIPMENT	$29,246	$204,500	$202,264	1.1%	$2,236
86	RESPIRATORY AGENTS	$8,304	$88,688	$87,184	1.7%	$1,504
4	ANTIHISTAMINES	$1,487	$18,510	$17,140	8.0%	$1,369
76	OXYTOCICS	$43	$1,083	$484	123.7%	$599
50	EAR, NOSE AND THROAT PREPARATIONS	$5,306	$50,332	$51,743	-2.7%	($1,411)
60	ANTIRHEUMATIC AGENTS	$1,981	$31,216	$35,254	-11.5%	($4,038)
24	CARDIOVASCULAR DRUGS	$20,419	$259,480	$268,106	-3.2%	($8,626)
68	HORMONES AND SYNTHETIC SUBSTITUTES	$13,229	$237,878	$247,362	-3.8%	($9,484)
52	EYE PREPARATIONS	$7,233	$107,146	$133,165	-19.5%	($26,019)
20	BLOOD FORMATION AND COAGULATION	$16,125	$234,566	$269,285	-12.9%	($34,719)
64	DETOXIFYING AGENTS AND ANTAGONISTS	$762	$29,509	$69,567	-57.6%	($40,058)
94	TRIAL DRUGS	$23,486	$274,254	$410,284	-33.2%	($136,030)
36	DIAGNOSTIC AGENTS	$25,109	$523,367	$664,285	-21.2%	($140,918)
	SUB-TOTAL	$622,616	$7,777,400	$7,714,743	0.8%	$62,656
	LESS Section 21	$9,531	$139,030	$108,592		
	ADJUSTED TOTAL	$613,085	$7,638,370	$7,606,151	0.4%	$32,218

adjusted for 12 months advance purchase of $362,120 in June 1988/89 for 1989/90.
* Notional budget calculated from previous years purchases as a % of total purchases and adjusted for current year Drug Budget
~ Section 21 = Dietary Formula which although purchased by the Pharmacy are not included as drug expenditure for Drug Committee reports

Figure 7 Year-to-date Drug Purchase Report, sorted by percent variance form purchases for same period the previous year

PHARMACY DEPARTMENT - ROYAL ADELAIDE HOSPITAL
DRUG PURCHASE STATEMENT - 1990/91

For Month Ending:- June 1991
By: G. Misan, Project Pharmacist, Drug Committee

SORTED BY % VARIANCE FROM PREVIOUS YEAR

Drug budget	
Current year:	$7,489,106
Previous year:	$7,090,796
Expenditure	
Year-to-date:	$7,777,400
Last-year-to-date:	$7,714,743
Last year full year:	$7,714,743

SECTION NO.	CATEGORY DESCRIPTION	ORDERS MONTH TO DATE	ORDERS YEAR TO DATE	PREVIOUS YEAR YEAR TO DATE	YEAR TO DATE VARIANCE %	YEAR TO DATE VARIANCE $
76	OXYTOCICS	$43	$1,083	$484	123.7%	$599
92	UNCLASSIFIED THERAPEUTIC AGENTS	$1,082	$27,316	$15,454	76.8%	$11,862
80	SERUMS, TOXOIDS, VACCINES	$1,242	$58,936	$39,829	48.0%	$19,107
72	LOCAL ANAESTHETICS	$7,522	$83,586	$64,929	28.7%	$18,657
21	NUTRITION AND DIETETICS	$9,531	$139,030	$108,592	28.0%	$30,438
28	CENTRAL NERVOUS SYSTEM DRUGS	$42,061	$525,065	$455,051	15.4%	$70,014
12	AUTONOMIC DRUGS	$16,794	$237,927	$206,356	15.3%	$31,571
88	VITAMIN PREPARATIONS	$8,296	$63,616	$56,875	11.9%	$6,741
8	ANTI-INFECTIVE AGENTS	$107,815	$1,287,402	$1,175,074	9.6%	$112,328
40	ELECTROLYTE, NUTRITION/FLUID BALANCE	$75,772	$999,808	$923,760	8.2%	$76,047
4	ANTIHISTAMINES	$1,487	$18,510	$17,140	8.0%	$1,369
56	GASTRO-INTESTINAL DRUGS	$35,491	$438,646	$410,838	6.8%	$27,808
84	SKIN AND MUCOUS MEMBRANE PREPARATIONS	$54,023	$713,063	$680,395	4.8%	$32,668
10	ANTINEOPLASTIC/IMMUNOSUPPRESSANT AGENTS	$110,257	$1,142,477	$1,121,467	1.9%	$21,011
86	RESPIRATORY AGENTS	$8,304	$88,688	$87,184	1.7%	$1,504
19	PHARMACY EQUIPMENT	$29,246	$204,500	$202,264	1.1%	$2,236
50	EAR, NOSE AND THROAT PREPARATIONS	$5,306	$50,332	$51,743	-2.7%	($1,411)
24	CARDIOVASCULAR DRUGS	$20,419	$259,480	$268,106	-3.2%	($8,626)
68	HORMONES AND SYNTHETIC SUBSTITUTES	$13,229	$237,878	$247,362	-3.8%	($9,484)
60	ANTIRHEUMATIC AGENTS	$1,981	$31,216	$35,254	-11.5%	($4,038)
20	BLOOD FORMATION AND COAGULATION	$16,125	$234,566	$269,285	-12.9%	($34,719)
52	EYE PREPARATIONS	$7,233	$107,146	$133,165	-19.5%	($26,019)
36	DIAGNOSTIC AGENTS	$25,109	$523,367	$664,285	-21.2%	($140,918)
94	TRIAL DRUGS	$23,486	$274,254	$410,284	-33.2%	($136,030)
64	DETOXIFYING AGENTS AND ANTAGONISTS	$762	$29,509	$69,567	-57.6%	($40,058)
	SUB-TOTAL	$622,616	$7,777,400	$7,714,743	0.8%	$62,656
	LESS Section 21	$9,531	$139,030	$108,592		
	ADJUSTED TOTAL	$613,085	$7,638,370	$7,606,151	0.4%	$32,218

adjusted for 12 months advance purchase of $362,120 in June 1988/89 for 1989/90.
* Notional budget calculated from previous years purchases as a % of total purchases and adjusted for current year Drug Budget
~ Section 21 = Dietary Formula which although purchased by the Pharmacy are not included as drug expenditure for Drug Committee reports

4.1 Drug purchase reports

4.1.1 Aggregate reports

Aggregate reports were used to provide information to the Drug Committee and/or Finance Sub-committee as indicators of gross movements of major drug expenditure categories. Aggregate reports included month-to-date and year-to-date reports. The reports described the value of orders purchased at the end of a month together with the cumulative value of orders for the financial year up to and including the end of that month (ie. year-to-date). These were also used to compare actual drug purchases with predicted figures, or with purchases for the same period the previous year. Information was summarised under the first level of the headings used in the Formulary classification system (Appendix 1).

Aggregate reports were provided in different formats to emphasise particular aspects of purchase activity:

1. Orders month-to-date.
2. Year-to-date.
3. Percent or dollar variance from notional budget figures.
4. By expenditure for the equivalent period the previous year.

For month-to-date reports, the notional budget figures for the respective classes were presented in addition to the purchase figures. The difference (variance) in both percentage and dollars between the value of orders and the predicted purchases (notional budget) was also described. Percentage variances were calculated by dividing the difference between the current month order value and the notional budget by the notional budget figure. Figures in parentheses represent negative variances which are favourable purchases trend relative to predicted figures. Subtotal, adjustment and explanatory notes for specific items were also included. Budget and expenditure figures were detailed at the top right corner of the reports.

Aggregate reports had several limitations which were more apparent when notional budgets rather than actual figures were used for comparisons between years. Firstly, they assumed movements in drug prices corresponded with the movements between drug budgets, which were generally adjusted upwards each year by an amount corresponding to the CPI. Secondly, they assumed there was concordance between drug utilisation and purchases. Unless changes in drug prices corresponded with changes in the budget between years, negative variances did not necessarily represent decreased utilisation. Decreased utilisation could only occur when there was a negative percentage purchase variance and when that variance exceeded the corresponding percentage budget increase between years (Figure 1) and then only if acquisition costs remained static. Equally, when increases in cost were greater than corresponding budget increases, a positive variance may have been associated with decreased utilisation. Thus, variances could not be interpreted without knowledge of price movements for individual drugs.

The other important limitation of aggregate data is that purchase variations within groups is unknown. A major drug group may comprise 100 or more drugs (eg. antiinfective agents) and alterations in purchase patterns among these agents are hidden by the aggregate nature of the report. For example, when there are general upward movements in purchase value for most drug lines within the group, or for those items which account for the majority of the expenditure of lines within the

group, this may be reflected in the aggregate value. In this case the net result for the group (ie. movements in aggregate figures and corresponding variances) would be indicative of movements for the whole group. This movement may then signal the need for closer scrutiny of the individual items within the groups. However, when upward movements of some lines are balanced by corresponding negative movements of others, the aggregate figure could remain static and mask changes within the group.

Percent and dollar thresholds

Sentinel thresholds were used to highlight variances from budgets and/or previous year expenditure. Thresholds provided greater sensitivity for interpretation of aggregate reports by enabling easier identification and targeting of 'problem' groups. Percentage or dollar thresholds were used. When report figures exceeded thresholds, items were flagged for further review.

Thresholds were arbitrarily set at one standard deviation[i] from the mean dollar or percent variance from budget, previous year expenditure or from year-to-date figures. The smaller the threshold, the more sensitive they became as a tool for identifying problem drug groups or individual drugs.

Because percentage variance values were generally smaller than dollar variances over the entire range of figures in the reports, the standard deviations for gross percentage variance were less than for the corresponding dollar figure. In some circumstances however, small dollar variances actually reflected large percentage variances for the group (Figure 4).

Here it can be seen that sorting data by percentage variance gives a different perspective on movements across drug groups. For example, the oxytocic group showed only small dollar movements between years. These movements however, represented a large percentage variance with respect to total expenditure for the group. The small dollar variance in these cases might have gone unnoticed if only dollar thresholds were used to provide the signal for further review.

4.1.2 Year-to-date purchase reports

Year-to-date reports (Figures 5 through 7) presented much the same information as month-to-date reports. Like the month-to-date reports, they were sorted to emphasise different aspects of purchase activity. The reports described orders month-to-date and year-to-date but instead of presenting notional budget figures, they detailed purchase figures for the corresponding period from the previous financial year. Here differences in purchases between successive years formed the basis of dollar and percentage variance calculations. This compared with the month-to-date reports which provided comparisons with notional budget forecasts.

Comparisons of actual purchases between years provided a clearer reflection of longitudinal utilisation patterns than notional budgets (which are projections). These comparisons were not influenced by inflation or other budget adjustments as were the notional budget comparisons. Differences in purchase price, buying patterns and/or utilisation were the only determinants of variance between years. Thus, year-to-date still had to be interpreted in conjunction with purchase price information. As for month-to-date reports, dollar variance and percentage thresholds were used to assist in identifying drug groups which required further scrutiny.

4.1.3 Summary reports

In certain cases even the detail evident in aggregate reports was superfluous to the needs of the Drug Committee. In these circumstances, reports were further contracted (Figure 8) to provide only dollar or/percentage variance from budget or the previous year and focus attention on the magnitude of the respective variances only.

Figure 8 Summary report detailing percent and $ variance of major therapeutic category expenditure from previous year

PHARMACY DEPARTMENT - ROYAL ADELAIDE HOSPITAL
DRUG PURCHASE STATEMENT - 1990/91

For Month Ending:- JUN-91
By: G. Misan, Project Pharmacist, Drug Committee

Drug budget	
Current year:	$7,489,106
Previous year:	$7,090,796
Expenditure	
Year-to-date:	$7,777,400
Last-year-to-date:	$7,714,743
Last year full year:	$7,714,743

SECTION		YEAR TO DATE VARIANCE	
		%	$
8	ANTI-INFECTIVE AGENTS	9.6%	$112,328
40	ELECTROLYTE, NUTRITION/FLUID BALANCE	8.2%	$76,047
28	CENTRAL NERVOUS SYSTEM DRUGS	15.4%	$70,014
84	SKIN AND MUCOUS MEMBRANE PREPARATIONS	4.8%	$32,668
12	AUTONOMIC DRUGS	15.3%	$31,571
56	GASTRO-INTESTINAL DRUGS	6.8%	$27,808
10	ANTINEOPLASTIC/IMMUNOSUPPRESSANT AGENTS	1.9%	$21,011
80	SERUMS, TOXOIDS, VACCINES	48.0%	$19,107
72	LOCAL ANAESTHETICS	28.7%	$18,657
92	UNCLASSIFIED THERAPEUTIC AGENTS	76.8%	$11,862
88	VITAMIN PREPARATIONS	11.9%	$6,741
19	PHARMACY EQUIPMENT	1.1%	$2,236
86	RESPIRATORY AGENTS	1.7%	$1,504
4	ANTIHISTAMINES	8.0%	$1,369
76	OXYTOCICS	123.7%	$599
50	EAR, NOSE AND THROAT PREPARATIONS	-2.7%	($1,411)
60	ANTIRHEUMATIC AGENTS	-11.5%	($4,038)
24	CARDIOVASCULAR DRUGS	-3.2%	($8,626)
68	HORMONES AND SYNTHETIC SUBSTITUTES	-3.8%	($9,484)
52	EYE PREPARATIONS	-19.5%	($26,019)
20	BLOOD FORMATION AND COAGULATION	-12.9%	($34,719)
64	DETOXIFYING AGENTS AND ANTAGONISTS	-57.6%	($40,058)
94	TRIAL DRUGS	-33.2%	($136,030)
36	DIAGNOSTIC AGENTS	-21.2%	($140,918)
	ADJUSTED TOTAL	0.4%	($32,218)

adjusted for 12 months advance purchase of $362,120 in June 1988/89 for 1989/90.
* Notional budget calculated from previous years purchases as a % of total purchases and adjusted for current year Drug Budget

4.1.4 Detailed reports

At the opposite end of the report continuum were reports which provided information about individual drug utilisation. These reports were used to track utilisation trends for individual drugs or drug groups over time. They were also useful for general characterisation or the dynamics of the major drug categories. Of these the most commonly used were those describing purchases or ward issues for individual drugs as opposed to the major categories or subclasses of drugs. In practice, the detailed reports were reserved for use by DUE personnel and/or their working parties.

Data were displayed under a range of headings corresponding to the hierarchy of the Formulary classification system (see Antiinfective example below).

8:00 ANTI-INFECTIVE AGENTS
8:08 Anthelmintics
..
..
8:12 Antibiotics
..
..
8:12:06 *Cephalosporins*
..
..
cefamandole
ceftriaxone
..
..
8:12:07 *Miscellaneous beta-lactam antibiotics*
..
imipenem/cilastatin
..
8:12:16 *Penicillins*
..
..
benzylpenicillin
flucloxacillin
..
..

The report illustrated in Figure 10 was for beta-lactam antibiotics. Some of these data were similar to those described for aggregate reports but included some additional data fields (eg. purchase unit description). Reports were sorted to highlight specific aspects of purchase activity and these details, particularly when combined with reports of issues to the hospital cost centres, provided a clear picture of quantitative hospital drug utilisation.

A number of conclusions could be derived even by superficial inspection of this type of report. For example, for the antibiotics described below (financial year ending June 1993) the following observations were noteworthy:

- antiinfectives accounted for 21% of total drug purchases;
- beta-lactam antibiotics accounted for almost 50% of anti-infective drug expenditure;
- beta-lactam antibiotics accounted for 10% of total drug expenditure for the hospital;
- the 'top 5' antibiotics accounted for 56% of the beta-lactam expenditure and the 'top 10' for 78% of category expenditure;
- most beta-lactam antibiotics demonstrated expenditure greater than the budget figure;
- Timentin™ was the greatest expenditure item and demonstrated a 33% increase over the previous year's expenditure and a 53% increase over the budget figure;
- drug items which showed no purchases were those which had been discontinued or where the particular purchase brand had changed.

During the course of a year, detailed analysis for each of the 25 drug Formulary drug categories was undertaken using this report format as a starting point. Two to three major categories were targeted each month enabling all drug categories to be reviewed at least once each year. As interesting utilisation trends emerged, drug issue reports were requested from the finance department in order to identify user groups. The extent of distribution of the particular drugs of interest dictated the subse-

quent strategies. For example, where utilisation was restricted to one or two clinical units, department or division heads were supplied with the data and asked to explain reasons for changing trends. For drugs displaying broad utilisation, qualitative investigations were initiated.

4.2 Drug issue reports

Computerised drug issue or cost centre reports described (in gross terms) the value of drugs issued to wards and departments. Up to late 1993, prescriptions could be separated by clinics and then into inpatient or outpatient groups for each clinic. This was on the basis of the numbering system applied to cost centres (eg. 6000 series of numbers related to inpatient areas and 7000 series to outpatient areas; Figure 9). The ability to follow drug issues through to particular patients was not available. The number of units issued was calculated by dividing the value of the issues by the average unit purchase price of the drug for the issue period. Quantification of patient issues for specialised drugs (eg. Drugs of Dependence, Investigational and Trial Drugs) could be obtained manually from registers, other records or from stand-alone PC databases designed by the author. For other drugs, individual patient utilisation data could only be obtained from a manual review of copies of prescriptions or of medication charts. This process was so labour intensive, that except when performed as part of the qualitative review process, it could not be used to prepare trend data.

With the implementation of the new pharmacy computer and drug distribution system between late 1993 and mid-1995, much better utilisation information became available. The new system allowed accurate quantification of patient types as well as the number of units issued, the number of times a drug was dispensed and the drug cost associated with each transaction. Statistics for all prescription types could be reported including inpatient, outpatient, discharge, casualty, radiotherapy and other patient types. In addition to providing better utilisation data, these data also facilitated the collation of workload statistics for use by department managers.

Figure 9 Differentiation of Cost Centre Categories at the Royal Adelaide Hospital

Royal Adelaide Hospital
Pharmacy Department

Individual Patient Supply (I.P.S.) Drug Distribution System

Cost Centre Categories

There are 2 series of cost centres used by the Finance Department for allocating costs for drugs supplied by the Pharmacy

1. The 7000 series

- Used for I.P.S. INPATIENT drugs. Costs are allocated to the *Clinic* associated with the patient UR number on the I.P.S. drug order.
- Used for I.P.S. EMERGENCY / AFTER HOURS drugs. Costs are allocated to the *Clinic* associated with the patient UR number on the I.P.S. drug order.
- Used for DISCHARGE drugs. Costs are allocated to the *Clinic* associated with the last inpatient encounter associated with the patient UR number & date on the discharge Rx.
- Used for OUTPATIENT drugs. Costs are allocated to the *Clinic* associated with the *ward code* assigned at the time the OPD appointment is entered onto the hospital's computerised OPD booking system.
- Used for ORAL CYTOTOXIC drugs and adjunctive treatments. Costs are allocated to the *Clinic* (for inpatients) or *ward code* (for outpatients) associated with the patient UR number on the Rx.

Note: All patient orders can be identified by a six digit Pharmacy reference number on the Finance Department Microfiche.

2. The 6000 series

Used for:

- WARD ORDER drugs (Non-I.P.S. drugs).
- DRUGS OF DEPENDENCE (DDs).
- PARENTERAL CYTOTOXIC drugs and I.V. ADDITIVES prepared by the Pharmacy.
- IMPREST ITEMS.
- I.P.S. SPECIAL IMPREST ITEMS.

- Costs for the above orders are allocated via the *ward code* for the area (e.g. S8) identified on the order. The ward code is then mapped to a *Cost Centre* by the Finance Department through the Finance computer system (Note: Only the ward code is entered into the Pharmacy computer system). All cost centre determinations and mapping are performed by the Finance Department on the Finance computer system.) .

Note: The above orders can be distinguished from patient orders because they have Pharmacy reference numbers other than six digits on the Finance Department Microfiche.

Figure 10 Detailed drug purchase report showing detail for individual drugs

SUMMARY REPORT -
Anti-infective agents - Formulary Section 08

Month End: Jun 93

Description	Purchase Unit	Order Value Ytd	Last Year Ytd	Last Year Full Year	Year to Date Notional Budget 92/93	Dollar variance	As % of budget	Purchases (YTD) as:- % of Category	Cumulative total	% of Total Purchases
TIMENTIN INJECTION 3.1gram CODE: N2150	1	$129,179	$96,691	$96,691	$83,994	$45,185	153.8%	6.518%	6.518%	1.371%
CEFTRIAXONE INJECTION 1 G (ROCEPHIN)	1	$118,514	$109,745	$109,745	$95,333	$23,280	124.4%	5.985%	12.502%	1.259%
CEFTAZIDIME INJECTION 2G 'FORTUM'	1	$103,837	$87,133	$87,133	$75,691	$28,145	137.2%	5.239%	17.741%	1.102%
CEPHALOTHIN SODIUM INJECTION 1G	1	$93,588	$93,790	$93,790	$81,474	$12,114	114.9%	4.722%	22.463%	0.993%
FLUCLOXACILLIN 1gram INJECTION 'FLOXAPEN'	5	$72,505	$79,391	$79,391	$68,966	$3,539	105.1%	3.658%	26.121%	0.769%
IMIPENEM INJECTION 500MG WITH CILASTATIN	5	$56,466	$108,680	$108,680	$94,408	($37,942)	59.8%	2.849%	28.970%	0.599%
AMOXYCILLIN INJECTION 1G 'MOXACIN' 00020205	5	$47,128	$48,464	$48,464	$42,100	$5,028	111.9%	2.378%	31.348%	0.500%
PIPERACILLIN INJECTION 3GRAM 'PIPRIL'	1	$42,390	$18,800	$18,800	$16,331	$26,059	259.6%	2.139%	33.487%	0.450%
AUGMENTIN FORTE TABLET		$38,910	$21,474	$21,474	$18,654	$20,255	208.6%	1.963%	35.450%	0.413%
BENZYL PENICILLIN INJECTION 600MG CSL 00177705	5	$31,110	$31,063	$31,063	$26,984	$4,126	115.3%	1.570%	37.019%	0.330%
FLUCLOXACILLIN CAPSULES 500MG		$27,375	$26,918	$26,918	$23,383	$3,992	117.1%	1.381%	38.401%	0.291%
CEFTAZIDIME INJECTION 1 G 'FORTUM'	1	$21,353	$25,658	$25,658	$22,289	($936)	95.8%	1.077%	39.478%	0.227%
CEFOXITIN INJECTION 1g 'MEFOXIN' 03780205	5	$18,315	$17,485	$17,485	$15,189	$3,126	120.6%	0.924%	40.402%	0.194%
CEPHALEXIN 500mg CAPSULES 'CEPOREX'	30	$17,933	$16,669	$16,669	$14,480	$3,453	123.8%	0.905%	41.307%	0.190%
AZTREONAM INJECTION 1 G (Azactam)	5	$14,292	$2,056	$2,056	$1,786	$12,506	800.1%	0.721%	42.028%	0.152%
AMOXYCILLIN CAPSULES 500MG		$13,625	$12,433	$12,433	$10,800	$2,825	126.2%	0.687%	42.715%	0.145%
CEFOXITIN INJECTION 2g (MEFOXIN)	5	$13,166	$16,335	$16,335	$14,190	($1,024)	92.8%	0.664%	43.379%	0.140%
AUGMENTIN TABLET		$9,360	$8,480	$8,480	$7,366	$1,994	127.1%	0.472%	43.852%	0.099%
PIPERACILLIN INJECTION 4g (PIPRIL)	1	$9,262	$1,985	$1,985	$1,724	$7,538	537.2%	0.467%	44.319%	0.098%
FLUCLOCACILLIN 1gram INJECTION 'FLUCIL'	5	$8,424	-	-	-	$8,424	-	0.425%	44.744%	0.089%
TICARCILLIN INJECTION 3G (VIAL) TARCIL BEECHAM	5	$7,000	$3,750	$3,750	$3,258	$3,742	214.9%	0.353%	45.097%	0.074%
AMOXYCILLIN INJECTION 500MG		$5,994	$7,749	$7,749	$6,731	($737)	89.0%	0.302%	45.400%	0.064%
CEFTRIAXONE INJECTION 2G (ROCEPHIN)	1	$5,896	$10,318	$10,318	$8,963	($3,067)	65.8%	0.297%	45.697%	0.063%
PENICILLIN V CAPSULE 500MG 'CILICAINE VK'	25	$5,026	$3,916	$3,916	$3,401	$1,625	147.8%	0.254%	45.951%	0.053%
FLUCLOXACILLIN INJECTION 500mg 'FLOXAPEN'	5	$4,465	$7,030	$7,030	$6,107	($1,642)	73.1%	0.225%	46.176%	0.047%
BENZYLPENICILLIN INJECTION 3g 00170805	5	$3,051	$915	$915	$795	$2,257	384.0%	0.154%	46.330%	0.032%
AUGMENTIN FORTE SYRUP	1	$2,135	$1,967	$1,967	$1,709	$426	124.9%	0.108%	46.438%	0.023%
FLUCLOXACILLIN SYRUP 250MG/5ML		$1,891	$1,933	$1,933	$1,679	$212	112.6%	0.095%	46.533%	0.020%
CEPHALEXIN SYRUP 250MG/5ML 100ML (CEPOREX)	100	$1,820	$1,316	$1,316	$1,143	$677	159.2%	0.092%	46.625%	0.019%
CEPHAMANDOLE INJECTION 1g (MANDOL)	1	$1,463	$150	$150	$130	$1,332	1122.4%	0.074%	46.699%	0.016%
AMOXYCILLIN CAPSULE 250MG (ALPHAMOX)	20	$1,371	$347	$347	$301	$1,070	455.0%	0.069%	46.768%	0.015%
AMOXYCILLIN MIXTURE 250MG/5ML		$1,299	$1,470	$1,470	$1,277	$21	101.7%	0.066%	46.833%	0.014%
FLUCLOXACILLIN CAPSULES 250MG STAPHYLEX ALP	30	$1,040	$1,240	$1,240	$1,077	($37)	96.5%	0.052%	46.886%	0.011%
FLUCLOXACILLIN 500mg INJECTION 'FLUCIL'	5	$975	-	-	-	$975	-	0.049%	46.935%	0.010%
PROCAINE PENICILLIN INJECTION 1.5g (Cilicaine)	5	$968	$360	$360	$313	$655	309.2%	0.049%	46.984%	0.010%
CEPHAZOLIN 1gram INJECTION 'CEFAMEZIN'	5	$757	$224	$224	$195	$562	389.0%	0.038%	47.022%	0.008%
PENICILLIN G BENZATHINE 1.8gram SYRINGE	0	$512	$309	$309	$269	$243	190.4%	0.026%	47.048%	0.005%
CEFTRIAXONE INJECTION 250MG (ROCEPHIN)	1	$322	$196	$196	$170	$152	189.6%	0.016%	47.064%	0.003%
TICARCILLIN INJECTION 3G (VIAL) TICILLIN	5	$247	$3,549	$3,549	$3,083	($2,836)	8.0%	0.012%	47.077%	0.003%
PENICILLIN V MIXTURE 250MG/5ML (CILICAINE)	100	$246	$227	$227	$197	$48	124.6%	0.012%	47.089%	0.003%
AMOXYCILLIN DISPERSIBLE SACHET 3G (AMOXIL)	1	$63	$63	$63	$55	$8	114.7%	0.003%	47.092%	0.001%
AZLOCILLIN INJECTION 2G (SECUROPEN)	5	$0	$4,810	$4,810	$4,178	($4,178)	-	-	-	-
AMPICILLIN INJECTION 1 G (AUSTRAPEN)	5	$0	$8	$8	$7	($7)	-	-	-	-
AMOXYCILLIN CAPSULE 250MG (AMOXIL)	20	$0	$1,360	$1,360	$1,181	($1,181)	-	-	0.000%	-
AZLOCILLIN INJECTION 5G (SECUROPEN)	1	$0	$13,828	$13,828	$12,012	($12,012)	-	-	-	-
PENICILLIN VK CAPSULE 500MG (LPV 0030 0111)	25	$0	$348	$348	$303	($303)	-	-	-	-
PIPERACILLIN INJECTION 2g (VIAL) (PIPRIL)	1	$0	$1,080	$1,080	$938	($938)	-	-	-	-
CEPHAZOLIN INJECTION 1G KEFZOL	1	$0	$32	$32	$28	($28)	-	-	-	-
Beta-lactam Purchases - Subtotal		$933,369	$891,742	$891,742	$774,642	$158,726	20.5%	47.092%	47.092%	9.906%
Anti-infective purchases - Total		$1,982,007	$1,679,328	$1,679,328	$1,458,807	$523,201	135.9%	100.0%	100.0%	21.035%
Total drug purchases		$9,422,563	$9,122,996	$9,122,996	$9,169,788	$252,775	102.8%	-	-	-

Utilisation in DDDs

The availability of information about the number of dosage units supplied for different patient types also allowed me to explore the application of the DDD as a measure of utilisation (Figure 11). The use of DDDs overcame the influences of inflation, variations in purchase price and other factors. The DDD (although a unit with its own range of limitations) allows direct comparison of utilisation figures over time.

The DDD normalises data by converting information to a multiple of a standard unit. Since the standard unit does not change over time, changes in the number of DDDs which relate to the dispensing of a particular drug over any time period, represents a true change in drug utilisation. Thus, this first (for the RAH) attempt at describing the hospital utilisation pattern using DDDs, represented a baseline from which future longitudinal trend data for the RAH could be developed. This data could also be used to compare utilisation between clinical units within the hospital and between the RAH and other hospitals.

Figure 11 ***Extract from antibiotic report showing activity linked expenditure and DDD data for drug, dose form and strength, aggregated under ATC code and separated for inpatient and non-inpatient populations. Data are for last quarter of 1994/95 financial year***

ATC Code & Chemical Class	Drug	Form	Strength		DDD gm's	Total Mass Units (mg)	Inpatient Cost($)	Total Inpatient DDDs	Inpatient DDDs per 100 occupied bed days	DDD's per 100 inpatient occasions of service	Non-inpatient Drug cost ($)	Total Non-inpatient DDDs	DDD's per 100 non-inpatient occasions of service
J01A													
J01AA01	demeclocycline												
		capsule	150	mg	0.6	4,500	$8.19	7.50	0.0401	0.1686	$51.66	47.3118	0.1288
J01AA02	doxycycline												
		encapsulated	100	mg	0.1	52,650	$85.74	526.50	2.8166	11.8341	$540.87	3,321.2906	9.0407
		encapsulated	100	mg	0.1	54,600	$159.12	546.00	2.9209	12.2724	$1,003.77	3,444.3013	9.3756
		encapsulated	100	mg	0.1	447,300	$1,194.93	4,473.00	23.9287	100.5394	$7,537.91	28,216.7763	76.8075
		encapsulated	50	mg	0.1	10,275	$15.62	102.75	0.5497	2.3095	$98.50	648.1721	1.7644
		oral suspension	100	mg/10ml	0.1	1,500	$15.00	15.00	0.0802	0.3372			
J01AA08	minocycline												
		capsule	100	mg	0.2	3,300	$11.82	16.50	0.0883	0.3709	$74.56	104.0860	0.2833
		injection,powder for dil.	100	mg	0.2	2,250	$151.88	11.25	0.0602	0.2529			
		tablet	50	mg	0.2	4,500	$16.11	22.50	0.1204	0.5057	$101.63	141.9355	0.3864
J01B													
J01BA01	chloramphenicol												
		capsule	250	mg	3	7,500	$10.62	2.50	0.0134	0.0562	$66.99	15.7706	0.0429
		injection,powder for dil.	12	g	3	1,134,000	$1,915.47	378.00	2.0221	8.4963			
J01C													
J01CA04	amoxycillin												
		capsule	250	mg	1	367,500	$124.95	367.50	1.9660	8.2603	$788.22	2,318.2797	6.3105
		capsule	500	mg	1	2,361,750	$803.00	2,361.75	12.6344	53.0850	$5,065.49	14,898.4957	40.5545
		capsule	500	mg	1	2,625,000	$1,840.13	2,625.00	14.0427	59.0020	$11,607.96	16,559.1410	45.0748
		injection,powder for dil.	1	g	1	1,605,000	$3,531.00	1,605.00	8.5861	36.0755			
		injection,powder for dil.	500	mg	1	297,750	$714.60	297.75	1.5928	6.6925			
		oral syrup	250	mg/5ml	1	45,000	$21.30	45.00	0.2407	1.0115	$134.37	283.8710	0.7727
J01CA12	piperacillin												
		injection,powder for dil.	3	g	14	1,746,000	$6,285.60	124.71	0.6672	2.8032			
J01CA13	ticarcillin												
		injection,powder for dil.	3	g	15	220,500	$724.71	14.70	0.0786	0.3304			
J01CE01	benzylpenicillin (penicillin g)												
		injection,powder for dil.	3	gram	3.6	436,500	$541.26	121.25	0.6486	2.7253			
		injection,powder for dil.	600	mg	3.6	2,245,500	$4,865.25	623.75	3.3368	14.0200			
J01CF05	flucloxacillin												
		capsule	250	mg	2	217,500	$113.10	108.75	0.5818	2.4444	$713.46	686.0216	1.8674
		capsule	500	mg	2	1,782,000	$855.36	891.00	4.7665	20.0270	$5,395.82	5,620.6456	15.2997
		capsule	500	mg	2	2,542,500	$1,920.44	1,271.25	6.8007	28.5738	$12,114.57	8,019.3554	21.8291
		injection,powder for dil.	1	g	2	465,000	$1,088.10	232.50	1.2438	5.2259			
		injection,powder for dil.	1	gram	2	2,304,000	$5,391.36	1,152.00	6.1627	25.8935			
		injection,powder for dil.	500	mg	2	195,750	$508.95	97.88	0.5236	2.1999			
		mixture	250	mg/5ml	2	30,000	$47.40	15.00	0.0802	0.3372	$299.01	94.6237	0.2576

5. QUANTITATIVE REVIEW: APPLICATION AND OUTCOMES

As part of my implementation of the DUE program at the RAH, quantitative DUE methods were applied to the structural as well as the process aspects of drug use. Examples included review of information systems, streamlining of purchasing and inventory practices, exploring discounts available by entering into preferred supplier and payment arrangements, and/or undertaking aggressive negotiation with suppliers for 'deals' for selected agents. Such measures enhance the value of each dollar spent on drugs and therefore improve utilisation in its broadest sense. Studies of rate and cost patterns assisted further by identifying drug trends which required closer scrutiny. The following case studies illustrate how quantitative methods were used for measuring and effecting changes to drug utilisation at the RAH.

5.1 Calcium folinate and methylprednisolone

Routine review of drug purchase and issue reports in late 1988 demonstrated that utilisation of methylprednisolone and calcium folinate injections had increased by 94% and 542% respectively, compared with the previous year. The corresponding cost centre reports indicated the major consumers were the Haematology Unit (methylprednisolone) and Oncology Unit (calcium folinate). The Drug Committee provided this information to the respective Units with a request for justification of the increased usage.

The change in methylprednisolone consumption was due to a change in treatment protocol for advanced multiple myeloma. The previous protocol employed a combination regimen of vincristine, doxorubicin and parenteral dexamethasone (VAD) as salvage therapy in patients failing to respond to other treatments. The dexamethasone was used for a total of 12 days and was thought to be associated with muscle wasting in certain patients. Methylprednisolone given for 5 days had replaced dexamethasone (VAMP) during the previous 12 months, following experience reported from other Australian units. Unit policy also now recommended that VAMP become first line therapy for patients with Stage II and Stage III disease. This was based on reported but unpublished studies from several European centres. Following further literature review and discussion with the Unit, it was proposed that similar results might be obtained by substituting parenteral methylprednisolone with equipotent doses of oral dexamethasone (and given for 5 days only). This suggestion was well received by the Unit as being pharmacologically valid and also as offering clinical advantages by obviating the need for patients to remain in hospital to complete the previous parenteral methylprednisolone or dexamethasone courses. The change was adopted with no apparent clinical detriment and produced a $30,000 saving in methylprednisolone expenditure over the next 12 months.

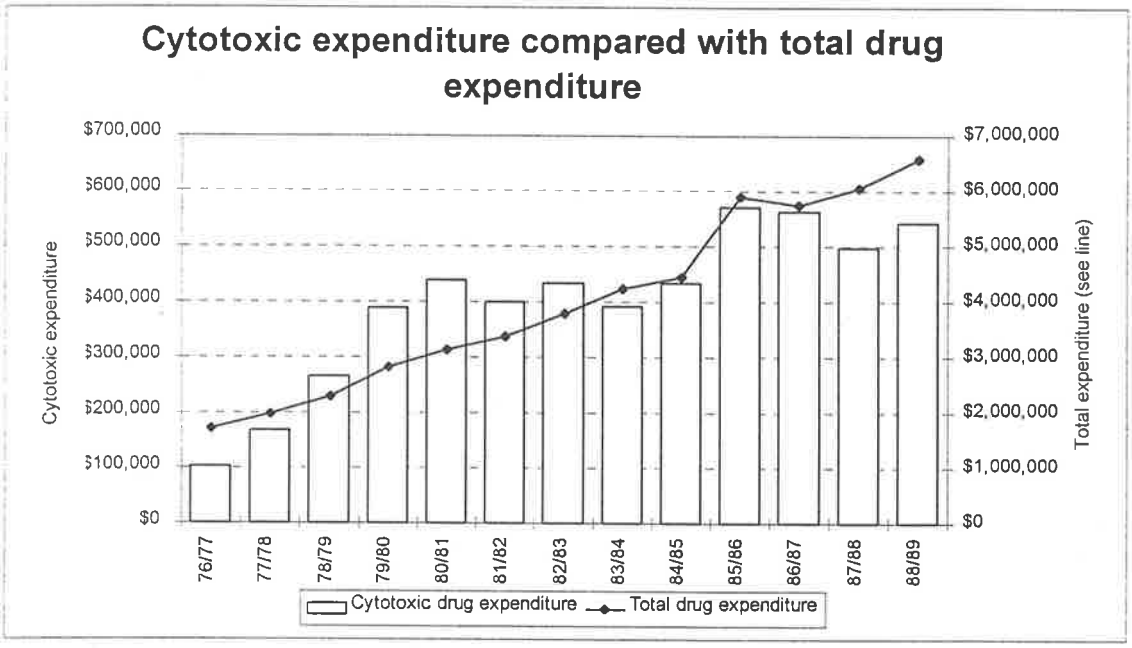
Similar results were obtained with calcium folinate. Clinical investigation had established that parenteral calcium folinate was being coadministered with 5-fluorouracil in the treatment of colorectal cancers. The Drug Committee request for justification of the exponential increase in expenditure prompted the Oncology Unit to review its case histories. This review demonstrated that calcium folinate had not produced the response rates and survival benefits reported in the literature. They concluded that the regimen was not cost beneficial and recommended that further use of the combination be deferred until further evidence supporting its efficacy became available or until a prospective randomised trial could be instigated at the RAH. This recommendation resulted in cost savings of $15,000 per annum.

5.2 Cytotoxic agents

My experience with review of cytotoxic drug utilisation below, demonstrated that it was important to apply different analyses to utilisation figures in order to properly interpret their meaning. The example clearly demonstrates that the method of analysis markedly influences the interpretation of findings.

In late 1990, I undertook a comprehensive review of cytotoxic expenditure and price movements (including CPI adjustments) for 1976/77 to 1988/89. Gross cytotoxic expenditure figures showed a dramatic increase from 1976/77 to 1980/81, plateaued between 1980 and 1984, and increased again thereafter (Graph 1). In addition, the analyses showed that the number of units purchased for selected agents was also increasing. Expenditure was accounted for by a small range of drugs (Table 1) with the anthracycline antibiotics being the most costly. The initial response of the Drug Committee to these findings was to curb this apparent rapid increase in cytotoxic expenditure.

Graph 1 Graph showing total cytotoxic expenditure for years 1976/77 to 1988/89 compared with total drug expenditure



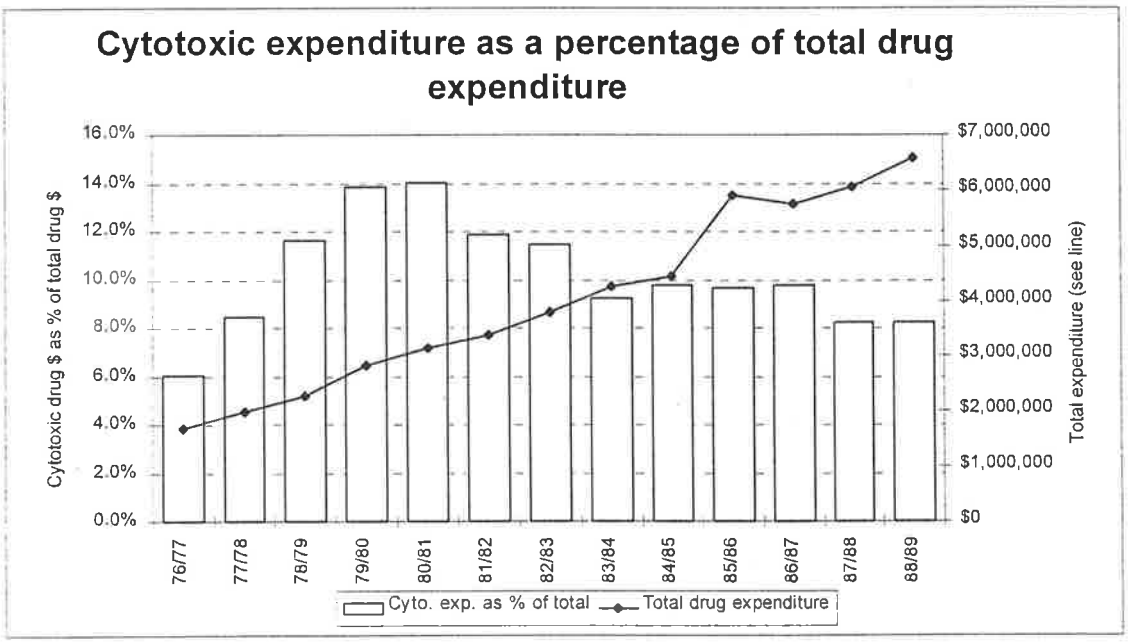
By way of contrast, when expenditure figures were expressed as a percentage of total expenditure, the expenditure for cytotoxics drugs was shown to have been decreasing (Graph 2) over the years relative to overall expenditure. Moreover, an increasing number of units of selected drugs were being bought with less of the drug budget. The main reason being the introduction of generic brands for some drugs (eg. platinum analogues) which hitherto had been very costly per unit. The savings generated by the favourable pricing arrangements also allowed the introduction of newer drugs - as well an opportunity to purchase more of the 'traditional' agents - without increasing the overall expenditure for the group. Thus, a different method of analysis now provided favourable findings and pointed to more efficient use of the drug budget.

Table 1 Cytotoxic drugs which accounted for the majority of antineoplastic expenditure during the period 1976/77 to 1988/89

Financial year	76/77	77/78	78/79	79/80	80/81	81/82	82/83
asparaginase	$ -	$ -	$ -	$ -	$ -	$ 2,999	$ 5,204
cyclophosphamide	$ -	$ -	$ -	$ 5,594	$ 5,539	$ 12,060	$ 6,550
cytarabine	$ -	$ -	$ -	$ -	$ -	$ 9,194	$ 8,637
daunorubicin	$ -	$ -	$ 7,949	$ 11,606	$ 14,520	$ 26,155	$ 21,189
doxorubicin	$ -	$ -	$ 95,789	$ 132,110	$ 132,796	$ 141,360	$ 171,568
epidophyllotoxins	$ -	$ -	$ -	$ -	$ -	$ 8,119	$ 24,588
fluorouracil	$ -	$ -	$ -	$ -	$ -	$ 14,877	$ 8,270
folinic acid	$ -	$ -	$ -	$ -	$ -	$ 19,823	$ 19,908
methotrexate	$ -	$ -	$ 8,169	$ 13,805	$ 21,454	$ 27,597	$ 18,038
platinum analogues	$ -	$ -	$ -	$ -	$ 3,750	$ 39,457	$ 40,809
vinca alkaloids	$ -	$ -	$ 19,749	$ 24,098	$ 24,529	$ 40,079	$ 36,757
Total	$ -	$ -	$ 131,656	$ 187,213	$ 202,588	$ 341,720	$ 361,518

Financial year	83/84	84/85	85/86	86/87	87/88	88/89	Total
asparaginase	$ 4,314	$ 2,430	$ 4,681	$ 5,202	$ 6,092	$ 6,680	$ 37,602
cyclophosphamide	$ 12,555	$ 15,469	$ 23,113	$ 14,631	$ 14,950	$ 17,861	$ 128,322
cytarabine	$ 11,077	$ 10,193	$ 6,266	$ 9,972	$ 19,323	$ 17,652	$ 92,314
daunorubicin	$ 22,855	$ 19,489	$ 25,945	$ 22,289	$ 23,786	$ 35,651	$ 231,434
doxorubicin	$ 128,023	$ 136,563	$ 150,400	$ 130,999	$ 131,280	$ 169,428	$ 1,520,316
epidophyllotoxins	$ 20,911	$ 19,260	$ 400,067	$ 57,283	$ 50,732	$ 38,934	$ 619,894
fluorouracil	$ 11,840	$ 8,544	$ 25,095	$ 19,320	$ 22,015	$ 7,162	$ 117,123
folinic acid	$ 17,920	$ 17,764	$ 22,608	$ 36,768	$ 47,367	$ 71,414	$ 253,572
methotrexate	$ 13,780	$ 20,316	$ 22,551	$ 28,256	$ 20,159	$ 15,591	$ 209,716
platinum analogues	$ 52,985	$ 46,230	$ 42,021	$ 41,172	$ 16,570	$ 21,818	$ 304,812
vinca alkaloids	$ 39,592	$ 31,043	$ 23,074	$ 18,811	$ 20,176	$ 18,292	$ 296,200
Total	$ 335,852	$ 327,301	$ 745,821	$ 384,703	$ 372,450	$ 420,483	$ 3,811,305

Graph 2 Graph showing cytotoxic expenditure as a percentage of total drug expenditure for the period 1976/77 and 1988/89, after adjusting figures for CPI



However, it was still apparent that expenditure for cytotoxic and adjunctive drugs (antibiotics, cyclosporin) for cancer patients consumed a disproportionate amount of the hospital drug budget. For the 13 years illustrated in Graph 1 and 2, cancer patients consumed an average of 10.2% of the entire drug budget. At the RAH , approximately 450 patients were receiving cancer chemotherapy in any given year compared with about 40,000 other in-patients who consumed what remained of the

drug budget.

This apparent inequity prompted the Drug Committee to convene a working party to consider a range of issues which might curb costs for this group of drugs and perhaps appease other Clinical Services who were critical of the magnitude of this expenditure. Issues including access to expensive drugs, notification of protocol changes, development of drug usage guidelines, alternative funding sources, and alterations to the drug budget were discussed. The result was a consensus statement which was endorsed by the Drug Committee and by Medical Administration as a general policy statement for drug use at the Royal Adelaide Hospital (Appendix 2).

Two significant initiatives were implemented as a result of this statement. Firstly, requests for inclusion of a new drug on the formulary had to include information for:

- treatment indications;
- patient selection criteria (inclusion and exclusion);
- treatment objectives;
- other treatment options;
- precise treatment endpoints;
- drug dosage and schedule;
- anticipated annual patient numbers;
- safety and efficacy data.
- financial considerations, including comparisons with other treatments (including non-drug)

Secondly, guidelines for the use of the drug at the RAH and which could also form the basis of subsequent qualitative DUE activities were required before new drug submissions were accepted for consideration. Guidelines for a number of drugs - such as alprostadil, anti-thymocyte globulin, urokinase and botulinum A toxin - have since been prepared.

Also from this statement, grew a model for assigning priority to new drug requests submitted to the Drug Committee (1). The objective of the model was to enable ranking of new drug requests based on a principle of obtaining the greatest benefit for the most patients for each dollar spent. The model was to consider both quality and economical issues and not be dominated by cost considerations. A quality:cost ratio consisting of a *quality score* (the numerator) divided by a *cost score* (the denominator) - the higher ratio the higher the funding priority - was calculated for each submission which was then ranked for funding priority. The consistent application of this model allowed the Drug Committee to objectively determine funding priorities.

5.3 Other drugs

A review of the use of non-depolarising muscle relaxants and other drugs in the Intensive Care Unit (ICU) identified a number of items which showed increased expenditure. A range of discussions with ICU medical and nursing staff resulted in review of ward drug use protocols and implementation of changes in several procedures in an effort to reduce drug expenditure. These included:

- purchase of a standardised electrolyte containing TPN solution, obviating the need for use of individual electrolyte additives to TPN solutions;
- development of a protocol for selective use of intravenous ranitidine for stress ulcer prophylaxis;
- change in procedures for the use of water for irrigation solutions (from 100mL single use

packs to 1 litre multi-use packs) for tracheostomy care;

- development of protocols for selective use of propofol, midazolam, vecuronium and atracurium, which recommended the drugs be used for selected procedures only.

These measures were estimated to have resulted in savings of approximately $72,000 per year.

Review of bowel preparation expenditure demonstrated increasing use and costs for colonic lavage solutions. Investigation of alternative products resulted in a change from a prepacked large volume liquid preparation to a less expensive 'powder-for-reconstitution' (Go-Lytely™) preparation. This change also reduced wastage and storage problems in Pharmacy and at ward level posed by the liquid formulation. Savings were estimated at $10,000.

A review of dermatology preparations demonstrated high usage of topical minoxidil preparations for alopecia. This was discussed with the dermatologists who acknowledged that male-pattern baldness was probably not a medical condition which required a high priority allocation of the drug budget. The usage guidelines for topical minoxidil were therefore reviewed resulting in contraction of $5,000 pa expenditure.

Routine survey of the dermatology products in 1988 indicated significant expenditure by the Vascular Surgery Unit for thrombin topical powder (Elase™). A literature review at the time failed to demonstrate any advantage of the expensive Elase preparation over regular saline soaked dressings for wound management following vascular surgery. Following discussions with the Unit members, who declined to undertake a formal evaluation of the Elase versus saline dressings, the Drug Committee suspended the use of Elase at the RAH. Elase was subsequently deleted from the Formulary which resulted in savings of $30,000 pa.

6. INVENTORY IMPROVEMENTS

Yearly stock-take estimated the value of drug inventory external to the Pharmacy at $500,000. This inventory was held by wards and departments and comprised a range of items including oral tablets and capsules, parenteral dose forms, large volume intravenous fluids, antiseptic solutions and sundry pharmaceuticals and diagnostic items which were identified as being in common use and therefore sensible to maintain as local stock items. The value of this inventory was compounded by 'hoarding' of many other drugs by ward staff 'just in case' they might be needed at some future time. Periodic recording of drugs returned to pharmacy also indicated that at least an additional $100,000 of drug inventory was wasted each year due to poor storage conditions, expiry and inability to reuse selected items.

Attempts were made to rationalise these holdings from time to time, but were hampered by inadequate management information to show objectively that items were not required at ward level. As a result, much of this inventory sat idle and constituted a waste of resources. Subsequent studies of pharmacy inventory and materials management processes indicated that 10-15% savings to pharmacy stock holdings were achievable through computerisation and other system modifications (2).

These inefficiencies were addressed in several ways. The matter of local ward inventory and wastage was addressed by introduction of the Pharmacy Individual Patient Supply Drug Distribution System (IPS) described previously. The first step in the transition was to computerise the existing drug distribution system. In so doing, it was possible to obtain accurate ward drug usage reports

which could be used to objectively adjust ward inventory lists to reflect real rather than perceived needs.

Rigid criteria were applied to the quantities of the revised range of drugs supplied to wards. Generally, no more than 5 patient starter packs (5 days supply of oral medication or 48 hours supply of parenteral products) were available as ward stock items. Of the range of drugs available, only one of any particular chemical or pharmacological class was available as a floor stock item. Similarly, only a small range of 'essential' antibiotics were kept in wards. Overall, approximately 80% of ward floor stock drugs available were common to all clinical areas. The remainder were chosen to satisfy usage in specific areas and also complement the range of drugs kept in other areas. Except in infrequent circumstances, an alternative drug (even if not the desired drug) was available for after-hours use throughout the hospital. In situations where drugs were not maintained in ward inventory, they could be obtained from the pharmacy or from the on-call pharmacist. This reduced the number of items and the value of ward inventory across the hospital. Corresponding average overall savings were in excess of 60% of the previous inventory value (Table 2).

Table 2 Value of ward/clinic inventory before and after implementation of Pharmacy Individual Patient Supply (IPS) drug distribution system

Clinical Service	Internal Medicine	Cancer	Gastro-enterology	Cardio-vascular	Orthopaedic	Surgical	Total
Data element							
Before							
Hoarded drugs	$ 34,947	$ 17,344	$ 7,446	$ 8,078	$ 6,844	$ 13,497	$ 88,156
Floor stock	$ 24,393	$ 13,569	$ 9,536	$ 17,694	$ 6,675	$ 8,416	$ 80,283
Total	$ 59,340	$ 30,913	$ 16,982	$ 25,772	$ 13,519	$ 21,913	$ 168,439
After							
Floor stock	$ 14,125	$ 8,083	$ 8,161	$ 14,934	$ 4,583	$ 7,040	$ 56,926
Total	$ 14,125	$ 8,083	$ 8,161	$ 14,934	$ 4,583	$ 7,040	$ 56,926
Difference $	$ 45,215	$ 22,830	$ 8,821	$ 10,838	$ 8,936	$ 14,873	$ 111,513
Difference %	76.2%	73.9%	51.9%	42.1%	66.1%	67.9%	66.2%

A pharmacy compiled, alphabetical compendium detailing the locations of all drugs maintained as floor stock items in wards and departments was available to each ward, and to after hours staff, to enable wards to rapidly locate required items. This list obviated the need for a centralised 'after-hours' drugs cupboard and its associated cost.

After-hours medical staff (as opposed to nursing staff) were made responsible for determining which of the drugs prescribed to a newly admitted patient, was actually required overnight. If a patient required a drug not available from the ward floor stock, a doctor was asked to determine which of the drugs from the after-hours drug list would be suitable as an interim measure. In the occasional instance where drug needs were not satisfied by the after hours list, the pharmacy was easily accessible to after hours medical staff. These procedural changes resulted in a gradual change in perception of hospital staff and the previously held notion - that all drugs must be available in all places at all times - was gradually dispelled.

This was underpinned by a number of improvements in Pharmacy customer services:

- changes to the stationery and processes for drug ordering;
- a change to individual patient drug supplies thereby increasing patient safety and reducing wastage;
- computerisation of the dispensing process;
- extension of Pharmacy operating hours;
- changes in imprest systems;
- review of ward drug storage sites;
- introduction of a second pharmacy courier and timetabling efficiencies;
- the turnaround time from the time of receipt of drug orders in Pharmacy to return to the wards was 4 hours or less.

These changes resulted in wards being more confident in the Pharmacy's ability to supply drugs in a timely fashion. This in turn reduced the incidence of drug hoarding with corresponding reductions in the value of ward inventory. Sample recording for the Internal Medicine Service indicated that savings of approximately $4000 per month were achieved.

Similarly, the value of the pharmacy inventory was reduced through the establishment of a computerised perpetual inventory system. This provided the long overdue ability to credit wards for drugs returned to the pharmacy. This feature of the system together with the local drug budget management responsibilities, produced the incentive for wards to return all non-floor stock items to pharmacy as soon as patients were discharged. By so doing, wards received a monthly credit for drugs not used and the pharmacy was able to recycle a range of drugs.

The prompt return of unused drugs to inventory reduced the stock holdings, the need to purchase some drugs to replenish shelves, and also reduced drug expenditure. The result of better materials management reports from the new computer system also resulted in inventory savings due to better management and control of the ABC inventory system (described previously). These reports, combined with 'just-in-time' ordering and resultant increased stock turnover, produced savings of 13% of internal pharmacy stock holdings between yearly stock-takes undertaken before and after implementation of the system (ie. 1993/94 and 1994/95).

7. REVIEW OF PURCHASING ARRANGEMENTS

Other improvements for drug utilisation at the RAH without application of qualitative methods were proposed (2). These primarily concerned reviewing supplier purchase payment arrangements and obtaining additional discounts on purchases in return for trading through a preferred supplier or by effecting prompt payment of business invoices. Preferred supplier contracts were negotiated in 1996 but other arrangements (Table 3) are yet to be implemented.

Further financial benefits resulting from the use of Electronic Data Interchange (EDI) for drug purchasing were proposed. Electronic trading was thought to offer savings through reduction of clerical staff - in the pharmacy, supply and finance departments - by streamlining processing of orders and reducing paper work. Although there was general support for these innovations, implementation was hampered by government audit requirements (3) and potential industrial difficulties.

Aggressive negotiation with suppliers to achieve more favourable pricing for selected drugs also enhanced value for money expended on drugs. Negotiations generally took place at the time of renewal of tender contracts (5). Some examples of the impact of tender contract negotiations are provided in Table 4. This table shows the effect of price changes for a 'basket' of drugs chosen to reflect a cross section of pharmacy purchases. Projected costs were modelled using actual purchases during the preceding contract period.

Table 3 Projected savings from implementation of review of purchaser and/or payment arrangements

Proposal	Projected savings
Establishment of preferred supplier relations	$74-87,000 pa.
Discounts for alternative payment arrangements for preferred supplier(s): • prepayment 2.5 % • 7 days 2 % • month of invoice 1.25 % • 30 days 1 %	$32-80,000 pa.
Discounts for alternative payment arrangements for all other supplier(s):	$45-113,000 pa.

In instances where costs rose with the new contract, the pharmacy could stockpile drugs at the 'old' price, thus providing a buffer for the next financial year. This occurred most often for expensive drugs (eg. cyclosporin) where small percentage changes in price would otherwise have had a significant impact on total expenditure figures.

Successful non-contract negotiations included:

- *ceftriaxone*: re-negotiation on the contract price in 1990 from $21 to $18.60; recurrent saving totalled $30,000 pa.
- *Panadeine Forte*™ (paracetamol 500mg with codeine phosphate 30mg): reduction in the price of approximately 50% per pack; resultant saving totalled $21,000 per annum
- *non-ionic radiographic contrast media*:
  - *June 1989:* reduction in cost of 48% was negotiated in return for agreement to pre-purchase 2 years supply; annual saving of $70,000.
  - *July 1991*: arrangements (with a competitor company) for further 30% discount; additional saving of $115,000 per annum

Table 4 Projected savings from implementation of review of purchaser and/or payment arrangements

drug	strength (mg)	form	Cost		Projections		Variance	
			1988/89	1989/90	1988/89	1989/90	$	%
acyclovir	250	injection	$ 116.64	$ 130.92	$ 48,709	$ 54,672	$ (5,963)	12.2%
amoxycillin	1000	injection	$ 6.94	$ 7.70	$ 46,637	$ 51,744	$ (5,107)	11.0%
amoxycillin	500	capsule	$ 100.70	$ 93.00	$ 32,023	$ 29,574	$ 2,449	-7.6%
atenolol	50	tablet	$ 5.90	$ 5.90	$ 21,325	$ 21,325	$ -	0.0%
bm-test-20-800	-	reagent strip	$ 17.31	$ 17.31	$ 54,838	$ 54,838	$ -	0.0%
calcitonin	0.1	injection	$ 25.60	$ 22.75	$ 12,288	$ 10,920	$ 1,368	-11.1%
calcium folinate	15	injection	$ 46.00	$ 39.00	$ 4,968	$ 4,212	$ 756	-15.2%
calcium folinate	15	tablet	$ 77.35	$ 55.10	$ 24,783	$ 17,654	$ 7,129	-28.8%
calcium folinate	50	injection	$ 24.30	$ 20.25	$ 52,488	$ 43,740	$ 8,748	-16.7%
captopril	50	tablet	$ 61.52	$ 60.50	$ 22,147	$ 21,780	$ 367	-1.7%
cefoxitin	2000	injection	$ 85.80	$ 96.10	$ 39,125	$ 43,822	$ (4,697)	12.0%
cefoxitin	1000	injection	$ 43.61	$ 48.84	$ 87,918	$ 98,461	$ (10,544)	12.0%
cephalothin	1000	injection	$ 1.89	$ 1.70	$ 107,730	$ 96,900	$ 10,830	-10.1%
cyclosporin	50 mg/ml	solution	$ 263.74	$ 263.74	$ 433,905	$ 433,905	$ -	0.0%
doxorubicin	50	injection	$ 153.16	$ 145.00	$ 201,987	$ 191,226	$ 10,761	-5.3%
enflurane	-	anaesthetic solution	$ 64.50	$ 70.00	$ 48,298	$ 52,416	$ (4,118)	8.5%
erythromycin	300	injection	$ 3.10	$ 2.20	$ 13,801	$ 9,794	$ 4,007	-29.0%
erythromycin	1000	injection	$ 8.93	$ 7.05	$ 15,967	$ 12,605	$ 3,361	-21.1%
fentanyl	0.5	injection	$ 26.00	$ 19.00	$ 56,160	$ 41,040	$ 15,120	-26.9%
flucloxacillin	1000	injection	$ 13.50	$ 16.00	$ 77,760	$ 92,160	$ (14,400)	18.5%
fluoruracil	250	injection	$ 21.00	$ 16.00	$ 25,200	$ 19,200	$ 6,000	-23.8%
glucose 1000ml	0.05	injection	$ 0.98	$ 0.95	$ 28,788	$ 27,907	$ 881	-3.1%
glucose 100ml	0.05	injection	$ 1.47	$ 1.27	$ 2,286	$ 1,975	$ 311	-13.6%
glyceryl trinitrate	0.6	tablet	$ 0.95	$ 0.95	$ 4,925	$ 4,925	$ -	0.0%
insulin - actrapid	100	injection	$ 15.62	$ 14.04	$ 30,928	$ 27,799	$ 3,128	-10.1%
isoflurane	-	anaesthetic solution	$ 55.00	$ 60.00	$ 11,088	$ 12,096	$ (1,008)	9.1%
methotrexate	500	injection	$ 54.00	$ 44.00	$ 15,552	$ 12,672	$ 2,880	-18.5%
methyprednisolone	1000	injection	$ 39.95	$ 39.00	$ 24,929	$ 24,336	$ 593	-2.4%
methyprednisolone	2000	injection	$ 79.90	$ 76.00	$ 46,981	$ 44,688	$ 2,293	-4.9%
metoclopramide	100	injection	$ 26.50	$ 31.19	$ 17,490	$ 20,585	$ (3,095)	17.7%
metronidazole	500	injection	$ 3.00	$ 2.30	$ 51,840	$ 39,744	$ 12,096	-23.3%
nifedipine	20	tablet	$ 16.07	$ 18.59	$ 19,284	$ 22,308	$ (3,024)	15.7%
papaveretum	10	injection	$ 10.20	$ 10.15	$ 4,590	$ 4,568	$ 22	-0.5%
papaveretum	20	injection	$ 10.00	$ 9.50	$ 6,000	$ 5,700	$ 300	-5.0%
piroxicam	10	capsule	$ 8.11	$ 7.67	$ 4,866	$ 4,602	$ 264	-5.4%
ranitidine	150	tablet	$ 24.00	$ 24.00	$ 103,680	$ 103,680	$ -	0.0%
ranitidine	50	injection	$ 8.85	$ 9.51	$ 24,330	$ 26,145	$ (1,814)	7.5%
salbutamol	0.2	aerosol	$ 2.05	$ 1.79	$ 8,856	$ 7,733	$ 1,123	-12.7%
sodium chloride 1000ml	0.009	injection	$ 0.95	$ 0.95	$ 66,663	$ 66,663	$ -	0.0%
sodium chloride 100ml	0.009	injection	$ 1.47	$ 1.27	$ 83,293	$ 71,960	$ 11,332	-13.6%
suxemethonium	100	injection	$ 15.00	$ 17.00	$ 2,520	$ 2,856	$ (336)	13.3%
tamoxifen	20	tablet	$ 34.81	$ 34.82	$ 25,063	$ 25,070	$ (7)	0.0%
Total			$ 1,576.37	$ 1,543.01	$ 2,012,008	$ 1,960,001	$ 52,007	-2.6%

8. SUMMARY

Recording and analysis of quantitative drug utilisation data form the cornerstone upon which the RAH hospital DUE program was built. Data assist the pharmacy and the Drug Committee to monitor changes in drug usage patterns. Also, comparing drug use between wards/services/time periods is helpful in targeting possible problem prescribing or drug use.

A number of report types are used to describe the hospital utilisation profile. These reports emphasise different aspects of drug utilisation and assist in determining potential concerns in usage patterns. Their format is determined both by the information systems used to generate and analyse them and by the needs of the recipients.

RAH data sources include drug purchase, issue or expenditure information. These data describe major therapeutic groups, major classes within groups and sub-classes within classes. The most detailed reports are those derived from purchase or issue data for individual drugs. Interpretation of data sources are variably influenced by inflation, buying patterns, price changes and accounting systems.

Drug utilisation is generally expressed in dollars and reports describe month and year-to-date utilisation figures and offer comparisons with notional budget or with the previous year. Dollar and percent variances from budget or previous year are used to identify drugs or drug groups which require closer scrutiny.

The application of quantitative methods, by review and improvement of information systems, streamlining purchasing, inventory and drug distribution practices, and undertaking negotiations for discounts for selected agents, have resulted in significant economies in drug utilisation at the RAH. Examples have included changes in methylprednisolone and calcium folinate usage resulting in savings of $30,000 and $15,000 per annum, respectively. Similar exercises with ICU preparations, colonic lavage solution and topical minoxidil resulted in a further savings of $85,000 pa. Suspension of the use of thrombin topical powder reduced expenditure by a further $30,000 pa.

Computerisation and other alterations to the pharmacy drug distribution and materials management systems resulted in significant contraction of ward and pharmacy inventory estimated to be in excess of $115,000 and $150,000 pa respectively. These changes were also expected to reduce drug wastage by at least $100,000 pa. Review of purchasing arrangements and selected contracts has also produced significant reductions in expenditure, particularly for radiocontrast media and some antibiotics. Savings resulting from the latter activities are estimated at $90,000 and $50,000 pa respectively. Aggressive negotiation through the State Supply Board resulted in average savings of 2.6% (or $50,000 pa) for contract items. Establishing agreements for preferred suppliers for all State Supply Tender items is expected to realise a further saving of $75,000 pa by providing extra discounts on contract items. In total, per annum savings resulting from quantitative DUE activities in recent years have exceeded $775,000. Importantly, these savings are recurrent and therefore cumulative.

Lastly, efforts to minimise expenditure on cytotoxic agents resulted in the development of a consensus statement for drug use at the RAH. From this statement grew a priority drug funding model which was used to assign priorities to different drug treatments. Using this model, the hospital has been able to fund new treatments through savings achieved in other areas.

Quantitative DUE is therefore an important activity for optimising drug expenditure. It offers considerable opportunity for direct savings as well as providing a foundation from which to initiate qualitative DUE methods and monitor their effectiveness.

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CHAPTER 8

QUALITATIVE DUE: DESCRIPTIVE REVIEWS

1. PREAMBLE

Chapters 8 to 21 describe my application of qualitative DUE methods at the RAH. Qualitative methods were used to assess individual drugs, drug groups and the drug management aspects of selected disease and medical procedures. Some audits were descriptive in nature, undertaken without application of criteria. Others compared drug use with predetermined, explicit criteria. A variety of recommendations and findings resulted. In some cases, projects have been revisited to assess the effectiveness of education or other strategies used to correct drug misuse.

The reviews described are noteworthy for either the methods used, the patient group evaluated or the subsequent findings. Relevant background, method, results, discussion, conclusions and recommendations are provided. Additional data and other supporting documentation may be found in Appendix 3 and 4. Only one type of review is presented in detail in each chapter. Other reviews of similar types may have been conducted and if so are presented in the summary table in chapter 21.

2. INTRODUCTION

Descriptive DUEs are reviews of drug utilisation for which explicit audit criteria are not developed. Without explicit criteria against which to compare drug practices, it is not possible to make precise assessments about the quality of drug use. Nevertheless, subjective assessments of the quality of drug use may be made, and may result in drug policy recommendations or form the basis for more detailed review activities. Reviews of this type are useful when reviewing broad aspects of drug use or a drug class which is widely used.

3. LAXATIVE USE AT THE RAH (1991)

3.1 Study background and aims

In 1990-91 it was noted that laxative expenditure was steadily increasing. A large proportion of this expenditure (25%) was attributable to lactulose solution, a synthetic disaccharide derivative of lactose, supposedly reserved for the management of hepatic encephalopathy. No study of the general pattern of laxative use or of lactulose in particular, had been undertaken previously at the RAH.

The purpose of the study was to document patterns of all laxative use at the RAH (including the Hampstead campus) and to record factors which might contribute to laxative use in this patient group.

3.2 Study method

This was a concurrent, non interventional, intention-to-treat study in which data were collected over a 6 week period. Audit criteria were not applied to data so no objective assessments of quality were made. A cross-sectional sampling method was used for wards demonstrating high use of laxatives from quantitative utilisation reports. Patients prescribed or administered laxatives up to the time of review were included in the study. Recorded data included:

- the laxative(s) used or prescribed;
- dosage, route of administration, duration and type ('stat', 'prn', regular) of use;
- whether prescription was initiated by patient, nurse or doctor;
- prior laxative use;
- concomitant constipating medication;
- bowel habits, fluid and dietary fibre intake and patient mobility.

3.3 Results

A total of 275 inpatients, of whom 123 were prescribed or administered one or more laxatives, were reviewed. Three hundred seventy five discharge prescriptions and 453 outpatient prescriptions were also assessed (Table 1).

Patients at the Hampstead Centre were more likely to be prescribed laxatives than patients at the RAH campus. All patients were presumed to be taking laxatives for constipation although this was largely undocumented in patient notes (Table 1).

Of patients administered laxatives on the day surveyed, stool softener/lubricant laxatives were most commonly prescribed at the RAH campus. Osmotic laxatives (including lactulose) were prescribed for 21% of patients. Patients admitted under the care of the Radiation Oncology Unit or the Orthopaedic Unit were most likely to be prescribed laxatives. At Hampstead Centre, stimulant laxatives were most commonly prescribed (Table 2,3,4,5).

Forty nine percent and 12% of patients reported an effective result from laxatives at the RAH and Hampstead campuses, respectively. Of the 86 patients who were administered laxatives on the day of survey, 58 (67%) had been administered a different laxative at some other time during the admission (Table 3,4). Fifty one (59.3%) were taking medications which may have contributed to constipation. (Table 5). Twenty three (26.7%) reported a history of regular laxative use (range: 2 months - 6 years), with stimulant or stool softener/lubricant laxatives being used most commonly. Forty eight percent of patients consumed less than 1500 mL of fluids per day and 69% were bed-ridden or restricted in their movements. Seven percent had bowel disease which may have contributed to constipation (Table 6). No patients prescribed laxatives were ordered high fibre diets.

For patients ordered laxatives at discharge, softener/stimulant (31%) or osmotic laxatives (21%) were most commonly prescribed. For outpatient prescriptions, 63% of patients were prescribed osmotic laxatives (including lactulose) (Table 7).

Table 1 No of patients surveyed in laxative DUE

No. surveyed: • RAH • Hampstead	 221 54
Total	275
Total No. prescribed or administered laxatives: • RAH • Hampstead	n=275 88 (32%) 35 (12.7%)
Total	123 (44.7%)
Total No. given a laxative on the day surveyed: • RAH • Hampstead	n=123 70 (56.9%) 16 (13%)
Total	86 (69.9%)
No. administered laxatives other than on the day surveyed: • RAH • Hampstead	n=123 13 (10.6%) 17 (13.8%)
Total	30 (24.4%)
No. prescribed but not administered laxatives: • RAH • Hampstead	n=123 7(5.7%) 5 (4.1%)
Total	12 (9.8%)
No. of discharge prescriptions reviewed	373
No of discharge prescriptions with laxatives	58 (15.6%)
No of outpatient prescriptions reviewed	453
No of outpatient prescriptions with laxatives	16 (3.5%)

Table 2 Types of laxatives used on day surveyed

LAXATIVE	No. of Patients Using & Type of Use							
	RAH (N=70)	regular	'prn'	'stat'	Hampstead (N=16)	regular	'prn'	'stat'
Bulk-forming								
• Metamucil™	5 (7%)	5	-	-	-	-	-	-
Bulk-forming + Stimulant								
• Granacol™	1 (1%)	1	-	-	2 (13%)	2	-	-
Stool Softener/Lubricant								
• Coloxyl™ tabs • Microlax™ • G + O enemata	30 (43%)	15	5	10	5 (31%)	5	-	-
Stool Softener + Stimulant								
• Coloxyl + Senna™	21 (30%)	14	6	1	-	-	-	-
Stimulant								
• Bisacodyl tabs, sup positories + enemata • Senekot™ tabs + granules • Nulax	15 (21%)	8	5	2	1 (6%)	1	-	-
Osmotic								
• Lactulose • "Golytely"™ • Magnesia S. Pellegrino™ • Magnesium Sulfate mixture	15 (21%)	8	5	2	1 (6%)	1	-	-
TOTAL	**81***	**45**	**19**	**17**	**25***	**23**	**2**	**-**

Legend: 'prn' = as needed; 'stat' = on demand

R.A.H: - 9 patients were taking 2 laxatives
- 1 patient was taking 3 laxatives

Hampstead: - 6 patients were taking 2 laxatives
- 1 patient was taking 4 laxatives

Table 3 Laxative use on individual wards on day surveyed

		No. OF PATIENTS USING:-					
RAH WARD	% Using Laxative	Bulk forming	Bulk-form. + Stimulant	Stool softener /Lubricant	Softener + Stimulant	Stimulant	Osmotic
Medical							
• R8	7/29 (24%)		1 Granacol	3 Microlax 2 Coloxyl	2 Coloxyl + Senna		
• S8	7/26 (27%)	1 Metamucil		2 Coloxyl	2 Col/senna	1 Senokot	1 Mag.Sulf.
Surgical							
• Q7	3/12 (25%)					2 Senokot	1 Golytely
• Q6	4/26 (15%)	1 Metamucil		1 G+O enema 1 Coloxyl			1 Magnesia Pellegrino
Orthopaedic							
• Q3	7/20 (35%)	1 Metamucil		4 Coloxyl 1 Microlax		1 Senokot	3 Lactulose
• R3	10/19 (53%)	1 Metamucil		3 Coloxyl 4 Microlax	2 Coloxyl + senna		1 Lactulose
• R4	1/6 (17%)					1 Bisalax™ enema	
Geriatrics + Palliative Care							
• B8	4/12 (33%)			2 Coloxyl	2 Coloxyl + senna		1 Lactulose
Dermatology + Renal							
• D8	4/16 (25%)			1 Microlax	3 Coloxyl + senna		
Dialysis OPD							
• C8	1/6 (17%)					1 Senokot	
Radiation Oncology							
• B6	12/25 (48%)				10 Coloxyl + senna.		5 Lactulose
Psychiatry							
• C3	10/24 (42%)	1 Metamucil		6 Coloxyl		2 Senokot 1 Nulax	2 Lactulose
TOTAL		**5**	**1**	**30**	**21**	**9**	**15**

Table 4 Laxative use on individual wards on day surveyed

		No. OF PATIENTS USING:-					
HAMPSTEAD WARDS	% Using Laxative	Bulk-form	Bulk-form. + Stimulant	Stool softener /Lubricant	Softener + Stimulant	Stimulant	Osmotic
Orthopaedic + Nursing Home • 2A	4/16 (25%)			2 Coloxyl		2 Bisalax enemas 1 Senokot	1 Lactulose
Rehab + Nursing Home • 2B	0/22	None on day surveyed					
Spinal Injuries • M4	12/16 (75%)		2 Granacol	3 Coloxyl		10 Bisalax enemas 2 Nulax 2 Senokot	
TOTAL		**0**	**2**	**5**	**0**	**13***	**1**

* Some patients were taking more than one laxatives
2 patients were taking Bisalax + Senokot
1 patient was taking Coloxyl + Nulax
1 patient was taking Coloxyl, Bisalax, Senokot, Nulax.

Table 5 Other laxatives prescribed during admission to patients who had taken laxative on day surveyed

LAXATIVES	No. of Patients	Reason for change	Type of Use		
			regular	prn	stat
Bulk-forming	-	-	-	-	-
Bulk-forming + Stimulant	-	-	-	-	-
Stool Softener/Lubricant • Microlax • Coloxyl • Enamax • Glycerol suppository	35 (74%)	ineffective	-	9	26
Stool Softener + Stimulant • Coloxyl suppository • Coloxyl + Senna • Coloxyl + Senokot • G + O enema	11 (23%)	ineffective	2	-	9
Stimulant • Bisacodyl tabs, supps + enemata • Senokot tabs + granules	21 (45%)	ineffective or adverse reaction (Senokot)	-	2	19
Osmotic • Magnesium Sulphate • Magnesia S. Pellegrino • "Golytely" • Lactulose	18 (38%)	Lactulose ineffective or unpalatable	-	5	13

Table 6 Constipating medications

DRUG	No. TAKING THIS DRUG		TYPE OF LAXATIVE USE					
	R.A.H (N=70)	HAMPSTEAD (N=16)	regular	prn	stat	regular	prn	stat
Opioid analgesics • Panadeine Forte™ • morphine • oxycodone	24 (34%)	4 (25%)	54%	17%	29%	100%	-	-
Tricyclic antidepressant • amitriptyline • nortriptyline	5 (7%)	-	100%	-	-	-	-	-
Calcium channel blockers • verapamil • nifedipine	3 (4%)	1 (6%)	67%	-	33%	-	-	-
Diuretics • Dyazide™	2 (3%)	-	50%	-	50%	-	-	-
Other • Ferro-gradumets™ • haloperidol • amiodarone • mianserin • carbamazepine	10 (14%)	2 (13%)	70%	20%	10%	-	-	-

- No phenothiazines or aluminium antacids were prescribed in patients surveyed
- 10.5% (9/86) of patients were on more than one medication with constipating properties

Table 7 Fluid Intake

FLUID AMOUNT	NUMBER OF PATIENTS		
	RAH (N=70)	HAMPSTEAD (N=16)	TOTAL %
< 1500 mls/day	38 (54%)	48%	48%
1500 - 2000 mls/day	20 (29%)	4 (25%)	28%
Not recorded	12 (17%)	9 (56%	24%

Table 8 Summary of distribution of types of laxatives prescribed

LAXATIVES	No. OF PATIENTS PRESCRIBED	
	(N = 58)	(N = 16)
Bulk-forming • Metamucil	10 (17%)	2 (13%)
Bulk-forming + Stimulant • Granacol	2 (3%)	-
Stool Softener + Stimulant • Coloxyl + Senna • Coloxyl + Senokot • Coloxyl drops	18 (31%)	3 (19%)
Stimulant • Bisacodyl tab, supps, enemata • Senokot tabs, granules	6 (10%)	2 (13%)
Osmotic • Lactulose • Mag. S. Pellegrino	12 (21%)	10 (63%)

* (N=58) Some patients were prescribed more than 1 laxative
* (N=16) One patient was prescribed 2 laxatives

3.4 Discussion

A number of observations from the review were noteworthy. There were many causes of constipation:

- **Physiological:** age, inactivity, diet, drug, dehydration, depression, poor bowel habits.
- **Structural:** intraluminal or extraluminal disease, anal disorders.
- **Metabolic:** hypercalcaemia, hypokalaemia.
- **Neurological:** neuropathy, cord lesions, compression of neural structures.

Many patients were at risk of constipation due to inadequate dietary fibre (an added benefit of 'bulking' agents), immobility and poor fluid intake. There appeared to be significant opportunity to optimise these measures for some hospital inpatients.

Overuse of laxatives should be discouraged and where possible, correction of underlying disorders should form the mainstay of treatment for constipation. These measures may be more successful in alleviating long term constipation than laxative drugs. Long term or inappropriate use should be minimised because of adverse effects including bowel atony, abdominal discomfort, electrolyte imbalance and nutritional defects (1).

Forty five percent of patients received one or more laxatives during admission despite only 26% taking them before coming to hospital. This figure is high when compared with other studies (1,2,3). Some use may be explained by the need for preparatory bowel cleansing before certain investigations. However, most patients indicated that laxatives had been prescribed for constipation rather than as bowel 'preps'. Other uses may be nosocomial, partly originating in the traditional training and resulting concern of the nursing profession over bowel function and urinary output of their patients.

In a number of patients Microlax™ enemata were administered within 24 hours of the administration of Coloxyl™ because patients described Coloxyl as 'ineffective'. Coloxyl requires administration for 2-3 days before an effect is seen. 'Stat' doses are therefore inappropriate and adequate time should be allowed for them to work before dismissing them as ineffective. Although simple to use and inexpensive, stool softeners and lubricants (eg. docusate sodium (Coloxyl™), Microlax™, Glycerin and Oil enemata) have been associated with colonic damage (1).

Only 54% of patients on chronic opioids were receiving regular laxative drugs. This was despite hospital recommendations for the prevention and treatment of opioid induced constipation. Most patients prescribed this combination (Coloxyl with Senna) at the RAH were from the Radiation Oncology Unit, known for its high use of opioids. The use in this instance was likely to be appropriate.

At Hampstead Centre, high usage of the less potent bisacodyl was noted, mainly by patients with spinal injury. Bisacodyl (tablets and/or enemas) was judged subjectively by patients to be effective. Side effects including atonic colon and gastrointestinal cramping may be troublesome in some patients. Use should be restricted to necessary clinical situations only.

Lactulose appeared to be used less discriminately than stimulant laxatives. Twenty one percent of patients received lactulose, which was also more expensive than other laxatives. Lactulose should be reserved for patients with hepatic encephalopathy or as a second or third line agent for constipation when other agents have proved unsuccessful (3). The highest users of lactulose were in oncology

and orthopaedic patients. These patients did not have liver disease. Their past history of laxative use was not largely different from other surveyed patients. This supported the premise that unnecessary use of lactulose was likely.

The use of osmotic agents in elderly patients was also noteworthy. Osmotic agents should be avoided in the elderly and for long-term use because they can produce electrolyte disturbances. Osmotic laxatives (magnesium sulphate, colonic lavage solution (Go-Lytely™) produce prompt and sometimes violent evacuation, and should be reserved for recalcitrant constipation. Absence of bowel obstruction should be confirmed before using these agents.

Bulking agents (Metamucil™, Granacol™) were used by very few patients. These agents are cheap and more effective for the restoration of normal bowel habit compared with other laxatives. They require adequate fluid intake for optimal effect and should be added to chronic laxative regimens.

3.5 Conclusion

This study probably underestimated laxative use at the Royal Adelaide Hospital since it only represented a point estimate of inpatient, outpatient and discharge utilisation. Although the review did not compare laxative use with objective criteria, findings indicated a number of opportunities for education and improvement in the way laxatives were used. Collectively, these observations demonstrated a need for further education about the pharmacology, dosage and rate of onset of laxative drugs, the causes of constipation and information about what constitutes 'normal' bowel habit. Attention and education about the management of patients with special needs (eg. bedridden) or patients taking drugs predisposing to constipation, is also required.

3.6 Recommendations

Recommendations to come from this study were to review the RAH laxative guidelines. Promulgation of general information via the formulary and pharmacy newsletter about factors predisposing to constipation was also recommended. Finally, enforcement of restrictions of lactulose use, that is to patients with hepatic encephalopathy or for constipation where other agents had failed, was recommended.

3.7 Project outcomes

The latter recommendation was implemented by arranging for Pharmacy staff to question all orders for lactulose with ward staff before supply. Subsequently, a recommendation was made to replace lactulose used for constipation by sorbitol solution. Lactulose is now reserved almost exclusively for patients with hepatic encephalopathy. Projected savings through implementation of these measures were estimated at $10,000 per annum.

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CHAPTER 9

QUALITATIVE DUE: REVIEWS OF DRUG USE BY PARTICULAR CLINICS

1. INTRODUCTION

Criteria based audits require the development of explicit audit criteria before the review is undertaken. Criteria can be applied to drugs, drug groups, or the drug components of procedures or disease management. At the RAH, criteria audits investigated many aspects of the use of a particular drug. Often this included determining whether the indication for the drug was appropriate and whether the correct drug for the indication was selected. The process (ie. how the drug was used) was then evaluated and recommendations made as a result of findings. In some cases the effects of treatment or changes to treatment were also evaluated.

2. PRESCRIBING PATTERNS IN THE DEPARTMENT OF OROFACIAL AND MAXILLARY SURGERY (DOFMS) (1994)

This DUE was of particular interest because it involved an assessment of a broad range of drugs and associated practices used within a particular practice setting by a select group of prescribers. The review combined descriptive elements, some application of explicit criteria and subjective assessment.

We did not know in advance which drugs would be assessed during the review process, so it was not possible to predetermine the audit criteria which would be used for evaluation. RAH Formulary guidelines, ward protocols or external consensus statements (Antibiotic Guidelines, published by the VMPF) were used as the benchmarks for evaluation wherever possible. When hospital or other criteria were not easily available, assessments based on either the experience of the reviewers or following interaction with the prescribers or other clinicians were made.

2.1 Study background and aims

The goals of this review were to review prescribing patterns of the Department of Orofacial and Maxillary (DOFMS) Surgical Unit at the RAH. The review came about because of several adverse drug events which had occurred when 'medical' drugs (eg. anticoagulants) were prescribed by 'dentists' (ie. oral surgeons) in the management of dental conditions. In addition there was some friction between the parent clinic and the DOFMS regarding responsibility for prescribing. The parent clinic (Gastrointestinal Surgical Unit) requested a review of the range of drugs prescribed by the oral surgeons to establish whether prescribing practices or protocols would benefit from modification to minimise further adverse events.

The review goals were to:

- describe the prescribing patterns of the Department;
- assess the quality of use by comparing utilisation with:
  - the DOFMS's own guidelines;
  - other guidelines developed by either the Royal Adelaide Hospital Drug Committee or

other consensus statements.

2.2 Study method

This was a concurrent, non-intervention DUE. Study subjects were randomly selected from patients under the care of the DOFMS. Demographic and clinical details were recorded. In particular, drugs prescribed during admission which were different from those taken before admission were recorded. Prescribing or administration errors, adverse drug events or drug interactions, were also recorded. Analysis was performed on an intention-to-treat basis.

2.3 Results

Data from 50 patients (41 elective, 9 emergency admissions) were collected. In 64% of cases, drugs were prescribed by DOFMS doctors only (Table 1). The most common procedures performed were extractions, osteotomy or graft procedures, fixation of fractures, and removal of cysts and tumours (Table 2).

An average of 1.4 (range: 0-8) compared with 6.7 (range: 0-16) drugs were prescribed before and during admission, respectively. Drugs most commonly prescribed before admission were bronchodilators, corticosteroids and antihypertensives. During admission, commonly prescribed drugs included analgesics (all patients), anti-nauseants, steroids, anti-ulcer drugs and bronchodilators (Table 3). Antibiotics were also widely prescribed for both treatment and as surgical antibiotic prophylaxis agents (Table 4).

Variations from DOFMS protocols were seen in 10% of patients (eg. cephalothin used instead of penicillin). Antibiotic prophylaxis was not administered in one patient with a known cardiac valve abnormality and in another case antibiotic prophylaxis continued beyond the recommended period. Some patients received antibiotics which were not described in any protocols and others received antibiotics variably (ie. some patients received antibiotics for certain procedures when others with the same procedures did not). Other instances of wrong dose or wrong frequency or route of administration were also recorded.

No adverse effects were recorded during the review period.

Table 1 Prescribing clinics

Clinic	Elective Patients No. (%)	Non Elective Patients No. (%)	Total No. (%)
OMF only	24 (48)	8 (16)	32 (64)
Surgical C only	2 (4)	-	2 (4)
Combination	15 (30)	1 (2)	16 (32)
Total	**41 (82)**	**9 (18)**	**50 (100)**

Table 2 Distribution of procedures

Procedure	No. of patients	% of total
extraction(s)	12	24%
fracture(s)	7	14%
osteotomy / graft	8	16%
TMJ reconstruction	3	6%
removal of cyst / tumor	7	14%
implant(s)	2	4%
abscess	2	4%
fistula closure	3	6%
alveoloplasty	1	2%
parotidectomy	1	2%
vermilianectomy	1	2%
restoration	1	2%
vestibuloplasty	1	2%
nerve cryofreeze	1	2%
TOTAL	50	100%

Table 3 Distribution of drugs prescribed before and after admission

Drug class	Before admission	After admission
analgesics	2	50
hypnotics	3	9
corticosteroids	6	14
antihypertensive / cardiac	6	7
hypoglycaemics / insulin	2	2
laxatives	-	5
bronchodilators	7	10
anti-nauseants	3	36
antidepressants / tranquillisers	4	2
anticoagulants	3	3
diuretics	3	3
anti-ulcer medication	8	10
antibiotics		
• topical	-	8
• oral	4	18
• IV	-	24
drixine nasal spray	-	8
other	13	16

Table 4 Antibiotic therapy (Note: Groups are not mutually exclusive)

Therapy type (n=50)	No. of Patients Elective	No. of Patients Non Elective	Total (%)
no antibiotic	14	1	15 (30)
single dose only (ie. prophylaxis)	4	1	5 (10)
extended IV therapy	9	8	17 (34)
IV then oral	6	4	10 (20)
oral only	7	1	8 (16)
topical	7	1	8 (16)

3. DISCUSSION

Several observations were noteworthy:

- the use of intravenous metronidazole 8 hourly when 12 hourly dosing would have sufficed;
- the use of intravenous metronidazole when oral or rectal metronidazole could have been used;
- the 6 hourly ('QID') prescribing of oral amoxycillin when 8 hourly dosing was preferred;
- the use of topical chloramphenicol for other than ocular administration when topical povidone iodine (betadine) or mupirocin would have been preferred;
- the use of high dose oral dexamethasone following oral surgery;
- the prescribing of non-formulary analgesics (eg. Mersyndol™ (paracetamol / codeine / doxylamine));
- missed drug doses by nursing staff (3 instances).

Also of particular interest were the number and range of drugs prescribed during admission compared with those taken by patients before coming to hospital. Closer inspection indicated that most instances were justified. Pre-admission medication was generally continued during admission. Changes in therapy were related to procedures performed during admission. Analgesics were most commonly prescribed peri-operatively for pain control. Anti-nauseants, antibiotics, nasal decongestants (for patients with wired jaws) and corticosteroids were initiated by DOFMS doctors in accordance with predefined protocols. Other medications (eg. anti-ulcer, cardiac drugs) were commenced by or in consultation with the parent unit for other conditions.

A 5 fold increase in prescribed drugs would have been expected to increase the number of potential interactions. No increase however was observed, possibly because the antibiotics and analgesics used have a low incidence of clinically significant interactions. Other medications were administered 'as required', further reducing the incidence of potential drug interactions. Some irrational combinations of laxatives or sedative drugs were noted but these were not especially different from practices observed on other wards. In one instance, anticoagulant control was disrupted by unnecessary administration of vitamin K by the parent clinic. No adverse sequelae resulted and anticoagulation was re-established uneventfully over the ensuing week. Better communication between the parent unit and the DOFMS would have prevented this occurrence.

The greatest area of confusion was the timing and choice of surgical antibiotic prophylaxis. In a number of cases, antibiotics were not administered until after a surgical procedure, despite prophylaxis being indicated beforehand. In others, antibiotics were given to some patients but not others with the same indications. The use of topical antibiotics (along suture lines) was also identified as a concern.

3.1 Conclusion

DOFMS drug use was not associated with notable adverse effects, even when the number of drugs prescribed was much greater than that taken by patients prior to admission. The major findings were inconsistencies in the application of DOFMS protocols and of drug choices for various procedures. Of particular note was confusion regarding antibiotic selection and surgical antibiotic prophylaxis.

3.2 Recommendations

The amendment of certain aspects of DOFMS drug protocols was recommended. These included protocol inconsistencies for antibiotic choice, route, schedule and duration. Specific advice for anti-coagulant management (temporary cessation of warfarin before surgery) and use of topical antibiotics was also recommended.

3.3 Project outcomes

These findings were well accepted by the DOFMS and parent clinic. Subsequent meetings between Unit Heads and me resulted in all recommendations being incorporated into treatment protocols. Ongoing, subjective clinical pharmacist review revealed no major divergence from the revised guidelines.

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CHAPTER 10

QUALITATIVE DUE: REVIEW OF DRUG USE IN A DEFINED PATIENT POPULATION

1. RECOMBINANT TISSUE PLASMINOGEN ACTIVATOR (r-TPA) FOR PERIPHERAL ARTERY EMBOLI (1990)

This DUE was undertaken in 1990 when the role of thrombolytic agents in general and r-tPA in particular, in peripheral artery embolism was still in evolution. The review is noteworthy because it considered a well circumscribed group of patients, specifically patients who received r-tPA for peripheral artery emboli. In addition, clinical outcomes of treatment courses were documented. The study demonstrated poor compliance with hospital and literature recommendations for use of r-tPA for this indication.

1.1 Study background and aims

The use of r-tPA was well established in coronary artery thrombosis at the Royal Adelaide Hospital but its role in peripheral artery emboli was less clear. Ad-hoc usage of r-tPA for non-coronary indications had been noted. No objective evaluation of its use in this condition had been undertaken. The considerable cost of r-tPA ($1800 per treatment course) also mandated a review to ensure that any use for 'non-approved' indications was cost effective.

1.2 Study method

This was a retrospective review of all patients who received r-tPA for non-coronary indications over an 18 month period from January 1989 to July 1990. Patents were identified from Pharmacy and Transfusion Department records. Usual patient demographic and clinical data were recorded. In addition, relevant past medical history including streptokinase administration, treatment dosage and duration and, treatment outcome and adverse reactions were recorded. Audit criteria included treatment guidelines for urokinase and r-tPA promulgated by the Haematology Unit. Cases were also reviewed by a senior vascular surgical registrar.

1.3 Results

Nine patient cases were reviewed (5 male, 4 female, mean age 61.5 years, range: 24-81 years). Treatment indication, r-tPA dosage, prior streptokinase exposure, treatment outcomes and adverse events are summarised in Table 1.

Only two treatment courses complied with all audit criteria. For other courses, indication, dosage or monitoring parameters were at variance with criteria.

Eight of 9 patients with a prior history of streptokinase therapy had evidence of streptokinase resistance (antibody titre > 100 Units/mL). Selection of r-tPA in these cases was therefore appropriate.

Four of 9 patients had occlusions of less than 24 hours duration; all had initial thromboembolic clearance. One of these later re-occluded and required surgery. One of the remaining patients had occlusion of 5 days duration; this also cleared successfully. The remainder (4 patients) had occlu-

sions of more than 2 weeks duration and all failed to clear. These patients required surgical intervention.

Angiographic or Doppler assessment was performed for all patients prior to therapy but only 2 had repeat procedures to assess clearance. Seven patients developed bleeding complications or abnormally prolonged bleeding times.

Total expenditure for r-tPA was $17,500 of which 23% resulted in complete clearance, 50% in limited clearance and 27% in no benefit.

1.4 Discussion

Careful selection of patients to reduce unnecessary cost, reduce risk of bleeding and achieve thromboembolic clearance is important. For thrombolytic therapy to be most effective, it is recommended that treatment be initiated within 4 days and preferably within 24 hours from the onset of occlusion (1,2). Patients less than 70 years old are most likely to benefit from therapy. Three patients were more than 70 years old and 4 had occlusions > 5 days duration. All required subsequent amputation of critically ischaemic limbs.

Doses higher than 0.5 mg/hr have not been shown to provide added benefit and may contribute to excessive bleeding. Only 2 patients adhered to literature dosage recommendations. These patients still developed bleeding complications. Careful attention to dosing was therefore warranted.

Overall, only 30% of patients had clinical benefit from the r-tPA and did not require surgery. This figure did not compare well with other studies (1,2) and suggested imprudent use of r-tPA at the RAH.

1.5 Conclusion

The use of r-tPA for non-coronary artery occlusion at the RAH was sub-optimal. Patient selection criteria, dosage and duration of therapy were shown to be at variance with audit criteria or the literature in 7 out of 9 treatment courses. Bleeding complications were common, even in patients complying with dosage recommendations. Inappropriate use of r-tPA at the RAH also contributed to patient morbidity and unnecessary cost. This study emphasised the need for careful patient screening before commencing thrombolytic therapy.

1.6 Recommendations

The study recommendations were that review of patient selection and other criteria be undertaken by the Haematology and Vascular Surgery units. Prospective monitoring of the use of r-tPA for all non-coronary artery occlusions was recommended. Restriction of prescribing to relevant specialists was also advised.

Table 1 ***Table of treatment outcomes for patients treated with r-tPA for non-coronary artery occlusion***

Patient Number	Indication	Previous streptokinase	Dose (mg/h)	Treatment outcome	Other effects
1	Occluded (R) femoral - popliteal bypass	Yes	2 mg/h for 12 hours then 1.25 mg/h for 4 hours	amputation of fourth toe of (R) leg (toe became gangrenous)	Bleeding from arterial puncture sites leading to cessation of infusion followed by continuation at lower dosage
2	Embolism of (R) pop/tib trunk from coronary angiogram	Yes	0.2 mg/h for 21 hours then 0.5 mg/h for 37 hours	Complete thromboembolic clearance	Haematoma in right groin
3	Superior vena cava obstruction (Hickman catheter sepsis)	Yes	10mg stat then 20 mg/hr for 5 hrs with doses decreasing over 24 hours with cessation at this time	Complete clearance	
4	Occluded (L) femoral artery	Yes	2.5 mg/hr for 20 hrs then 2.0 mg/hr for 22 hrs then 2.5 mg/hr for 17.5 hrs then 2.5 mg/hr for 19.5 hrs	Deterioration of leg leading to below knee amputation	Extended coagulation times leading to cessation of treatment and subsequent decrease in dosage
5.	(L) Popliteal artery stenosis	Yes	1 mg/hr for 23 hrs then 1 mg/hr for 13 hrs	Deterioration of leg leading to above knee amputation	Extended coagulation times initially leading to cessation of therapy and then further infusion
6.	Pulmonary thromboembolism with both (L) and (R) side involvement	No	Course of rt-PA over a period of 4 months	Limited reperfusion and increased capacity	
7.	(L) Popliteal embolus	Yes	2.5 mg/hr for 17 hrs and 30 minutes	Complete thromboembolic clearance	Haematoma developed in old cheek wound (from recent plastic surgery)
8.	Occluded (R) femoro-popliteal bypass graft	Yes	2 mg/hr for 17 hrs then 1 mg/hr for 2 hrs then 2 mg/hr for 19 hrs	Removal of gortex graft leading to improvement, however reocclusion in 1 month	Extended coagulation times requiring dose alteration. Retroperitoneal bleed requiring surgery
9.	(R) femoro-popliteal bypass graft occlusion	Yes	0.1 mg/hr for 24 hrs then 0.5 mg/hr for 29 hrs	Partial clearance of graft via r-tPA. Stenosis of right external iliac artery dilated with 8mm balloon leading to significant result	Haemorrhage from angiogram site and haematoma formation leading to dosage decrease

1.7 Project outcomes

These recommendations were accepted by the Drug Committee. Treatment protocols for the use of r-tPA and urokinase were revised. Prescribing was restricted to the Haematology or Vascular Units only. Prospective monitoring was achieved by mandating consultations by specialists familiar with the guidelines before r-tPA was dispensed by the pharmacy. A prospective patient monitoring form, completed by the consulting specialist, had to be forwarded to the Pharmacy before replacement stock could be ordered. Cases not complying with criteria were referred to the Drug Committee. Justification for 'disputed' cases was sought from the relevant specialists.

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CHAPTER 11

QUALITATIVE DUE: REVIEWS OF THE DRUG COMPONENT OF PROCEDURES

1. ANTIBIOTIC PROPHYLAXIS IN COLORECTAL SURGERY (1990)

This review is interesting because it describes a logical progression of different methods to determine, correct and re-evaluate a drug utilisation pattern associated with a particular procedure (colorectal surgery). A 2 stage process is described: (i) a pilot review with subsequent correctional strategies implemented, followed by (ii) a re-evaluation of prescribing practices and monitoring of cost and clinical implications.

Quantitative methods were first used to identify the need for a qualitative assessment of cefoxitin use. This drug directed qualitative evaluation highlighted problems with the use of cefoxitin and metronidazole as surgical antibiotic prophylaxis in colorectal surgery. Corrective actions were implemented and assessment of compliance with the new policies was undertaken by conducting a procedure based review. The procedure based review was necessary because following policy changes from the first review, the use of cefoxitin was so infrequent that patient episodes could not be targeted by following the drug. In addition, we were unsure which drugs were being used in place of cefoxitin, so other drugs could not be targeted to elicit changes in drug utilisation patterns. Instead, by choosing study subjects from surgical lists instead of drug lists, we were able to assess all antibiotic regimens being used for this indication.

1.1 Background

This review was prompted by purchase data demonstrating a 25% increase in expenditure for intravenous cefoxitin between 1987/88 and 1988/89. Also, anecdotal evidence of non-compliance with established formulary guidelines for surgical prophylaxis had been provided by the chart review activities of clinical pharmacists. These findings prompted a pilot review of cefoxitin use. This review was subsequently followed by a comprehensive review of antibiotics used for antibiotic prophylaxis in colorectal procedures.

1.2 Method

Patients who were administered cefoxitin or intravenous metronidazole were selected at random from surgical units, the intensive care and high dependency units over a two week period. For each course, data were collected on treatment indication, antibiotics administered, dosage, frequency, timing and duration of administration together with patient demographic details and culture and sensitivity results. Data were assessed by comparison with formulary criteria by the project pharmacist and a clinical microbiologist.

1.3 Results

Data for 29 patient courses (11 cefoxitin, 18 IV metronidazole) were recorded. Eighteen (62%) were for treatment and 11 (38%) were for prophylaxis.

Sixty three percent of prophylactic antibiotic courses involved an inappropriate drug choice. In all prophylactic cases, antibiotics were administered for longer than required (48 hours instead of 24 hours). Average dose, frequency and duration of cefoxitin prophylaxis were 1300 mg, 6 hourly, 51 hours, respectively. The corresponding figures for metronidazole were 500 mg, 8 hourly and 48 hours, respectively. No prophylactic course was given for the recommended 24 hours.

Thirty three percent of therapeutic courses involved either inappropriate drug choice or indication. Cefoxitin and metronidazole were used in combination in a number of instances. In others, microbiology results confirmed inappropriate use of cefoxitin or metronidazole.

Potential savings were estimated at $50,000 ($30,000 cefoxitin) for a full year.

1.4 Preliminary recommendations

Significant recommendations from the pilot study were to:

- promote oral metronidazole or tinidazole over parenteral agents for surgical antibiotic prophylaxis;
- promote single dose metronidazole and gentamicin for surgical prophylaxis when oral therapy was not indicated;
- restrict cefoxitin prophylaxis to patients with impaired renal function.

1.5 Preliminary project outcomes

Following the pilot review, a number of meetings were held with the surgical and ICU staff to provide study feedback and to determine a strategy to improve use of these antibiotics. Surgical specialists were 're-educated' about principles of antibiotic prophylaxis, the microbiology of the operative field and the spectrum of alternative antibiotics. The formulary guidelines were revised (Figure1 and 2) and disseminated throughout the hospital in the Drug Committee Bulletin. Key prescribers were detailed individually. Surgical unit protocols were similarly amended. Stocks of cefoxitin were removed from all treatment areas except surgical suites. Stock in these areas was reduced to emergency stock levels to prevent borrowing by wards.

Subsequent usage and expenditure were monitored and a second review was conducted approximately 6 months after the education campaign.

Figure 1 Initial Colorectal Surgery Antibiotic Prophylaxis Guidelines

NATURE OF OPERATION	RECOMMENDED REGIMEN (1 DOSE ONLY)
ABDOMINAL SURGERY 1. **Colonic Surgery**	1.1 metronidazole 600 mg IV or 1g suppository inserted rectally *in addition* gentamicin 1.5 mg/kg IV stat (single dose only) may be added ***Note**: For patients with renal impairment cefoxitin 1g IV may be used instead of above.*
2. **Biliary Surgery and / or Invasive Diagnostic Techniques.** * prophylaxis indicated in patients: - over 70 years - with jaundice or common bile duct stones - with evidence of infection	2.1 gentamicin 1.5 mg/kg IV stat (single dose only) *plus* amoxycillin 1 g IV ***Note**: For patients with renal impairment cefoxitin 1g IV may be used instead of above.*
3. **Gastric Surgery** * prophylaxis indicated in the following patient groups: - with achlorhydria - on ranitidine or cimetidine therapy - with carcinoma of the stomach - with ulcer haemorrhage - with obstruction or decreased GI motility.	3.1 gentamicin 1.5 mg/kg IV stat (single dose only) *plus* amoxycillin 1 g IV ***Note**: For patients with renal impairment cefoxitin 1g IV may be used instead of above.*

1.6 Follow-up evaluation

All patients undergoing a colorectal surgical procedure over an 8 week period (March - May 1990) were reviewed. Data similar to those recorded during the pilot survey were collected. Patients undergoing colorectal surgical procedures were randomly selected for review. Antibiotic usage was compared to the updated guidelines described above.

Approximately 90% of courses were for surgical prophylaxis. Tinidazole was the commonly used anti-anaerobic agent (69% of courses). Cefoxitin was used in only 4% of courses. In 78% of courses, drug choice was consistent with guidelines. Cases of inappropriate prescribing were predominantly associated with dosing times (ie. oral drugs administered more than 15 hours before surgery; 12 hours was recommended limit). This aspect was identified as a subject for continuing education (Tables 1 to 5). No change in post-operative infection rate as a result of changes to protocol was identified.

The total cost of drugs administered inappropriately (after adjustment for correct drug costs) during the study period was $152. A $50,300 contraction in expenditure for cefoxitin was noted for the 9

months between study periods 1988/89 - 1989/90. This equated to $68,000 for the full year. Additional expenditure for gentamicin, metronidazole and tinidazole were within projections and did not detract from cefoxitin savings.

Figure 2 Revised colorectal Surgery Antimicrobial Prophylaxis Guidelines

ANTIMICROBIAL PROPHYLAXIS IN COLORECTAL SURGERY THERAPEUTIC GUIDELINES (ex Royal Adelaide Hospital formulary , 1991/92))

RECOMMENDED REGIMEN :

(1 dose only)

* tinidazole 2g oral *OR*

* metronidazole 2g oral *OR*

** metronidazole 500mg IV *OR*

metronidazole 1g suppository

PLUS

** gentamicin 1.5mg/kg IV over 15 minutes

For patients with significant renal impairment

Cefoxitin 1g IV may be substituted for the above (for patients > 80kg, use cefoxitin 2g IV). It should not be used for continuing therapy; ONLY for prophylaxis.

Notes:

* Oral medications should be administered not less than 4 hours or more than 15 hours before surgery.

** Metronidazole and gentamicin injections may be mixed together immediately prior to administration and the combination infused over 15 minutes, immediately following induction of anaesthesia. Alternatively, gentamicin may be given as an intramuscular injection at the time of pre-medication.

General Points

1. Intravenous antibiotics should be administered immediately after induction of anaesthesia.
2. A single dose of parenteral drug is sufficient in most situations. A second dose may be administered if surgery is delayed or prolonged.

Table 1 Distribution of treatment types and procedures

Treatment types	Clinic		Total (%)
	Colorectal	Other	
Prophylaxis	42	6	48 (89)
Early treatment	4	1	5 (9.3)
Treatment	1	1	2 (3.7)

Table 2 Nature of surgical procedure

Procedure	Number of patients (%)
Appendicectomy	13 (24.1)
Hemicolectomy	9 (16.7)
Sigmoid colectomy	4 (7.4)
Procto-colectomy	2 (3.7)
Sub-total colectomy	2 (3.7)
Anterior resection	8 (14.8)
Reversal / closure of previous procedure	9 (16.7)
Other	7 (12.9)
TOTAL	**54 (100)**

Table 3 Summary of antibiotic use

Antibiotic	Number 0f patients (%)
tinidazole	37 (68.5)
metronidazole	16 (29.6)
gentamicin	43 (79.6)
cefoxitin	2 (3.7)
amoxycillin	7 (12.9)

Table 4 Distribution of process indicators for courses classified as appropriate by drug choice

INDICATOR	APPROPRIATE (%)	INAPPROPRIATE (%)
Dose	42 (100)	-
Frequency	42 (100)	-
Route	41 (97.6)	1 (2.4)
Duration	40 (95.2)	2 (4.8)
Pre-operative administration time	26 (61.4)	15 (85.7)

Table 5 Distribution of doses administered inappropriately with respect to timing of surgery

Antibiotic (Route)	Number %
tinidazole (oral)	13 (30.9)
metronidazole (rectal)	1 (3.3)
metronidazole (IV)	1 (2.3)

1.7 Discussion

The most striking finding from this DUE was the marked reduction in cefoxitin use. The previous study indicated that cefoxitin was the predominant agent used for prophylaxis, often in combination with metronidazole. Subsequently, cefoxitin usage was replaced by oral tinidazole. Significant savings resulted.

The main divergence from guidelines was in the timing of prophylaxis in relation to surgery, particularly for oral tinidazole. This was because tinidazole was given routinely at 2200 hours on the evening before surgery, regardless of when the patient was scheduled for surgery on the following day. In other instances, undertreatment rather than overtreatment was evident. However, no adverse patient sequelae were documented.

1.8 Conclusion

The pilot DUE resulted in major recommendations for changes to prescribing practices for antibiotic prophylaxis in colorectal surgery. A multidisciplinary approach to revision of guidelines, based on objective evidence for drug misuse, resulted in hospital-wide endorsement of policy changes. A re-evaluation confirmed significant improvement in drug utilisation. No adverse sequelae (increased infection rate) were noted as a result of the change. Significant cost savings resulted.

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CHAPTER 12

QUALITATIVE DUE: REVIEW OF THE DRUG MANAGEMENT OF A DISEASE PROCESS

1. COMMUNITY ACQUIRED PNEUMONIA (1991)

This DUE describes a concurrent review of antibiotic treatment of community acquired pneumonia. Guidelines for the management of a disease process rather than specifically for the use of a drug were defined. This was the first time an objective assessment of the appropriateness of general antibiotic selection for this disease process was undertaken at the RAH. Correlations of microbiology results where available, were made with the prescribed therapy. Assessments of clinical outcome were also attempted.

1.1 Study aim

To evaluate the pattern of antibiotic use in the treatment of community acquired pneumonia at the RAH.

1.2 Study method

This was a concurrent DUE of patients admitted to the RAH between May-July 1991, with an admitting diagnosis of pneumonia. For study purposes pneumonia was defined as a new pulmonary infiltrate on chest x-ray with accompanying fever, chills, cough, purulent sputum, and shortness of breath. The accuracy of diagnosis was not the subject of review in this instance. Patients with community acquired pneumonia were those not hospitalised during the previous 4 weeks, or where pneumonia developed within 48 hours of admission. Immunosuppressed and cystic fibrosis patients were excluded from the evaluation.

Patients were recruited on an intention-to-treat basis, identified from hospital admission lists. Antibiotic therapy was evaluated even if the working diagnosis was amended following commencement of treatment. However, if the diagnosis was not pneumonia, further follow-up was not performed.

Audit criteria (Figure 1) were defined taking into account the medical literature, local microbiology and antibiotic sensitivity patterns, and the advice of infectious disease specialists. Process parameters were assessed individually. Courses were classified as appropriate only if they complied with all criteria. Cases which were equivocal by one or other parameter, were classified as appropriate.

Demographic, clinical and drug data were collected using a special data collection form (Appendix 3).

1.3 Results

Over the 6 week study period, 5271 patients were admitted to the hospital of whom 41 had pneumonia. Eighteen people did not satisfy entry criteria. One patient died 10 days after admission (unrelated to pneumonia) and a second patient, 24 hours after admission (atypical pneumonia).

Positive microbiology was available for only 4 patients despite all patients submitting samples. Three samples confirmed the diagnosis of pneumonia (2 x *S. pneumonia*, 1 x *H. influenzae*)

Sixty antibiotics were administered for 23 treatment courses (Table 1). Sixty percent of inappropriate courses comprised an inappropriate choice of drug and overall 82.6% of treatment courses were inappropriate by one or more indicators (Tables 2 to 4).

The total antibiotic treatment cost was $1130; the cost of inappropriate treatment after adjustment for correct drugs was $340.

2. DISCUSSION

In addition to concerns over inappropriate drug use found in this study, were the low frequency of positive cultures (17.4%). This was despite all patients submitting one set of samples and 39% submitting additional specimens for viral and atypical serology. Other studies have shown positive cultures ranging from 35-50% to 97% (1-4). Previous studies at the RAH showed a 77% incidence of positive cultures (5). The latter study involved microbiologists collecting sputum samples. Positive sputum samples (which are Gram stained) are an important aid to appropriate selection of drug therapy, allowing specific therapy to commence before a pathogen has been cultured. The inference from the low yield shown in the study is that education on the proper technique for obtaining sputum samples by ward staff was required.

The small sample size in this study may limit broad conclusions about the appropriateness of drug therapy for this condition. Most patients had a satisfactory response to treatment even though courses were classified as inappropriate by one or other parameter. Even in cases where the choice of antibiotic did not comply with criteria, patient response was satisfactory. What are the implications of this observation ?

Experts often do not agree on the most appropriate drug for a particular clinical situation and even under closely controlled conditions, patients may respond variably. Some patients may do badly despite good therapy and others may improve despite bad treatment. Does this mean that any treatment will suffice and that criteria are therefore unnecessary ?

It is precisely for such clinical conundrums that all treatments, even empiric ones, should at least commence on a foundation of sound scientific principle. For this reason, explicit guidelines, even if not suitable for every clinical setting, are all the more important. They represent a literature and expert consensus for the management of a particular condition, and provide guidance to those who are not expert in such matters. We should take into account factors which impinge on the content of these guidelines and be prepared to regularly review and update criteria in accordance with new evidence.

These findings have relevance to the application of criteria in this and other settings. For example, does the fact that patients improve despite 'inappropriate' therapy mean that patients did not require drug therapy in the first place, or does it mean that our classification of 'appropriate' therapy requires revision? An answer to these questions is not possible without a group of matched controls or a randomised trial. The former may be unethical in the presence of clinical signs and symptoms, the latter would be impractical in the routine clinical setting.

Table 1 Reasons for exclusion from study

Reason for exclusion	No. subjects (% total excluded)
1. Change in diagnosis before treatment began	8 (44.5)
2. Hospitalisation < 14 days ago	6 (33.3)
3. Immunosuppressive drugs	2 (11.1)
4. Other	2 (11.1)

Table 2 Summary of diagnosis and treatment

Patient	Provisional diagnosis	Positive culture result	Drugs used, in order of use	Overall classification	Therapy Duration (days)
1.	Atypical	Yes	IV Erythromycin	Appropriate	3
2.	Typical	No	IV Amoxycillin, O Amoxycillin	Inappropriate	11
3.	Atypical	No	IV Amoxycillin, O Amoxycillin	Inappropriate	11
4.	Typical	No	IV Amoxycillin, O Amoxycillin, O Erythromycin	Inappropriate	18
5.	Atypical	Yes	IV Erythromycin, IV Penicillin, O Penicillin	Inappropriate	14
6.	Typical	No	IV Penicillin, O Penicillin	Appropriate	15
7.	Typical	No	IV Penicillin, IV Erythromycin, O Erythromycin	Inappropriate	7
8.	Typical	No	IV Penicillin, O Penicillin	Inappropriate	11
9.	Typical	No	IV Penicillin, IV Amoxycillin, IV Cefotaxime, IV Ceftriaxone	Inappropriate	20
10.	Typical	No	O Penicillin, O Erythromycin	Inappropriate	1
11.	Typical	Yes	IV Penicillin, IV Penicillin, O Penicillin	Appropriate	12
12.	Atypical	No	IV Amoxycillin, IV Ceftriaxone, IV Erythromycin, IV Penicillin O Penicillin, O Penicillin O Amoxycillin	Inappropriate	13
13.	Typical	Yes	IV Erythromycin, IV Ceftriaxone	Inappropriate	10
14.	Typical	No	IV Penicillin, IV Amoxycillin O Amoxycillin, O Amoxycillin	Inappropriate	14
15.	Atypical	No	IV Amoxycillin, O Augmentin™, O Augmentin Forte	Inappropriate	11
16.	Typical	No	IV Amoxycillin	Inappropriate	1
17.	Atypical	No	O Erythromycin	Inappropriate	3
18.	Atypical	No	IV Ceftriaxone, IV Amoxycillin, IV Metronidazole, O Metronidazole	Inappropriate	18
19.	Atypical	No	IV Erythromycin	Appropriate	5
20.	Aspiration	No	IV Erythromycin and IV Ceftriaxone	Inappropriate	1
21.	Typical	No	IV Amoxycillin, O Amoxycillin	Inappropriate	2
22.	Typical	No	IV Penicillin, O Augmentin	Inappropriate	9
23.	Typical	No	IV Amoxycillin, O Amoxycillin, O Amoxycillin	Inappropriate	11

***Legend**: O= Oral route, IV= Intravenous route*

Table 3 Details of appropriate versus inappropriate antibiotic courses for indication, drug choice and process indicators

Variable	No. Appropriate (% of total) n=60	No. Inappropriate (% of total) n=60
Indication	57 (95.0)	3 (5.0)
Drug choice	36 (60.0)	24 (40.0)
Dose	52 (86.7)	8 (13.3)
Frequency	45 (75.0)	15 (25.0)
Duration	54 (90.0)	6 (10.0)
Route of administration	58 (96.7)	2 (3.3)

Table 4 Distribution of inappropriate process parameters

Frequency	**n=15**
> recommended	7
< recommended	8
Duration	**n=6**
>recommended	3
< recommended	3
Dose	**n=8**
>recommended	3
< recommended	5
Route	**n=2**
Oral instead of IV	2
IV instead of oral	0

This is particularly relevant for empirical therapy, when antibiotics are required before pathogens are identified. Broad spectrum therapy may be indicated in situations where a range of potential causative pathogens is likely. Therapy should then be changed to a narrow spectrum agent when antibiotic sensitivities become known. The difficulty however occurs when, as in this study, many specimens do not yield positive cultures. In these cases, particularly if patients show a positive response to therapy, medical staff may be reluctant to alter treatment. In some cases this reluctance persists in the face of antibiotic sensitivity results which indicate other antibiotics would be satisfactory.

One way to manage this dilemma is to alter the way courses are classified. For example, this review may have benefited from the application of explicit or even subjective (eg. by an infectious disease expert) standards to the 'drug choice' indicator. A better classification system may have been: (i) complied with criteria; (ii) did not comply with criteria but acceptable on basis of microbiology, clinical or other factors, or; (iii) unacceptable.

2.1 Conclusion

This study highlighted difficulties experienced when attempts are made to correlate clinical outcome with 'best practice' guidelines. Overall, the study classified the treatment of community acquired pneumonia as largely inappropriate at the RAH. In particular, appropriateness of drug selection was a major failing. Despite this, most patients displayed a satisfactory response, and were changed from IV to oral therapy and subsequently discharged. The application of standards or use of a less rigid classification system may have been helpful in this regard.

Figure 1 Audit Criteria for Antibiotic Therapy of Community Acquired Pneumonia.

Recommended Empiric Therapy

1. **Typical bacterial pneumonia**

1.1 To cover Pneumococcus (ie. the most likely pathogen):

benzylpenicillin	600mg - 1.2g IV 4-6 hourly, then
penicillin V	500mg orally every 6 hours with or without
probenicid	500mg orally every 6 hours, or
amoxycillin	500mg orally every 8 hours

If there is a documented penicillin hypersensitivity:

cephalothin	1-2g IV 4-6 hourly or
lincomycin	600mg IV 8 hourly followed by
oral cephalexin or clindamycin	

1.2 If a Staphylococcal infection is suspected:

flucloxacillin	1-2g IV 4-6 hourly

Note: Vancomycin should be used only in patients with proven MRSA infections or documented Type 1 penicillin / cephalosporin hypersensitivity.

1.3 In elderly or debilitated patients:

benzylpenicillin	0.6-1.2g IV 4-6 hourly, plus
gentamicin	2mg/kg loading dose
	then 1-1.5mg/kg IV 8 hourly

This will provide cover against most Pneumococci as well as Gram-negative enteric bacilli (eg. Klebsiella).

For patients with renal impairment or Type 3 penicillin hypersensitivity, substitute:

ceftriaxone	1-2g IV daily (as a single agent)

Duration of therapy:

7-10 days with a change to forms when clinically indicated.

2. **Atypical pneumonia**

2.1 If mycoplasma or Legionella are suspected:

erythromycin	0.5-1g IV 6 hourly

For critically ill patients, add:

rifampicin	600mg IV 12 hourly

Note: Rifampicin should never be used alone due to the frequent emergence of resistant strains. It's use should be restricted to patients in whom Legionella is proven or highly likely.

An alternative agent in less severe cases is doxycycline.

2.2 If Psittacosis or Q fever are suspected:

doxycycline	100mg orally every 12 hours, or
rolitetracycline	275mg IV daily for severe cases

Erythromycin is an alternative agent, although this is less reliable.

Duration of therapy:

7-10 days although a longer course may be necessary in some cases.

3. **Aspiration pneumonia**

benzylpenicillin	0.6-1.2g IV 4-6 hourly, plus
metronidazole	500mg IV 12 hourly for 1-2 day s, then
metronidazole	200-400mg orally or 1g rectally every 8 hours

If there is a documented penicillin hypersensitivity:

erythromycin or cephalothin

In some cases, Staph aureus or Gram negative bacilli may also be involved. If suspected, flucloxacillin should be substituted for benzylpenicillin or gentamicin added, respectively.

These observations do not obviate the utility of criteria for patient management, but rather exemplify the lack of 'exactness' in medical practice, both in the diagnostic arena and in the application of drug or other treatment.

This study highlighted potential problems in the way sputum samples are collected by house staff at the RAH. It also raised questions about the relevance of criteria, however well developed, to clinical management. This may be particular pertinent when empiric therapy is contemplated.

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CHAPTER 13

QUALITATIVE DUE: DUE USING STRUCTURAL CRITERIA

1. INTRODUCTION

This DUE investigated the quality of prescribing by assessing structural criteria rather than indication or process parameters. The aim was to determine whether the system in place for recording adverse drug reactions (ADR) was effective in preventing drug use where a history of adverse drug reactions was known. The results highlighted the poor attention given to documenting ADRs and their consequences. In contrast to other DUE activities which identified specific issues relating to the use of a particular drug or treatment of a particular condition, this DUE exemplified deficiencies in the application of existing systems which, if improved, would lead to overall improvement in aspects of clinical care which can be measured using external indicators.

2. PRESCRIBING IN PATIENTS WITH A HISTORY OF ADVERSE REACTIONS TO THE PRESCRIBED DRUG (1995)

2.1 Background

The Australian Council on Health Care Standards (ACHS) has developed a number of indicators which describe the quality of care provided to hospital patients. Clinical Indicator 6.1 is a sentinel marker for prescription and drug monitoring. Indicator 6.1 describes the number of patients prescribed a medication to which they are known to have had a prior adverse reaction. Adverse reactions include allergy or hypersensitivity reactions or other unfavourable drug events. A known adverse reaction is defined as one indicated by an alert notice affixed to a medical record or other source document. Indicator 6.1 requires that all patients knowingly prescribed a drug for which there is a known prior reaction have the reason for such prescription documented.

The purpose of this study was to examine compliance with ACHS Clinical Indicator 6.1 at the Royal Adelaide Hospital. This project was undertaken with the assistance of two 4th year Medical students from the University of Adelaide as a research project requirement of the 4th year of the Medical student curriculum.

2.2 Subjects and method

Study subjects were selected from all elective and emergency/acute admissions to the RAH over a 22-day period during the first quarter of 1995. Patient selection was on the basis of a table of random numbers applied to the daily admission list obtained from the hospital Admission Department. Patients unavailable for interview within 48 hours of admission, day patients, cancer patients, patients with speech or English language difficulties and those with acute psychiatric or other cognitive neurological impairments were excluded.

The results of each patient interview were recorded using a structured questionnaire. These included prior adverse drug reactions and current drug therapy. Assessments were made on the basis of in-

tention to treat. Rechallenges were classified as intentional or accidental. The clinical outcomes of all rechallenge events were recorded.

Drug class, ADRs type, severity and causality were classified in accordance with standard systems. The past and current medical records, drug chart, Alert sheet or other clinical documentation were reviewed for concordance with the patient interview and evidence of ADRs documentation or the reason for rechallenge.

2.3 Results

2954 patients were admitted to the RAH during the study period. 1007 day patients were excluded. Of the remainder 743 were selected for interview using the table of random numbers. Data for 407 patients were recorded (Table 1,2,3).

ADRs were reported for 269 drugs by 155 (38.1%) patients (Table 4). Women were more likely than men to have a history of prior ADR. Most ADRs had occurred within the previous five years and were due to medications prescribed by general practitioners or private specialists (53.2% in total) as opposed to hospital doctors (Table 9).

The drugs most commonly implicated in ADRs were anti-infective drugs (32%) followed by analgesics (23%) and drugs acting on the musculoskeletal system (10.8%) (Table 6). The physiological systems most commonly affected were the gastrointestinal (35.3%) and the skin (21.2%) (Table 4).

Moderate or severe ADRs were described in over 65% of patients reporting an ADRs history. Fifty two percent of reactions were classified as being of probable causality. Reactions were most often Type A (Type A = predictable based on knowledge of the pharmacology of the drug) and occurred most commonly with analgesic drugs. Unpredictable reactions (Type B) were most often due to anti-infective agents (Table 6,8).

Of those patients described as having previous ADR, 12.8% were re-exposed to the same or similar drugs during hospital admission. Sixty seven medicines were implicated in these rechallenge (re-exposure) events. Of these events, 9 produced repeat ADR. Analgesics were the most commonly implicated and patients in Cardiology wards were the most likely to be re-exposed. Of the drugs implicated in re-exposure events, 44.8% were drugs previously prescribed by general practitioners or private specialists. Sixty one percent of drugs implicated in re-exposure events were prescribed intentionally. Of these more than half had been administered more than once previously (Table 10).

Documentation of prior ADRs was variable and inconsistent. Prior ADRs were most commonly documented in nursing notes (41.6% of prior reactions) compared with medical notes (24.5%). Among medical staff, anaesthetists documented ADRs more often than other medical staff. The ADRs section of the medication chart was generally poorly completed with only 18.8% of patient reported ADRs documented in the allocated part of the drug chart (Graph 1).

Patients re-exposed to causative agents were less likely to have prior ADRs documentation than those who were not re-exposed, (16.5% compared with 27.9% respectively). 9% of patients re-exposed to causative drugs had documentation of prior events in the medication chart compared with 21.8% of those who did not experience a rechallenge event. Type B reactions were more likely to be documented than Type A reactions. In the medical notes, Type A reactions were documented in 19.4% of cases compared with 36.2% of Type B reactions. In the medication chart, documentation rates were 13% and 27.5% for Type A and Type B reactions respectively (Graph 2,3).

Table 1 Survey sample

Description	No. of patients
No. patients admitted during study period	2954
No. patients screened	1947
No. patients selected from random table	743
No. patients interviewed	407
No. patients not interviewed	334
• No. patients unable to be located	239
• No. patients excluded from our study criteria	88
• No. patients refused interview	8
No. patients experiencing ADRs	155
Total ADRs reported	269
No. patients experiencing ADRs with re-exposure	52
Total ADRs with re-exposure reported	67

Table 2 Age distribution of patient sample

Male = 179 (44%); Female = 228 (56%)	
Age bands	No. of patients
1 - 15 yrs	1 (0.25%)
16 - 30 yrs	50 (12.3%)
31 - 45 yrs	73 (17.9%)
46 - 60 yrs	84 (20.6%)
61 - 75 yrs	126 (31%)
76 - 90 yrs	69 (17%)
91-105 yrs	4 (1%)
Mean Age: 56.6 years	**Total = 407 (100%)**

Table 3 Ward/clinic distribution of patient sample

WARD / CLINIC TYPE	NUMBER OF PATIENTS (n = 407)
General Medicine	71
Orthopaedic	52
Cardiology	41
Urology	29
Ear, Nose and Throat	25
Plastic Surgery	23
Neurosurgery	21
Cardiothoracic Surgery	21
Gastroenterology	17
Dermatology	16
Vascular Surgery	9
Thoracic Medicine	9
Haematology	6
Geriatric	1

Table 4 Organ system affected by ADR

Description of ADRs	Number of ADR (n= 407)
Gastrointestinal disorders	95
Skin disorders	57
Nervous system disorders	42
Psychiatric disturbances	19
Allergic immunological disturbances	12
Cardiovascular disturbances	12
Blood disturbances	6
Respiratory Tract disorders	5
Muscle and Bone disorders	5
Ear, Nose and Throat disorders	5
Urinary tract disorders	3
Endocrinopathy disorders	1

Table 5 Number of patients with a history of ADRs versus Age group (n=155)

No. of ADR	1	2	3	4	5	6	7	8	9	10	Total
Age											
1-15											**0**
16-30	12	6						1		1	**20**
31-45	16	10	2	1		1					**30**
46-50	22	10	1			1		1	1	1	**34**
61-75	34	11	4			1		1	1		**52**
76-90	11	4	3		1						**19**
Total	**95**	**41**	**10**	**1**	**1**	**3**	**0**	**2**	**1**	**1**	**155**

Table 6 Distribution of ADRs classification versus Type of Drug

Type of ADR / Type of Drug	TYPE A Adverse effects			TYPE B Adverse effects			
	Pharmaceutical	Pharmacokinetic	Pharmacodynamic	Immunologic	Pseudoallergic	Pharmacogenetic	TOTAL
Antiinfective agents	2	2	28	56	0	0	86
Analgesics	1	1	56	5	0	0	62
Musculoskeletal system drugs	0	0	32	2	0	0	34
Central nervous system drugs	3	3	23	5	0	0	31
Cardiovascular drugs	2	2	23	3	0	0	29
Surgical preparations	0	0	4	7	0	0	11
Other	0	0	15	1	0	0	16
TOTAL	1	8	181	79	0	0	269

Table 7 Classification of ADRs (n=269)

Classification of ADRs	Number of ADRs (n=269)
Type A	
(a) Pharmaceutical	1
(b) Pharmacokinetic	8
(c) Pharmacodynamic	181
Type B	
(a) Immunologic	79
(b) Pseudoallergic	0
(c) Pharmacogenetic	0
Total	**269**

Table 8 Distribution of prescribers for reported ADRs (n=269)

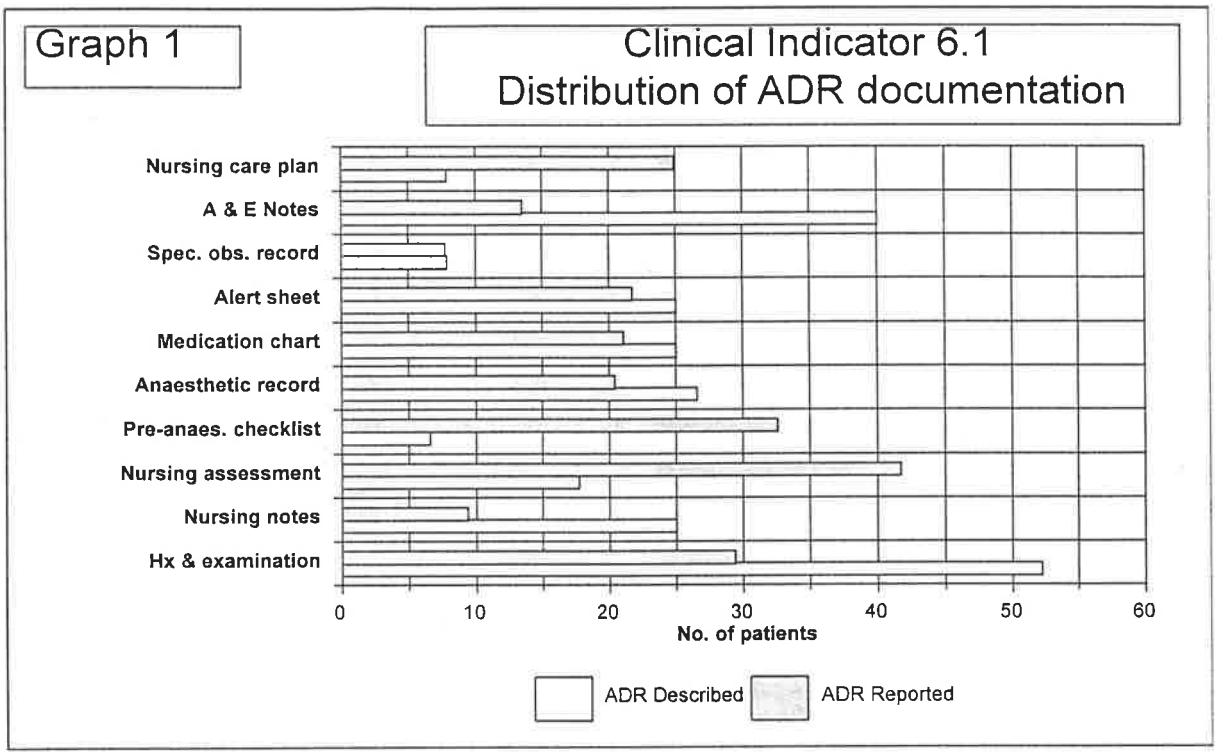
Hospital staff	111
G.P	131
Self	15
Others	12

Table 9 Presence of ADRs in current admission as a consequence of re-exposure events

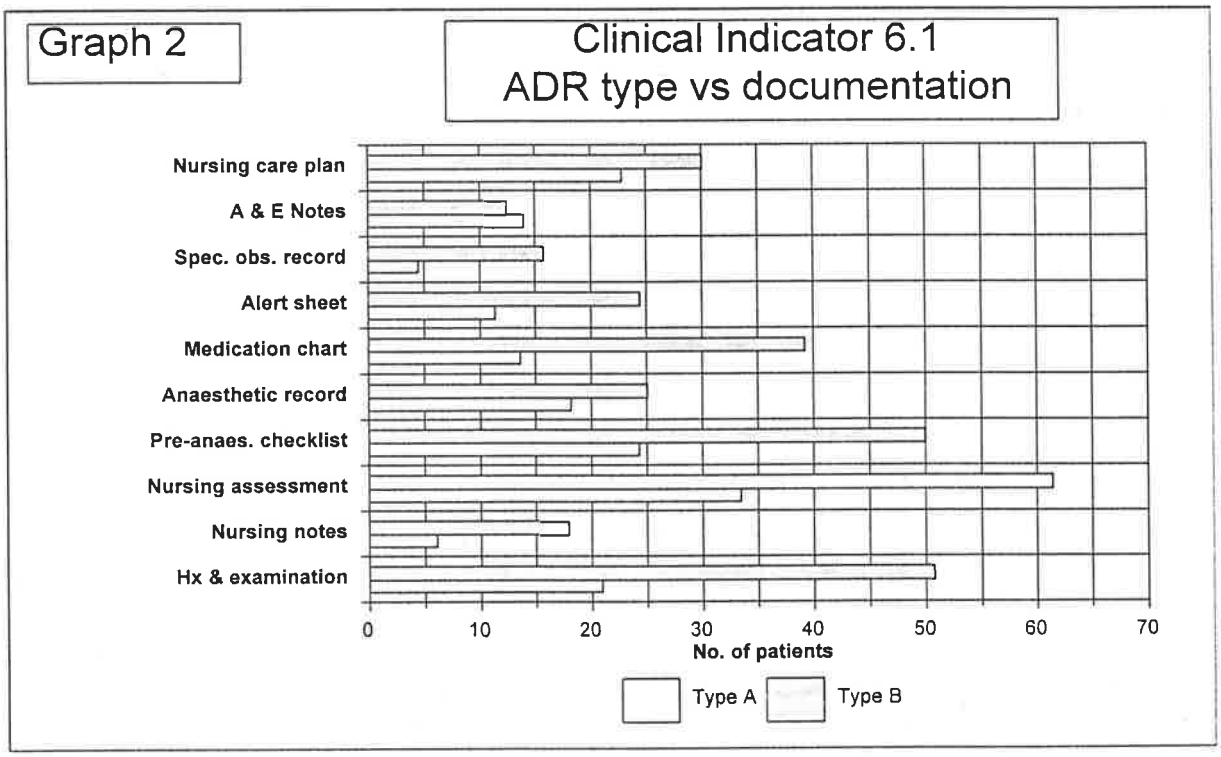
ADRs not present	43 (64.2%)
ADRs present	9 (13.4%)
ADRs present but in another form	0 (0%)
Don't know	11 (16.4%)
Not applicable (drug not administered)	4 (6.0%)
TOTAL	**67**

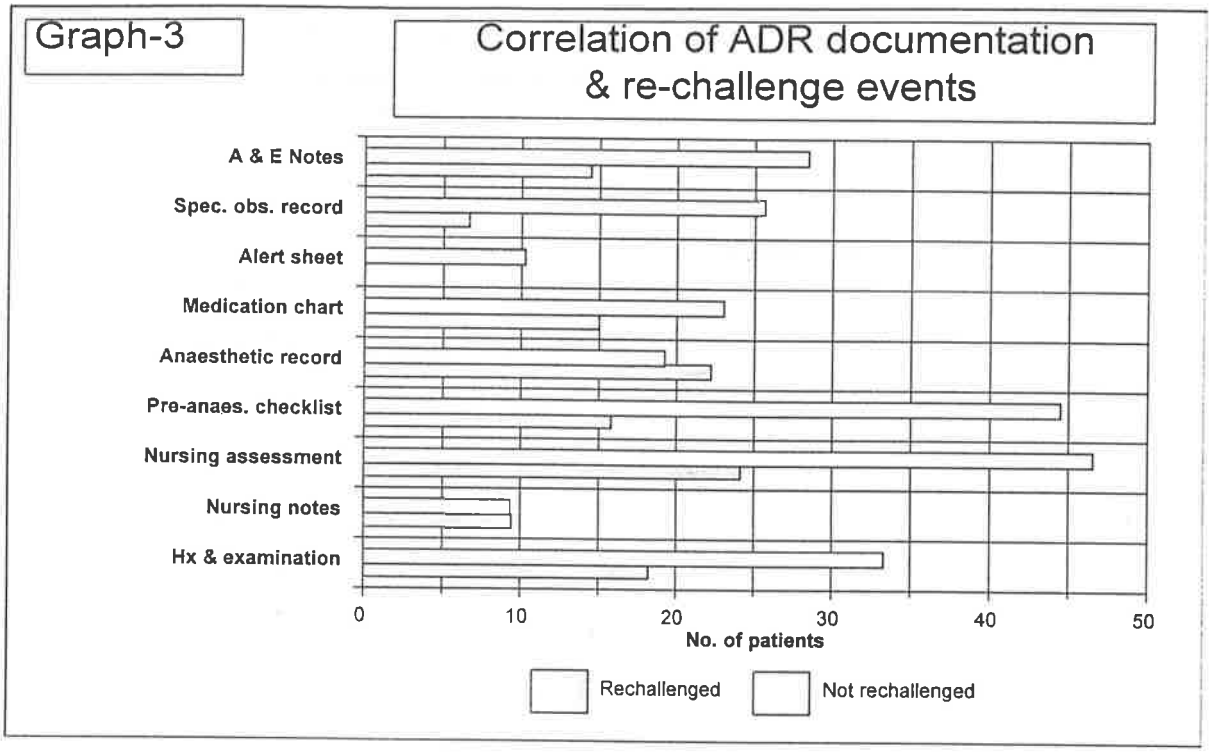
Morphine: vomiting	Co-trimoxazole: rash
Morphine injection: itch	Penicillin: respiratory distress
Panadeine Forte™: constipation	Theophylline: heartburn & dyspepsia
Morphine: vomiting	Morphine: constipation

Graph 1



Graph 2





2.4 Study limitations

Assessment of ADRs is a common problem and various methods of determining and classifying reactions have been described (1-3, 5-6). Our study used these standard classification systems to categorise reaction types, physiological systems affected, the severity of the reaction and the probability of the drug actually causing the reaction described. Despite this standardised approach, a major limitation inherent in this study was that all categorisations were performed on subjective data obtained from patient interview. Because the reported ADRs were not observed by the investigators in the study population, objective assessments of the reactions or their cause were not possible. Many reactions however were well described by study participants, and classification of the nature and severity was largely non-problematic using the systems described. The system used to assign causality underestimates probability scores (6) implying that this study probably understates the association between ADRs and the drugs implicated.

3. DISCUSSION

Estimates of ADRs in hospital populations range from 10-36% (4). Our figure of 38% was comparable with this range. In this study, reactions which were predictable (Type A) according to the pharmacological activity of the drug were more common than Type B reactions. This is consistent with previous literature. The dilemma is when to assess a patient event as an adverse drug reaction. The WHO definition of an ADR was used for the purposes of this study. The WHO defines an ADRs as *"...any response to a drug which is noxious and unintended and which occurs at doses normally used in man for the prophylaxis, diagnosis, therapy of disease, or for the modification of some physiological function."*

This definition was rigorously applied for our purposes. Exaggerated effects of drugs (eg. sedation by opiates) were not considered ADRs as such effects are not unexpected. However, urticaria or constipation, which would not be considered an intended effect of the drug (although predictable in

selected patients) were classified as ADRs. Most Type A reactions were caused by analgesic drugs which is not unexpected due to the wide prescription and availability of these agents. Nausea, vomiting, sweating and constipation were common ADRs reported for analgesic drugs. Such reactions although sometimes unpleasant, do not necessarily constitute a contraindication to re-administration of an otherwise effective drug. This was the case for a wide range of drugs implicated in the rechallenge events. This was also supported by the high percentage of intentional rechallenges reported by doctors, even though these were not documented as such.

The quandary is that Clinical Indicator 6.1 is a sentinel event quantifying one aspect of care. No threshold is given for the indicator which implies that institutions must address non-compliance as a significant area of concern. As described above, re-exposure to drugs previously known to have caused ADRs is not always a cause for concern. In some instances there may be no alternative and in others, the risk of using a drug which has been a cause of a prior ADRs may be outweighed by the clinical benefit the drug confers.

Of concern is not that drugs are given to patients who have had a prior ADR, but that the level of documentation of both reactions and the reason for rechallenge is universally poor. In this study, not one instance of reason for rechallenge was documented in any of the source documents reviewed.

Overall, the medication charts documented fewer than 20% of adverse drug reactions. When one considers that this document would seemingly be the most useful place to record ADRs history, it is worrying that this was the most poorly used document for recording such events. This is more evident when one considers that a special section for adverse drug reactions is clearly marked at the top front and centre of each medication chart. Nurses performed better than medical staff when documenting ADRs (Graph 1). Of the medical staff, anaesthetists were more likely to document prior ADRs than other staff. Most occurrences of ADRs were on anaesthetic checklists which suit the purposes of anaesthetists but are infrequently a source of referral by other staff.

The most important ADRs to document are those which occur unexpectedly (Type B ADR). Such reactions are idiosyncratic, often severe and may be life threatening in some instances. For this reason, it was some comfort to observe greater attention by all staff to recording prior ADRs of this type. Nursing staff still performed better than medical staff when documenting Type B reactions (Graph 2).

For this type of reaction anaesthetists and attending medical staff documented ADRs equally. This observation suggests that patients were more likely to be asked about hypersensitivity reactions than other types of ADRs which were less documented. This is particularly evident for antiinfective agents which accounted for the majority of Type B reactions.

Partly as a result of better documentation and possibly due to heightened alertness to hypersensitivity reactions over other ADRs, patients who had experienced Type B reactions were also less likely to have been rechallenged with the offending drug. Still of concern, however, is that 50% of Type B reactions were not documented, placing patients at significant risk of accidental re-exposure.

When taking a medical history from a patient, medical staff often only enquire about allergies rather than ADRs in general. Information regarding predictable reactions may not be actively sought, and thus not volunteered or documented. In addition, patients volunteer information about prescription

drugs more readily than non prescription medications as they do not often consider over-the-counter (OTC) drugs to be 'drugs'.

Documentation was consistently better in cases where patients were not rechallenged with drugs responsible for a prior ADRs (Graph 3). This lends support to the conclusion that the poorer the documentation of previous ADRs the more likely the chance of re-exposure.

Among the reasons for intentional rechallenge were that there were no alternative drugs or that reactions were common and generally harmless and did not preclude drug prescription or administration. Thus, intentional rechallenge occurred if the doctor judged that there was a high level of benefit to be achieved from drug administration even if an ADRs resulted.

In selected cases, prophylactic therapy was used to counter predictable effects, for example the use of metoclopramide to prevent known emetic effects of opioids in selected patients. Many patients were willing to tolerate ADRs and in some cases were of the opinion that if an ADRs was not experienced then the drug was not working. One patient commented that nitrates were taken until a headache resulted just to ensure that they were getting sufficient drug to control the angina.

Some rechallenges, however, occurred as a result of ignorance on the part of the medical staff. In one case for example, Augmentin™ was prescribed to a patient known to be allergic to penicillin in the mistaken belief that Augmentin did not contain a penicillin derivative. Other accidental rechallenges occurred as a result of patient experiences with ADRs for OTC medications. Such occurrences were not volunteered when interviewed by medical staff, but were apparent on close questioning by the investigators. For example, the self administration of aspirin in one patient (not considered a drug by many patients) led to GI symptoms which were not reported. This resulted in accidental re-exposure to a non steroid anti-inflammatory drug which produced a similar effect.

These findings lend support to the need for close questioning of patients for all types of ADRs and all types of medications during the admission interview. Alternatively, pharmacists could be encouraged to provide a more active role in this aspect of patient management.

The definition of Clinical Indicator 6.1 fails to recognise two components of drug use in the clinical setting. To this extent the indicator is not an entirely valid measure of clinical care. Firstly, the definition only cautions against exposure to drugs known to have caused a prior ADR. To this end, it fails to recognise that drugs of the same or related chemical class may similarly dispose patients to ADR. The definition should be expanded to accommodate drugs of the same or similar class to provide added protection for the patient. Secondly, there should be recognition that in certain circumstances the benefits of re-exposure to a drug known to produce an ADRs may well outweigh the risk. The requirement for documenting the reason for re-exposing patients should be retained. Such qualification would encourage the establishment of systems which identify acceptable variances from the indicator definition.

Interestingly, approximately half of the patients accidentally re-exposed to drugs known to have caused problems were prescribed these drugs in the first instance by general practitioners or private specialists. Details of these ADRs are either not reported to the doctor concerned or are not communicated to hospital staff. Such communication may be facilitated by patients carrying an alert card or

other device warning of potential risk, particularly when moderate or severe reactions have occurred.

3.1 Conclusion

A history of ADRs occurs frequently in patients admitted to the RAH. This history is easily elicited through structured questioning about ADRs to prescription drugs and other medicines.

Medical staff documentation of prior ADRs is sub-optimal. Anaesthetists were more likely to record ADRs than other medical staff. Nursing staff were better than all medical staff at recording ADR. There were a number of cases of accidental rechallenge of patients with drugs to which prior ADRs histories were elucidated.

There were some recurrences of ADRs as a result of these rechallenges. The reasons for rechallenge events were not documented in any of the sentinel cases. Some instances of rechallenge are justifiable. Intentional re-exposure may be appropriate when the benefits of treatment outweigh the risk of ADR. This is true for most drugs producing Type A reactions. However, in this study many cases of re-exposure were unintentional due to failure to elicit a complete medication history including ADRs which was compounded by incomplete documentation of drugs or past reactions.

Over half of reported ADRs occurred from drugs prescribed outside the hospital setting. These reactions are often not communicated to hospital medical staff. General practitioners and private specialists should provide patients with an alert card or other device to facilitate communication of ADRs information to all medical and other health care staff.

Patients at most risk include the elderly and those on multiple medications. Interestingly, women were more likely than men to have experienced an ADRs and to experience a rechallenge event. This is consistent with other literature.

Rechallenge events are largely avoidable if complete patient medication history interview is performed and documented. Patients should be questioned about all medications not only prescription drugs. Clinical pharmacists should be encouraged to assist with this aspect of patient care.

The definition of Clinical Indicator 6.1 should be expanded to provide recognition of beneficial rechallenge events and to caution against prescribing a drug from similar classes. With this modification, Clinical Indicator 6.1 remains a useful indicator as a sentinel marker for drug monitoring and prescription.

It is a concern that compliance with Clinical Indicator 6.1 was demonstrated to be deficient at the Royal Adelaide Hospital. Over 50% of patients with prior history of ADRs did not have reactions documented in any clinical stationery. Where documentation did occur, fewer than half included details of the reaction.

3.2 Recommendations

Hospital staff should be made more aware of the clinical, legal and cost implications of poor elucidation and documentation of ADR. Questioning in relation to ADRs should not be limited to prescription medicines. Documentation of the reasons for prescribing drugs when a prior history of ADRs is known, should become a routine practice. Review of clinical record stationery may facilitate this process.

Computerised systems to facilitate checking of ADRs history against prescribed medication may be helpful (2,5,7). Computerised prescription systems linked to a patient ADRs database would facilitate this process. Pharmacy Departments and pharmacists should be encouraged to undertake this role and commence research and development of systems for this purpose.

3.3 Project outcomes

The results of this study were reported to the RAH Drug Committee and Medical Records Committee. Their response was one of concern. A Working Party was subsequently established with the representation from pharmacy, nursing and medical records groups. Their aim is to develop and implement a plan to document and reduce adverse drug events at the RAH. Their initial task is to review and establish an adverse drug reaction reporting system for the hospital, review adverse drug event documentation, implement a comprehensive program of ACH Clinical Indicator 6.1 and review documented ADR prevention strategies.

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CHAPTER 14

QUALITATIVE DUE: RE-EVALUATION OVER A SHORT TIME FRAME

1. INTRODUCTION

This chapter describes a concurrent, comprehensive review of vancomycin use at the RAH, first performed in 1988. The initial DUE was followed 10 months later by a re-evaluation to assess the results of strategies implemented after the first study. This study is noteworthy for several reasons:

- it represented the first comprehensive DUE undertaken by me;
- it was the first review for which a re-evaluation was performed;
- it highlighted difficulties which can be encountered when implementing strategies to improve drug use. The initial recommendations of the Drug Committee were not well accepted by some prescribers. This resulted in a 'stand-off' which required mediation by a 'neutral' party.
- The results of the review were published in 1990 (1).

2. REVIEW OF VANCOMYCIN USAGE (1988/89)

2.1 Background

A review of anti-infective drug purchases for 1986/87 revealed significant increases in expenditure and unit consumption for vancomycin. Eleven percent of the 1986/87 antibiotic budget was spent on vancomycin, representing a 60% increase compared with the previous year. This had occurred despite a 6% decrease in the unit cost of the drug. The reason for this increasing expenditure was not entirely clear. For example, infection control data did not demonstrate a commensurate increase in the number of invasive isolates of MRSA, which was the main indication for the drug at the RAH.

2.2 Methods

A non-interventional review of vancomycin was conducted in the second quarter of 1988. The review was repeated in February 1989. The same prescriber and patient groups were evaluated providing closely matched patient and prescriber populations. Data were also collected and reviewed by the same personnel for both reviews.

Data for all patients prescribed parenteral or oral vancomycin were recorded. Treatment courses were followed until cessation of therapy. Patients administered vancomycin as surgical antibiotic prophylaxis were assessed during the admission for post-operative infection. The indication, dosage, route of administration, duration of therapy, results of culture and sensitivity tests, renal function, adverse drug reactions and therapeutic drug level monitoring were recorded.

Courses were compared with audit criteria prepared in association with a clinical microbiologist (Figure 1). Courses were subsequently reviewed by the same microbiologist. Identical audit criteria were used in both reviews. Therapy was considered inappropriate if clinical details did not match audit criteria for indication or process parameters (dosage, frequency, route of administration, duration of therapy, dosage adjustment in renal impairment, or serum drug level monitoring). The cost of treatment courses was calculated.

2.3 Results

During the initial phase, details for 60 patients were recorded. One patient was excluded because of incomplete documentation leaving 62 evaluable vancomycin courses in 59 patients (28 males, 31 females, average age 55 years, age range 20 - 87 years). Fifty percent of courses were for therapeutic indications and 50% for prophylaxis (Table 1).

During the re-evaluation phase, data for 45 patients were recorded. Two patients died of post-operative complications unrelated to infection, leaving 43 evaluable treatment courses in 43 patients (25 males, 18 females, average age 58 years, age range 23 - 81 years). Forty two percent of vancomycin courses were for therapy and 58 % for prophylaxis (Table 1). Details of appropriate versus inappropriate vancomycin courses are given for indications (Table 1) and process indicators (Table 2).

During the initial phase, 64% of vancomycin courses were classified as inappropriate by either indication and/or process parameters, occurring in 32% of therapeutic courses and 97% of prophylactic courses. During the re-evaluation, 65% of courses were inappropriate by either indication and/or process parameter, occurring in 17% of therapeutic courses and 100% of prophylactic courses. Criteria contraventions in both phases were mostly due to inappropriate indication (Table 1) or duration of therapy (Table 2). In the initial phase, inappropriate treatment duration was found in 19.4% of cases, compared with 5.6% in the second phase. This decrease was predominantly due to diminished vancomycin use in neutropenic patients.

Prospective investigator interventions during the re-evaluation resulted in additional savings totalling approximately $1,800 (corresponding whole year projections $9,000). These mainly involved inappropriate use of vancomycin for treatment of antibiotic associated colitis.

The cost of inappropriate vancomycin use during the initial phase was $11,500 or 55% of the total vancomycin cost compared with $3,600 or 25.7% of the total for the re-evaluation phase. This represented a reduction in cost of inappropriate drug use of over 50%. The overall cost of the review processes including personnel time, computing equipment and consumables, meetings, education programs, report and manuscript preparation was estimated at $4,000.

Table 1 Treatment indication and classification for Vancomycin DUE

	Initial phase			Re-evaluation phase		
	Number (% of total)	Appropriate (%)	Inappropriate (%)	Number (% of total)	Appropriate (%)	Inappropriate (%)
Treatment						
MRSA/MRSE	12 (19.4)	12 (100)	-	5 (11 6)	5 (100)	-
other organisms	2 (3.3)	2 (100)	-	2 (4.6)	2 (100)	-
Penicillin allergy	1 (1.6)	1 (100)	-	-	-	-
Bacterial endocarditis	1 (1.6)	-	1 (100)	1 (2.3)	1 (100)	-
C. difficile colitis	3 (4.8)	1 (33.3)	2 (66.7)	2 (4.6)	1 (50)	1 (50)
Neutropaenic patients	11 (19.8)	6 (54.5)	5 (44.5)	3 (7)	3 (100)	-
other	1 (1.6)	1 (100)	-	5 (11 6)	5 (100)	-
Subtotal	31 (50)	23 (74.1)	8 (25.9)	18 (41.8)	17 (94.4)	1 (5.6)
Prophylaxis						
Cardiothoracic surgery	29 (46.8)	2 (6.9)	27 (93.1)	25 (58.1)	1 (4)	24 (96)
other	2 (3 3)	1 (50)	1 (50)	-	-	-
Subtotal	31 (50)	3 (4.8)	28 (95.2)	25 (58.1)	1 (4)	24 (96)
Total	**62 (100)**	**26 (41.9)**	**36 (58.1)**	**43 (100)**	**17 (39.5)**	**26 (60.4)**

Table 2 Process indicator classifications for vancomycin DUE

	Initial phase			Re-evaluation phase		
	Number (% of total)	Appropriate (%)	Inappropriate (%)	Number (% of total)	Appropriate (%)	Inappropriate (%)
Treatment						
dose	31 (50)	30 (96.7)	1 (3.3)	18 (41.8)	16 (88.8)	2 (11.2)
route	31 (50)	31 (100)	-	18 (41.8)	17 (94.4)	1 (5.6)
duration	31 (50)	25 (80.6)	6 (19.4)	I8 (41.8)	17 (94.4)	1 (5.6)
Prophylaxis						
dose	31 (50)	31 (100)	-	25 (58.2)	25 (100)	-
route	31 (50)	31 (100)	-	25 (58.2)	25 (100)	-
duration	31 (50)	2 (6.4)	29 (93.5)	25 (58.2)	-	25 (100)

Note: Percentages are based on individual criteria only

Figure 1 Vancomycin Drug Utilisation Review - Audit Criteria

VANCOMYCIN USAGE GUIDELINES

The following audit criteria define those elements deemed critical to the optimal use of vancomycin. The criteria allow objective comparison of actual drug therapy to optimal drug use characteristics.

1. INDICATIONS FOR USE

1.1 Therapeutic Indications

1.1.1 Invasive infections with culture and sensitivity documented methicillin and cephalosporin resistant *Staphylococcus aureus* (MRSA) or *Staphylococcus epidermidis* (MRSE).

1.1.2 Invasive infections with other organisms which are culture and sensitivity documented methicillin and cephalosporin resistant (eg. *Cornybacterium jaekium*).

1.1.3 Invasive infections with culture and sensitivity documented methicillin and cephalosporin sensitive organisms where patient is allergic to Penicillin and where a cephalosporin is contraindicated.

1.1.4 Empirical therapy (in combination with an aminoglycoside) for the treatment of prosthetic valve endocarditis while awaiting culture and sensitivity reports, when there is a high suspicion of infection with MRSA or MRSE (eg. MRSA colonisation or previous documented MRSA infection.(1)

1.1.5 Empirical therapy for the treatment of bacterial endocarditis (in combination with an aminoglycoside) in patients allergic to penicillin and where a cephalosporin is contraindicated.(1)

1.1.6 Antibiotic associated enterocolitis as second line therapy, or for the treatment of second relapse, or as maintenance therapy for patients unresponsive to first line agents (ie. metronidazole/bacitracin). (2)

1.2 Prophylactic Indications

1.2.1 For the prevention of infection in any patient under- going a surgical procedure in whom there has been a previously documented invasive infection with MRSA or MRSE.

1.2.2 Prevention of endocarditis or infection of prosthetic implants for high risk patients (eg. immunosuppressed, prosthetic valves, extensive surgery, established infection or before GI or GU procedures) in patients allergic to penicillin or where a cephalosporin is contraindicated. (1)

1.2.3 For prophylaxis in the following types of surgery in patients who are allergic to penicillin or where a cephalosporin is contraindicated. (3)

1.2.3.1 arterial reconstructive surgery involving a prosthesis and/or groin incision

1.2.3.2 orthopaedic joint replacement or internal fixation of selected fractures

1.2.3.3 craniotomy involving prosthetic implants or where the continuity of the oral, nasal or aural mucosa will be disrupted.

2. PROCESS INDICATORS

The following parameters are evaluated in conjunction with the therapeutic and prophylactic indications above to determine appropriateness of use.

2.1 Culture results:

Should be obtained prior to initial dose, (except in 1.1.3, 1.1.4 and 1.2)

2.2 Dosage and route:

2.2.1 Prophylaxis and therapy: 1-2g/day IV in 2-4 divided doses, (except in 2.5.1 below), administered over not less than 1 hour. (1)

2.2.2 Antibiotic associated colitis (see 1.1.6): 250mg given orally four times daily. (2)

2.3 Duration:

2.3.1 Prophylaxis: no more than 2 doses or 24 hours therapy (ie. less than or equal to 2g Vancomycin/24 hours) for ALL prophylactic indications. (1,3)

2.3.2 Culture and sensitivity documented invasive infections (see 1.1.1, 1.1.2, 1.1.3: 7-14 days

2.3.3 Bacterial endocarditis: 4-6 weeks (1,4)

2.3.4 Empirical therapy: that culture and sensitivity reports should be obtained and reviewed or that review of continued requirement for antibiotic has been documented within 96 hours of first dose.

2.3.5 Antibiotic associated colitis: (see 1.1.6) - 7-10 days (2)

2.4 Other criteria

2.4.1 Pre-treatment serum creatinine (therapeutic indications only) required.

2.4.2. Serum creatinine should be monitored twice weekly or more frequently if indicated (therapeutic indications only)

2.4.3 Dosage adjustment required in renal impairment

2.4.4 vancomycin should be stopped in cases of potential ototoxicity or nephrotoxicity due to drug and suspected adverse drug reaction form completed

2.4.5 Therapeutic drug level (TDM) monitoring twice weekly or more frequently if indicated (therapeutic indications only).

2.4.6 dosage adjustment consistent with TDM and clinical state

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2.4 Discussion

Descriptive statistics of changes in vancomycin usage, a decrease in cost of inappropriate use between the study phases and an inability to demonstrate a change in post-operative infection rate, were considered indicators of the success of the vancomycin DUE.

Of the strategies implemented since the initial phase, direct consultations with prescriber groups were primarily responsible for the observed changes. General educational efforts and the distribution of written guidelines in various forms also contributed (Appendix 3).

These findings support the benefits of concurrent or prospective monitoring particularly when assisted by explicit criteria.

Similar observations of inappropriate vancomycin use and of cost savings following remedial strategies have been reported by other investigators (2-4). However, direct comparison of the results of these studies with our own is difficult because of differences in study populations, institutional microbial sensitivity patterns, study methodology, audit criteria and measured study endpoints.

The decreased therapeutic use was in part explained by a general decrease in the incidence of multi-resistant isolates at the RAH and a reduction in the number of patients receiving vancomycin as empirical combination therapy for neutropenic fever (Table 1). Only use of vancomycin for the latter indication was considered inappropriate. Even after cost adjustments were made for alternative therapies, savings were estimated at $10,000 per annum.

Antibiotic prophylaxis was (and still is) thought to be mandatory in surgery involving a cardiac valve or other prosthetic material implantation. The antimicrobial agents chosen should have activity against *S. aureus* and *S. epidermidis* with the choice dependent on resistance patterns at the individual hospital (6). Cephalosporins (usually cephazolin or cephalothin) are usually recommended except where hypersensitivity or MRSA is present (5-7).

MRSA was not endemic at the RAH at the time. This was verified for the cardiac surgery unit, which as a precautionary measure took nasal swabs of all patients as part of routine pre-operative assessment. Approximately half demonstrated the expected presence of Staphylococci but none showed the presence of MRSA. Nonetheless, almost every patient who underwent cardio-thoracic surgery during the study period was administered vancomycin. Interestingly, swab results were never available before patients underwent surgery and so did not have a bearing on the antibiotics administered.

The cardiac surgeons' case for the use of vancomycin was weakening. For verification, the study investigators sought the advice of other cardiac surgery units in Australia, New Zealand, the US and Great Britain. Except for hospitals where MRSA was endemic, none recommended routine use of vancomycin for cardiac or other surgery. Moreover, unrestricted use of vancomycin was of growing concern because of literature reports of the emergence of vancomycin resistant enterococci.

On this basis, the routine use of vancomycin for valve or other cardio-thoracic surgery prophylaxis was thought unnecessary at the RAH and could not be recommended by study investigators. This position was discussed at length by the investigators, the Drug Committee, the Division of Microbiology and the Cardiothoracic Surgery Unit. The cardiac surgeons were unwilling to alter their choice of vancomycin. They argued that their use of vancomycin had been recommended by the Di-

vision of Microbiology some 10 years previously[i]. Since that time the post-operative infection rate had remained acceptable and they saw no reason to change their procedures.

No amount of rational argument about infection statistics or other issues of relevance could change their position. Finally, the chief surgeon 'threatened' to recommend that patients sue the head of the microbiology department if they were prevented from using vancomycin. Consequently, the head of microbiology withdrew his support for the Drug Committee's recommendations.

This created an untenable position for the Drug Committee and certain individuals who had supported the Committee. The Medical Director was not prepared to intervene as it was considered to be a clinical rather than administrative matter.

In an effort to mediate this 'stand-off', the head of the Infectious Disease Unit was asked to assist. A compromise position was reached where the cardiac surgeons would not use vancomycin routinely for other than cardiac valve surgery. Moreover, they agreed to reduce the number of doses administered from 9 to 4 for this indication. This position was incorporated into revised hospital vancomycin guidelines.

As a result, changes in prophylactic vancomycin dosage regimens between survey phases were noted. Cephalothin was used in combination with vancomycin for cardiac valve surgery in both phases. However, in the initial phase, intravenous vancomycin 500 mg was administered every 12 hours for between 6-9 doses compared with only 4 doses during the re-evaluation. Average savings of $86 per vancomycin course resulted. Overall savings for the prophylaxis group were estimated to be $12,000 per year.

The incidence of post-operative infection was evaluated and no patient demonstrated infective cardiac, wound or other complications for up to 10 days following surgery. It is acknowledged however, that in situations where the overall incidence of infection rate is low, small patient samples may be unable to demonstrate changes in infection rates.

2.5 Project Outcomes

As a result of this experience, it was recognised that objective evidence alone would not always be sufficient to change prescribing practices. It was also recognised that achieving 'ideal' practices may not be possible in the first instance.

From that point forward, efforts were made to involve user groups, particularly in the development of criteria and guidelines, before reviews took place.

Steps were also taken to ensure that the Drug Committee would have the support of the hospital administration and senior clinicians when required. The Committee was concerned that without such support and therefore authority, the Drug Committee would lose credibility and be hampered in enforcing rational therapeutic policy. If the Drug Committee was forced to 'back-off' for political reasons, any desire of Drug Committee members to force particular issues with certain 'power' groups

[i] This was a short term recommendation (6-8 weeks) only, resulting from 2 cases of MRSA endocarditis in cardiac valve surgery patients in 1978. The cause was later determined to be a contaminated transducer used during surgery. The transducer was replaced, other equipment sterilised and infection control and other procedures subsequently modified. No further problems were recorded.

within the hospital, would soon dissipate and the Drug Committee would have risked becoming ineffectual in such matters.

Vancomycin continues to be used routinely for cardiac valve surgery at the RAH. I estimated the avoidable cost associated with this practice at $20,000 per annum. This matter has been brought to the attention of hospital administrators on several occasions but remains unresolved.

Vancomycin also continues to be reviewed periodically at the RAH. This is achieved by monitoring expenditure patterns and undertaking spot checks of compliance with criteria. Although this monitoring has demonstrated increasing expenditure for vancomycin, subsequent criteria audits have shown this use to be associated with increased prevalence of multi-resistant Gram-positive organisms (eg. *Diphtheroids sp.*, *Corynebacterium sp.*, MRSA). This use is considered appropriate.

Appropriate use has been confirmed by 2 further reviews of vancomycin conducted over 7 weeks in 1992 and 8 weeks in 1993. Each course (14 and 41 courses respectively) was reviewed within 48 hours of commencing therapy. The total cost of vancomycin used during the review periods were $400 and $7400, respectively. In 1992, all courses were classified as appropriate and in 1993 all but 1 course (1 dose only) were classified as appropriate.

Prospective monitoring of oral vancomycin orders is applied routinely. Each patient ordered oral vancomycin is assessed by a clinical pharmacist before the drug is issued. Prescribers are advised of the hospital recommendations and vancomycin is only issued to patients who satisfy the recommended criteria. As a consequence vancomycin is now used infrequently for antibiotic associated colitis at the RAH.

2.6 Conclusion

A follow-up vancomycin DUE conducted 10 months after the first review and after implementation of remedial strategies, demonstrated significant improvement in vancomycin utilisation. Inappropriate usage has decreased by 50%. Savings of $30,000 per annum have been demonstrated.

Improvements were due to reductions in the use of vancomycin use for neutropenia fever and in antibiotic associated colitis. Reduced use of vancomycin as surgical antibiotic prophylaxis in coronary artery bypass graft surgery and reduced duration of surgical antibiotic prophylaxis also contributed to improvements in drug utilisation.

Unnecessary use of vancomycin in cardiac valve surgery continues and represents an avoidable cost of approximately $20,000 per annum. The hospital administration has not been willing to force this issue with the cardiothoracic surgeons.

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CHAPTER 15

QUALITATIVE DUE: LONGITUDINAL DUE

1. INTRODUCTION

Four reviews of ceftriaxone usage have been performed at the RAH. All were criteria based, comprehensive reviews of need for the drug, choice of drug and process indicators. Some reviews were interventional and recorded whether recommendations from study investigators to change therapy were implemented and the effect of such changes on clinical outcome. The results of these and other cephalosporin reviews have been published recently (1).

2. REVIEW OF CEFTRIAXONE USE (1990, 1991, 1992, 1993)

2.1 Background

Ceftriaxone replaced cefotaxime in 1989/90 as the third generation cephalosporin of choice for severe infections due to susceptible organisms at the RAH. The change was based on comparable efficacy, antimicrobial spectrum, and side-effect profile compared to cefotaxime. Potential advantages included the convenience of once daily dosing with attendant reductions in delivery costs, and lower acquisition costs compared to cefotaxime at the time[1]. The introduction of ceftriaxone was accompanied by publication of ceftriaxone usage guidelines (Appendix 4), although formal education sessions were not conducted.

In the first year following the change, ceftriaxone expenditure increased markedly compared with cefotaxime. Subsequent reviews introduced recommendations to reduce this use. Overall expenditure on ceftriaxone use has been more than expected (Table 1). This increase has been due to a gradual broadening of indications for ceftriaxone primarily reflecting the broadening of indications for third generation cephalosporins described in sequential revisions of the Antibiotic Guidelines described previously. Even though the RAH guidelines were more restrictive than this publication, attempts to restrict the use of ceftriaxone have been frustrated by the wide availability of this publication.

2.2 Method

All studies were concurrent criteria-based reviews. Each reviewed all treatment courses prescribed during the designated time-frame. The reviews were conducted by me in conjunction with other pharmacy staff and the Clinical Microbiology and Infectious Diseases Units. The 1993 review was further assisted by fourth year medical students from the University of Adelaide. All courses identified as inappropriate or unnecessary were reviewed by a clinical microbiologist or infectious disease physician before final study classifications were made.

[1] Costs for ceftriaxone and cefotaxime were $19 and $13 per gram respectively. Savings were calculated on the assumption that 1 gram of ceftriaxone was clinically equivalent to 3 gram cefotaxime.

2.3 Results

The results of the reviews are summarised in Table 1. Some differences in review results were evident. The review in 1990 demonstrated significant inappropriate usage based on indication and/or drug choice, with correspondingly unfavourable cost implications. This outcome resulted in the promulgation of study findings and the development and wider promotion of usage guidelines.

Only slight improvement in the rate of appropriate use according to indication was reflected in subsequent reviews. Improvements in the process parameters of dosage, frequency of administration were noted between reviews. The duration of treatment also improved between the 1990 review and those conducted in subsequent years. In 1990, inappropriate drug use accounted for 34% of ceftriaxone expenditure compared with 23 - 27 % for previous years. However, despite improvements in ceftriaxone use and expenditure following the 1990 review, the ceftriaxone consumption remained high and was steadily increasing. This has been evident from pharmacy purchase data and by comparison of the number of courses prescribed during each study period; 59 courses in 6 weeks in 1990, versus 106 courses in 6 weeks in 1993 (Table 1).

Medical wards recorded the most significant increase in usage. This corresponded with ceftriaxone use for management of pneumonia[ii] and was possibly associated with the reviews being performed in winter months. The cost of ceftriaxone has remained unchanged during the period.

The results of interventions by Pharmacy or Microbiology Department staff are exemplified by the 1991 review (Tables 2-4). Suggestions for review of therapy were made by pharmacy or microbiology staff for 32 (of 62 courses, 51.6%) courses. All but 5 interventions resulted in cessation or alterations to therapy (Table 4). The cost avoidance associated with these interventions (after cost adjustment for alternative therapies where indicated) was $2,300 ($17,000 over a full year). The cost of monitoring and intervention was estimated at $3,075 over a full year. This gave a cost benefit ratio of 5.5:1 ($17,000 / $3,075) for establishing a regular review program.

In the 1993 review, ceftriaxone was withdrawn from all treatment areas to ensure that all patient courses were identified through pharmacy orders. This netted over 330 vials of ceftriaxone valued at $9,500. This demonstrated the hoarding which occurs at ward level and represents inefficient utilisation of drug resources.

Clinical and microbiological outcomes were also documented in these reviews, including those where interventions were made (Table 5). Over half of patients improved with antibiotic use. Approximately 30% neither improved nor deteriorated, signifying other factors besides antibiotic treatment influencing outcome (eg. co-existent disease). Assessment of microbiological outcomes was variable because repeat cultures were only performed when deterioration was evident.

[ii] The VMPF Antibiotic Guidelines recommend empirical use of ceftriaxone in combination with erythromycin for the treatment of severe community acquired pneumonia or nosocomial pneumonia.

Table 1 Summary of results from ceftriaxone DUE conducted at the Royal Adelaide Hospital

Year of review	**1990**	**1991**	**1992**	**1993**
Duration of review (weeks)	6	7	4	6
No. courses	59	62	28	106
Process Indicators (% of inappropriate courses) #				
Indication / drug choice	39	35	36	33
Starting Dose	5	16	18	4
Daily dosage	30	23	18	4
Frequency	29	16	7	1
Duration	17	3	7	6
Cost of inappropriate use ($ projected over 12 months)	$53,800	$27,240	$30,370	$34,400
% of total ceftriaxone expenditure	34%	23%	25%	27%
Total ceftriaxone expenditure ##	$160,500	$118,500	$120,300	$124,400

\# *Sum of indicators may not be 100% as courses may have been inappropriate for more than one reason.*

\## *Corresponding financial years were 1989/90, 1990/91, 1991/92, 1992/93*

Table 2 Details of initial clinical pharmacy review data

RESULTS OF REVIEW	NO. (%)
ceftriaxone already ceased at time of review	10 (16.1)
ceftriaxone therapy unchanged *	15 (24.2)
referral to Infectious Diseases	27 (43.5)
ceftriaxone therapy changed / ceased	10 (16.1)
TOTAL	**62 (100)**

* 5 courses in this group had already been reviewed by Microbiology or Infectious Diseases.

Table 3 Details of microbiology / infectious diseases reviews

RESULTS OF INFECTIOUS DISEASES REVIEW	NO. (%)
ceftriaxone ceased between pharmacy and I/D reviews	13 (20.1)
ceftriaxone therapy changed / ceased	14 (22.5)
ceftriaxone therapy unchanged	5 (8.0)
TOTAL	**32 (51.6)**

Total no. consults = 32* (* 5 courses had already been reviewed by micro / ID)
Referrals from Clinical Pharmacy after initial review = 27

Table 4 Distribution of alterations to therapy as a result of intervention

THERAPY ALTERATION	INTERVENTION BY (%)		TOTAL (%)
	PHARMACY	INFECTIOUS DISEASE	
Dose / frequency reduced	2 (3.2)	4 (6.4)	6 (9.6)
Change to other antibiotics	6 (9.6)	8 (12.9)	14 (22.6)
All antibiotic therapy ceased	2 (3.2)	2 (3.2)	4 (6.4)
TOTAL	**10 (16.1)**	**14 (22.6)**	**24 (38.7)**

Table 5 Distribution of clinical and microbiological outcomes

CLINICAL OUTCOME	NO. (%)	MICRO OUTCOME	NO. (%)
Recovered	21 (33.9)	Cure	15 (24.2)
Improved	18 (29.0)	Persistence	6 (9.7)
Unchanged	17 (27.4)	Unknown	36 (58.0)
Deteriorated	1 (1.6)	Not applicable	5 (8.1)
Death	3 (4.8)		
Undefined	2 (3.2)		
TOTAL	**62 (100)**		**62 (100)**

Figure 1 Ceftriaxone Indication codes & dosage guidelines (ex Royal Adelaide Hospital Formulary, 1991/92)

Ceftriaxone is indicated for:

1. Gram-negative meningitis due to *Enterobacteraciae* or resistant strains of Haemophilus influenzae.
2. Infections due to organisms resistant to earlier generations of cephalosporins where aminoglycoside (eg. renal impairment) or amoxycillin (eg. penicillin hypersensitivity) administration is contra-indicated.
3. Severe Gram-negative infections known to respond poorly to amoxycillin/aminoglycoside combinations or earlier generations of cephalosporins (eg. bone/joint infections, brain or hepatic abscesses).
4. Anorectal, or pharyngeal gonorrhoea, and in gonococcal urethritis caused by penicillin resistant strains.
5. Severe community acquired or nosocomial pneumonia of undetermined aetiology. Combine with erythromycin if Legionella is suspected.
6. Prophylaxis

DOSAGE

Severe/life-threatening infections: *Moderately severe infections:*

2G daily for 3 days followed by 1G daily for 7 - 10 days (1,2).

1G daily for 4 - 7 days (1,2,3,4).

Gonorrhoea

250 mg IM administered as a single dose

NOTES

1. Ceftriaxone should be administered as a single daily dose.
2. Ceftriaxone may be administered by IV bolus over 3 minutes, as an IV mini-infusion over 30 minutes or by deep IM injection.
3. Dosage reduction will be dependent upon a satisfactory response to therapy as indicated by improvement in clinical state, fever reduction, culture results or reduction in leucocyte count.

2.4 Discussion and summary

The increased usage of ceftriaxone over the years reflects a broadening of the indications for ceftriaxone in accordance with the Antibiotic Guidelines described previously.

Inappropriate selection of ceftriaxone remains the major impediment to optimal ceftriaxone utilisation. Some unnecessary use may be associated with ambiguity of abbreviations used on the microbiology sensitivity report forms. This issue was raised for review with the Division of Microbiology. Promotional activities of the pharmaceutical industry may be another factor influencing the use of ceftriaxone although this has not been substantiated.

Other indicators associated with ceftriaxone use have shown improvement over the years. Intervention by pharmacists and microbiologists has been shown to be cost effective and not associated with adverse clinical or microbiological outcomes.

2.5 Recommendations

Ceftriaxone use at the RAH warrants further control efforts and ceftriaxone DUE remains an important priority. Future options include more intensive promulgation of guideline recommendations with particular reference to treatment indications and implementation of a formal antibiotic restriction policy. This may incorporate automatic stop orders or time-related review requirements.

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CHAPTER 16

QUALITATIVE DUE: REVIEWS WITH OUTCOME MEASUREMENTS

1. INTRODUCTION

Similar to the vancomycin review described in chapter 16, the usage of acyclovir was also revisited after an initial review, although in this case, several years after the first study. Of particular note were (i) the first review was predominantly retrospective using a novel data collection sheet, (ii) the second review was a concurrent DUE, and (iii) despite a doubling of expenditure for acyclovir, the review demonstrated improved usage compared with the initial study.

2. ACYCLOVIR DUE (1990, 1993)

2.1 Background

In 1990 it was recognised that although acyclovir was prescribed for only a small number of patients at the RAH, acyclovir expenditure ($100,000) accounted for a significant portion (9.5%) of the anti-infective drug budget and 1.5% of the total drug budget. These figures prompted the Drug Committee to investigate the pattern of use of acyclovir at the RAH. A second review was performed in 1993 in response to significant increase in expenditure (to $250,000) for this drug over the intervening period. This review used criteria which had been modified since the first review and also assessed clinical and microbiological outcomes.

2.2 Method

The 1990 review was a retrospective review of unit records for patients prescribed parenteral and oral acyclovir. Parenteral courses were identified from the pharmacy sterile production records and the oral courses from a review of outpatient prescriptions.

Audit criteria were developed in association with a clinical virologist. The indications fell into 3 main groups: treatment, suppression and prophylaxis. Indications were stratified for immune competent and immunocompromised patients respectively.

A novel data collection sheet was developed (Appendix 3) which was designed to assign appropriateness as data was collected. By recording the indication and answering questions regarding preconditions and process criteria (by ticking a box), the assessment of appropriateness was automatically derived. Although the data sheet was time consuming to construct, it did markedly simplify data collection and analysis.

The second DUE (1993) was performed concurrently with patient treatment. Data were obtained from patient case notes and by patient interview.

2.3 Results

Initial review (1990)

Data for 58 treatment courses from 46 patients were reviewed. Half the patients were immunosuppressed. Fifty nine percent of courses were for treatment, 31% for suppressive therapy and 10% for prophylaxis. Audited indications included Herpes simplex (HSV) and Varicella Zoster (HVZ) infections, suppression of recurrent HSV in HIV patients and prophylaxis of HSV in patients undergoing bone marrow transplants.

Forty five percent of cases were inappropriate overall. 12% were inappropriate by indication. Fifty nine percent of treatment courses, 22% of suppressive courses and 33% of prophylactic courses were inappropriate. Oral and parenteral courses were inappropriate in 38% and 44% of courses respectively.

Some of the more interesting findings are summarised below:

- *Herpes zoster* was treated with 1/4 to 1/2 half the recommended dose;
- Parenteral acyclovir was used where oral therapy would have sufficed;
- Unproven mucocutaneous infections (eg. in patients undergoing chemotherapy) were treated for longer than the recommended 5 days;
- oral treatment courses of acyclovir were given less often than the recommended 5 times per day.

Eighty six percent of courses were administered to patients under the care of virology or infectious disease specialists. Eighty one percent of courses inappropriate by one or other indicator were prescribed by or as a result of specialist recommendations.

The total value of inappropriately administered acyclovir was $4,300. Half of this cost was classified as 'wastage' because patients were under treated. After adjusting for the cost of correct therapy ($1,900), the cost of unnecessarily administered drug was estimated at $2,400 (or 11.5%) of total cost of drug surveyed). Projected annual savings (including wastage) were estimated at $11,000 pa or 11% of total annual expenditure. The cost of the review process was estimated at $3,000.

Follow-up review

This review conducted in 1993, evaluated a total of 65 treatment courses from 48 patients. Two thirds of courses were prescribed to immunocompromised patients. Fifty percent of courses were for outpatients. The majority of courses were prescribed by the haematology unit (35%, primarily intravenous), and the infectious disease and dermatology unit (oral acyclovir, 29% and 18.5% respectively). Approximately 60% of courses were for therapy of presumed active lesions and the remainder for suppression or prophylaxis of HSV. Fewer than 5% of patients were not under specialist care.

Fifty four percent of courses were classified as appropriate overall (ie. met all criteria). Eighty nine percent of therapeutic courses were appropriate by indication. Dose and frequency of administration were most often inappropriate (21.4% and 19.8% respectively for courses appropriate by indication). Courses inappropriate by indication were more likely to be inappropriate for other reasons

also. Sixty six percent of courses prescribed by specialist units were classified as appropriate overall.

Appropriate investigations were performed for 50% of active lesions. Half of these yielded negative results. Twenty two percent of lesions had resolved or were resolving at the completion of the review. Thirty three percent of patients with lesions were lost to follow-up and could not be assessed. Annual savings by correcting inappropriate use were estimated at $3,800 per year.

Table 1 Summary of results of Acyclovir DUE

	Initial review	Re-evaluation
Duration of review	$^{6}/_{12}$ (retrospective)	$^{6}/_{52}$ (concurrent)
Total patients	**46**	**48**
Total acyclovir courses	**58**	**65**
• in immunosuppressed	29	41
• in immunocompetent	29	24
Courses appropriate overall	32	35
Inappropriate process indicators for courses appropriate by indication:	**n=29**	**n=56**
• dose	3	12
• route	9	2
• frequency	5	11
• duration	10	10
Cost of acyclovir during survey	$20,800	$14,050
Annual expenditure	$100,000	$250,000
Cost of inappropriate acyclovir	$2,400	$440
Projected annual savings	$11,000 (11% of total expenditure)	$3,800 (1.5% of total expenditure)

2.4 Discussion and conclusion

Improvements were noted between reviews. In the period between the initial and second review, guideline revision and, restriction of the use of acyclovir to specialist clinics (eg. virology, infectious diseases, haematology and dermatology) was implemented. These groups were provided with the results of the first review and targeted for education in correct use of acyclovir. As a result, inappropriate use by specialist units decreased to less than a third of that noted during the initial review.

Marginal percentage improvements in indication and process indicators were noted. However, the dollar value of drug used inappropriately was much less during the second review. This reflected shorter courses and lower doses being inappropriate in the second review. The first review identified approximately $11,000 worth of savings could be achieved by compliance with criteria. This was in addition to $10,000 of drug which was being under-utilised as a result of inappropriate dosage or duration of therapy. Potential savings represented 11% of total expenditure for the first review and

1.5% for the re-evaluation. This implies that 98.5% of acyclovir expenditure assessed during the second review was appropriate. This represents a significant achievement and augurs well for DUE as a means of improving drug use.

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CHAPTER 17

QUALITATIVE DUE: REVIEWS OF THE IMPACT OF PROCEDURES ON DRUG USE

1. INTRODUCTION

This review was noteworthy because it assessed the impact of a diagnostic procedure on drug use and also demonstrated the overlap between medical audit and DUE. The review investigated the relationship between blood culture test results and antibiotic prescribing. Where possible, the clinical and microbiological outcome of patients on whom blood cultures were performed was also evaluated. A number of issues relating to the performance of blood cultures themselves were referred to the microbiology and infectious diseases departments.

2. BLOOD CULTURE REVIEW (1991)

2.1 Background and aims

Blood cultures are an important microbiological tool for determining possible causes of infection, and as a guide to early treatment of susceptible infections. While there is much information on the use of blood cultures as a diagnostic tool, there is little about how cultures are performed or how their results are applied.

In 1990, almost 10,000 sets of blood cultures were referred for testing at the RAH and 874 yielded positive isolates. These figures are in themselves worrying. Did the large number of tests contribute to the seemingly high rate of negative or false negative test results? Were all the tests requested necessary?

Before this review, the pattern of blood culture testing and its association with antibiotic therapy was unknown. In 1990, a preliminary study over one week showed poor correlation between the blood culture results and antibiotic treatment, although no conclusions could be drawn.

The aim of this review was to determine the association between the results of blood culture testing and antibiotic treatment and, where possible, the clinical and microbiological outcomes of antibiotic treatment.

2.2 Method

Patients were selected with the assistance of the IMVS pathology services system computer. Blood culture results and patient clinical and drug details were recorded on a data collection sheet specifically developed for review purposes. Patients with positive blood cultures were matched with a random sample[i] of patients with negative culture results. Recorded data included patient details, clinic, indication for blood culture and culture and sensitivity results where relevant. Other microbiological

[i] A table of random numbers was used. Patients were selected from a 'day book' if their position in the book corresponded with the list on the random number table. If patients had a positive result or had already been entered into the study, they were excluded and the next number was used.

test results were also noted. Antibiotic treatment before and after blood culture results were recorded. Factors which might have influenced selection (eg. previous ADR) or dosage regimens (eg. renal impairment) were also documented.

Appropriateness assessments were made by comparing the antibiotics used with those recommended by the RAH Formulary or the VMPF Antibiotic Guidelines.

2.3 Results

Of 827 blood culture sets received by the laboratory over the study period, 82 returned a positive result (35 true positive, 39 false positive (contaminant) and 8 undefined). Fifty seven negative culture matched controls were used for comparison. Sex, clinic distribution and culture set distributions are provided in Tables 1 to 3.

The most common reason for performing blood cultures was presentation with fever and rigors (Table 4). Gram positive organisms were most commonly cultured with *S. aureus* being most often found (Table 5). The most common portals of entry were the GI tract and intravenous cannulae. For culture negative patients the most common infections sites were the respiratory and urinary tract (Table 6). Eighty seven percent of patients received antibiotics.

In 63 (49%) patients, antibiotic treatment was altered after culture results became available (Table 7). In only 26 (20%) were changes attributable to culture results (Table 8). In several instances, blood culture results initiated antibiotic treatment. Other results or clinical factors influenced changes in the remaining patients. Changes generally occurred the day the result was received. The most common change in therapy was the addition of another agent (Table 9).

Therapy was classified as inappropriate in 23% of patients with more patients being classified as inappropriate after results became known (Table 10). The most common reasons included unnecessary antibiotics (eg. tobramycin, Timentin™ and ceftazidime administered concurrently), or that suitable narrower spectrum agents were available (Table 11,12).

Table 1 Sample characteristics

SEX	NO. (%)
Male	75 (58)
Female	54 (42)
TOTAL	**129 (100)**

AGE: Average = 59 years
Range = 18 - 98 years

NO. SETS PER PATIENT:
Average = 1.5 sets
Range = 1 - 8 sets

Table 2 Clinic Distribution

CLINIC	NO. PATIENTS (%)
General Medicine	38 (30)
Haematology	22 (17)
Intensive Care	14 (11)
General Surgery	12 (9)
Other	43 (33)
TOTAL	**129 (100)**

Table 3 Breakdown of no. sets ordered

NO. BLOOD CULTURES	NO. PATIENTS (%)
1	82 (63)
2	35 (35)
3	10 (8)
4	1 (1)
8	1 (1)
TOTAL	**129 (100)**

Table 4 Distribution of indications for blood culture

INDICATION FOR CULTURE	NO. PATIENTS (%)
Febrile / febrile with rigors	91 (71)
Subacute bacterial endocarditis	8 (6)
Confusion / change in conscious state	4 (3)
Abdominal complaints	3 (2)
Clinical deterioration	2 (2)
Hypotension / shock	2 (2)
Erratic blood sugar levels in IDDM	1 (11)
Coagulation abnormalities	1 (1)
Focal infection work-up:	6 (2)
• pneumonia	6 (2)
• osteomyelitis	2 (2)
• cellulitis	2 (2)
• meningitis	1 (1)
• UTI	1 (1)
No indication apparent	5 (4)
TOTAL	**129 (100)**

Table 5 Distribution of organisms cultured

ORGANISM		SIGNIFICANCE			TOTAL
		TRUE (+)	FALSE (-)	UNDEFINED	
G	*Staphylococcus aureus*	11	1	-	12
R	*Staphylococcus epidermidis*	2	22	-	24
A					
M	Group B Streptococci	1	-	1	2
	Streptococcus pneumoniae	1	-	-	1
(+)	*Streptococcus sanguis*	1	-	-	1
	Faecal streptococci	-	-	1	1
C	*Staphylococcus epidermidis*	1	1	1	3
O					
C	*Streptococcus*	-	-	1	1
C					
I	*Micrococcus*	-	1	-	1
GRAM	*Diphtheroids, Staphylococcus epidermidis*	-	1	-	1
(+)	*Diphtheroids*	2	5	-	7
BACILLI	*Listeria*	1	-	-	1
SUB-TOTAL GRAM POSITIVE ISOLATES		**20**	**31**	**4**	**55**
G	*E. coli*	5	-	-	5
R	*Klebsiella*	3	-	1	4
A					
M	*Pseudomonas*	1	-	-	1
(-)	*Xanthomonas maltophilia*	-	4	-	4
B	*Enterobacter*	1	2	-	3
A					
C	*Yersinia sp.*	1	-	-	1
I					
L	*Haemophilus influenzae*	1	-	-	1
L					
I	*Other*	-	2	2	4
SUB-TOTAL GRAM NEGATIVE ISOLATES		**12**	**8**	**3**	**23**
YEAST	*Candida albicans*	1	-	-	1
TOTAL		**33**	**39**	**7**	**79***

TRUE (+) = Bacteraemia / Fungemia; FALSE (+) = Contaminant
NOTE: Some patients had more than one false (+) or undefined result
* Results of 3 cultures were lost to follow-up

Table 6 Suspected source of infection in bacteraemic and non-bacteraemic patients

SUSPECTED FOCUS OF INFECTION	BACTERAEMIC PATIENTS (%)	NON-BACTERAEMIC PATIENTS (%)	TOTAL (%)
Alimentary tract	10 (8)	7 (5)	17 (13)
Phlebitis / IV line colonisation	8 (6)	2 (2)	10 (8)
Cutaneous / wound	5 (4)	7 (5)	12 (9)
Urinary tract	2 (2)	13 (10)	2 (2)
Biliary tract	2 (2)	-	2 (2)
Respiratory	1 (1)	28 (21)	29 (22)
Osteomyelitis	1 (1)	2 (2)	3 (2)
Cardiac	1 (1)	-	1 (1)
Nervous system	-	2 (2)	2 (2)
Vascular graft	-	1 (1)	1 (1)
No obvious focus	3 (2)	34 (26)	37 (29)
TOTAL	**33 (26)**	**96 (73)**	**129 (100)**

Table 7 Changes to antibiotic treatment when blood culture results known (excluding patients whose treatment was unchanged, n = 63)

REASON FOR CHANGE	NO. PATIENTS (%)
Blood culture results	26 (41)
Other culture results (urine, sputum, pus, tracheal aspirate)	9 (14)
Altered diagnosis / clinical deterioration	14 (22)
Lack of response to original regimen	2 (22)
Microbiology consult	1 (2)
Change in route for dose only	7 (11)
No apparent reason	4 (6)
TOTAL	**129 (100)**

Table 8 Time delay between blood culture result and change in therapy (for patients where change was due to blood culture results n = 26)

TIME INVOLVED	NO. PATIENTS (%)
Same day	16 (61)
Following day	7 (27)
2 days later	2 (8)
3 days later	1 (4)
TOTAL	**26 (100)**

Table 9 Type of therapy change due to blood culture results

TYPE OF CHANGE	NO. PATIENTS (%)
Antibiotic treatment commenced	7 (27)
Antibiotic ceased	1 (4)
Change of antibiotic	8 (31)
Antibiotic added to empiric regimen	10 (38)
TOTAL	**26 (100)**

Table 10 Appropriateness of antibiotic therapy

TEST RESULT	NO. INAPPROPRIATE	
	BEFORE BC RESULTS	AFTER BC RESULTS
True (+)	3	8
False (+) / Undefined	5	6
Negative	4	12
TOTAL	**16**	**26**

NOTE: Antimicrobial therapy was considered inappropriate in 30 patients (23% of total).
Some of these patients had inappropriate therapy both before and after culture results were known.
BC = blood culture

Table 11 Inappropriate antimicrobial use

CRITERIA FOR INAPPROPRIATE CLASSIFICATION	NO. INAPPROPRIATE COURSES
Antibiotics given when no evidence of infection (excluding prophylaxis)	3
Organism not sensitive	-
Incorrect dose, frequency or duration	3
IV route used unnecessarily	-
Documented allergy to the antibiotic	3
Inadequate monitoring/dose adjustment with nephrotoxic agent	-
Equally effective, less expensive agent available	3
Component(s) of regimen superfluous	8
Other - based on clinical assessment	14
TOTAL	**34**

Table 12 Distribution of courses classified as inappropriate based on clinical assessment

REASON INAPPROPRIATE	NO. COURSES
Broad spectrum agent used when narrower spectrum agent suitable	4
Significant delay in treatment	1
Nephrotoxic agent used in renal impairment	2
Insufficient cover in neutropenia or burns	2
No MSSU done in UTI patients	3
No combination therapy in active TB	1
Inappropriate by indication (for pneumonia)	1
TOTAL	14

2.4 Discussion

A range of issues relating to the use of blood cultures was raised by the review. They are not immediately relevant to this DUE but included the low incidence of positive results, the timing and number of cultures, and the sites and technique of sampling. These matters required general medical education and were referred to the departments of microbiology and infectious diseases, for action.

Of particular concern for this DUE was the incidence of inappropriate antibiotic use. More so was the finding that the rate of inappropriate use increased after culture results became available. At the RAH empiric treatment should be guided by the RAH Formulary recommendations or where they are absent, then the Antibiotic Guidelines. It is clear that in almost one quarter of patients, no reference is made to these texts, despite both being issued free to all junior medical staff by the Drug Committee. Of additional concern is that inappropriate use increased when clear direction by culture results (and consequently microbiologists) was available. In all cases where blood culture results are positive, the caring physician is contacted by a microbiologist and therapeutic options are discussed. The higher rate of inappropriate or unnecessary antibiotic use following positive results indicates that clinicians either are not heeding this or that microbiologists were giving advice which was not in accordance with the aforementioned references. It was not possible to ascertain the reason for this finding.

2.5 Conclusion

The ultimate purpose of performing blood cultures is to confirm infection (bacteraemia) and to assist in determining which antibiotics are required for patient management. Results may indicate that empirical therapy does not need to be altered. Negative cultures may also assist this process by reassuring a clinician that antibiotics are not indicated.

My findings provide evidence for sub-optimal blood sampling among clinicians at the RAH. A significant incidence of inappropriate and unnecessary antibiotic use before and after blood culture results became known was also demonstrated. This indicates that prescribers are heeding references supplied freely by the Drug Committee or of advice provided by clinical experts.

These findings have financial and clinical care implications. Further investigation, prospective monitoring and clinician eduction programs are warranted.

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CHAPTER 18

QUALITATIVE DUE: CRITERIA AUDITS OF DRUG GROUPS

1. INTRODUCTION

Audits of this type are similar to reviews of individual drugs except that several drugs rather than a single agent, are reviewed at the same time. Similar to the laxative drugs described earlier in this thesis, the antiemetic 'group' represents a number of disparate agents used alone or in combination, to control the effects of nausea and vomiting associated with chemotherapy or other conditions. This review therefore assessed the use of a range of drugs by targeting a particular group of patients, rather than different drugs. Drug use was compared with recommendations for antiemetic use described in the RAH Formulary. In addition to the appraisal of appropriateness of therapy, the efficacy of treatment was also assessed for a range of drug regimens. This latter approach presented some interesting observations.

2. ANTIEMETICS

2.1 Background and aim

The RAH manages one of the largest cancer populations in the State. Consequently expenditure for antineoplastic and adjunctive agents is considerable. Chemotherapy induced nausea and vomiting, as a major cause of morbidity in patients undergoing chemotherapy, has been a subject of interest to nurses, pharmacists and doctors alike over the years. Traditional antiemetic regimens had included phenothiazines, metoclopramide, domperidone, and corticosteroids. These agents had been used with variable effects (and side effects) in many thousands of patients over the years. In 1992 a new class of antiemetic agents was introduced, serotonin (5-hydroxytryptamine (5-HT_3)) antagonists. The first of these, ondansetron, offered much promise for the management of some patients where other antiemetics had failed or were contraindicated. These drugs were many times more expensive than the traditional agents.

In an effort to curb the anticipated 'blow-out' in antiemetic expenditure, the Drug Committee developed strict guidelines for 5-HT_3 antagonists and restricted the use of these agents to cancer specialists. Despite these restrictions, expenditure for ondansetron exceeded predictions and the Committee thought it opportune to evaluate the use of antiemetic agents in general and ondansetron in particular. An assessment of antiemetic efficacy for the different chemotherapy regimens was also undertaken.

2.2 Method

This DUE was a concurrent, non-interventional, criteria based review, conducted over 6 weeks in 1994. All patients receiving cancer chemotherapy with or without ondansetron were eligible for review. Clinical, chemotherapy and antiemetic details were recorded. The number of episodes of nausea, vomiting and adverse effects were recorded. Antiemetic regimens were compared with RAH Formulary guidelines.

2.3 Results

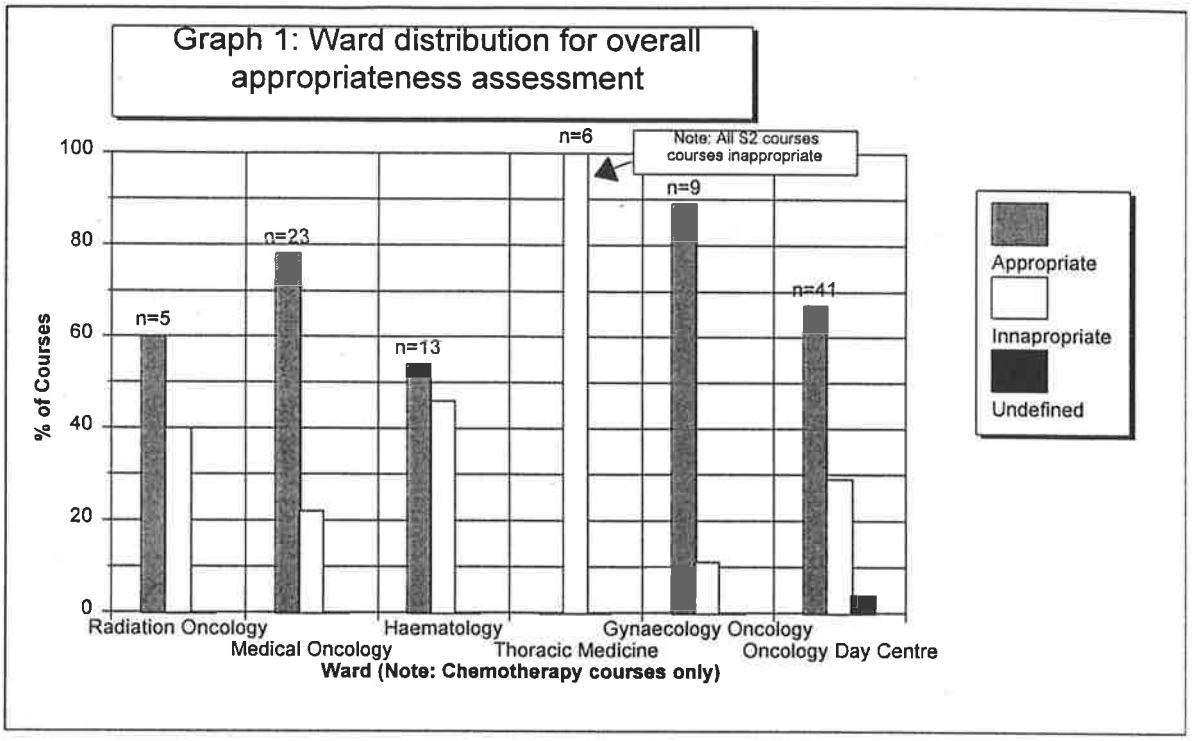
Ninety seven antiemetic courses were reviewed (48 male, 49 female, average age 49 years). Breast cancer and non-Hodgkins lymphoma were the most common indications for chemotherapy. Forty four percent of antiemetic regimens included ondansetron.

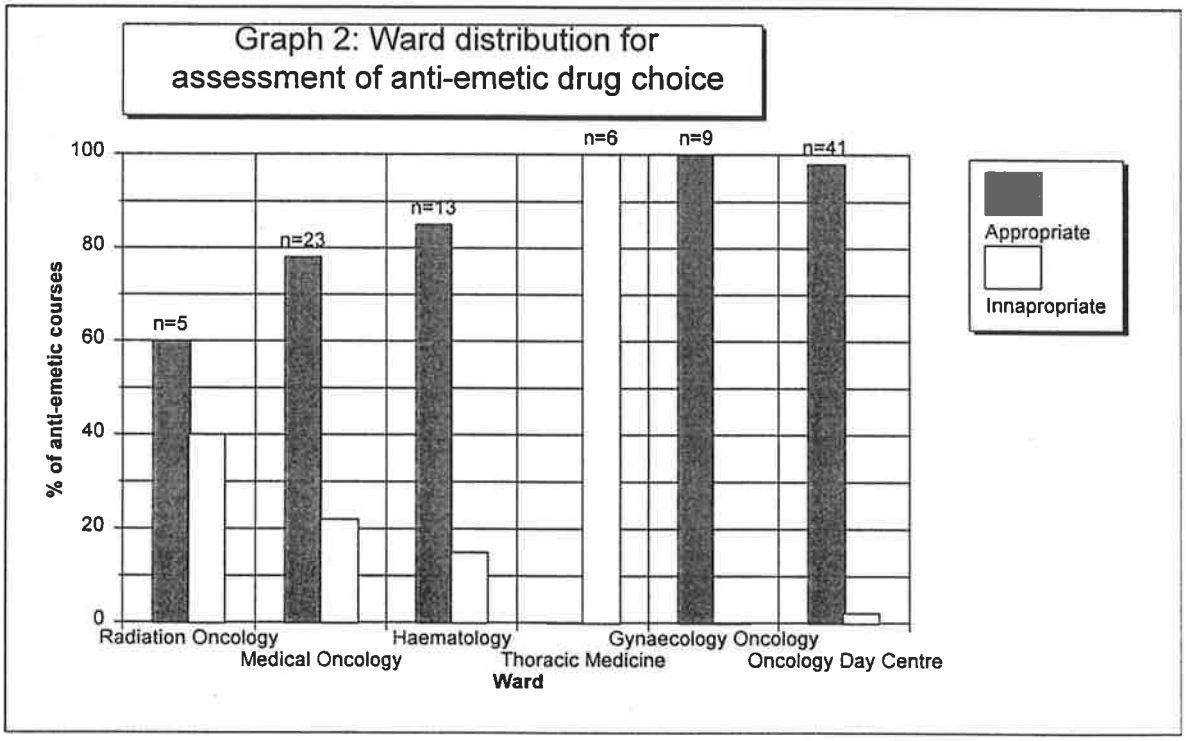
The majority of antiemetic courses were prescribed in the Oncology Day Centre (Graph 1). Sixty six percent of all antiemetic courses were judged appropriate by all criteria. Seventy five percent of acute antiemetic regimens and all delayed regimens were classified as appropriate. In 11% of courses, drug dose did not comply with criteria (Graph 3). Metoclopramide accounted for the majority of incorrect doses. In 83.5% of patients, either a complete or major response to the administered antiemetics was recorded (Graph 4). Inappropriate use accounted for 56% of total non-ondansetron antiemetic expenditure for the period.

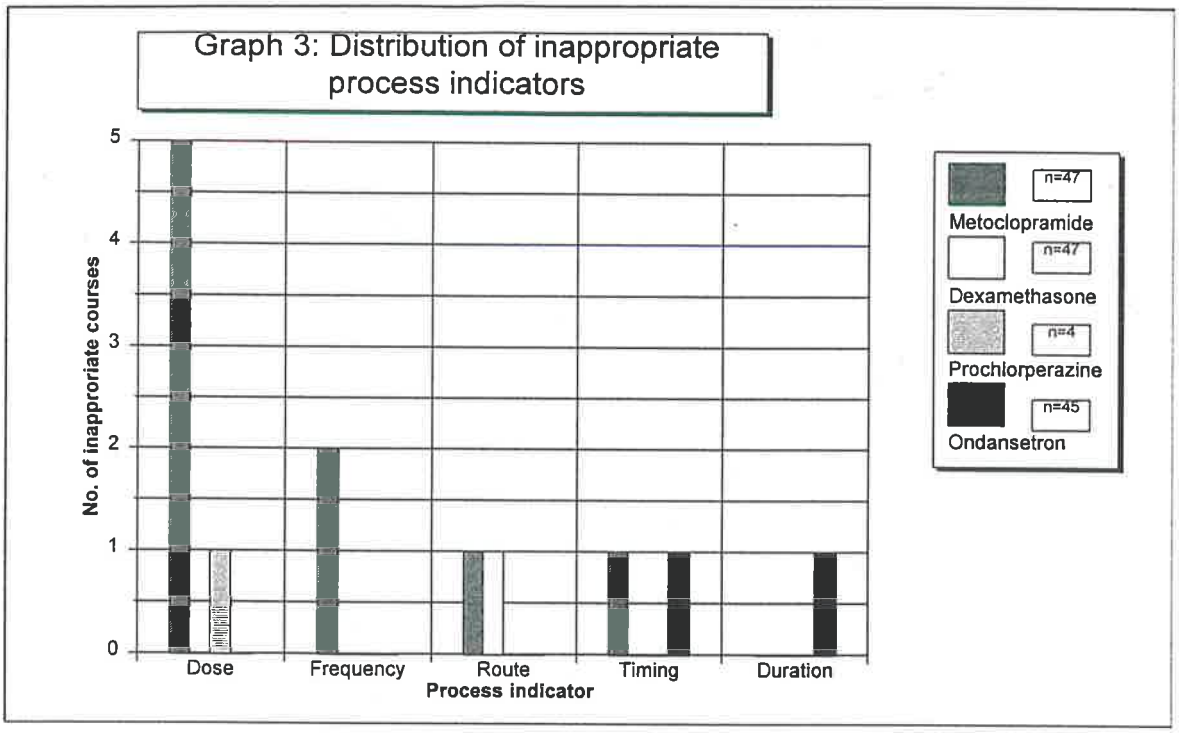
Only 67.4% of ondansetron courses were classified as appropriate with inappropriate drug choice being the major reason for failure to meet criteria. Eighty two percent of patients had complete or major antiemetic responses (Graph 5). Side effects were reported in 30% of ondansetron recipients with constipation being most common (29%). Inappropriate use of ondansetron accounted for 50% of ondansetron expenditure.

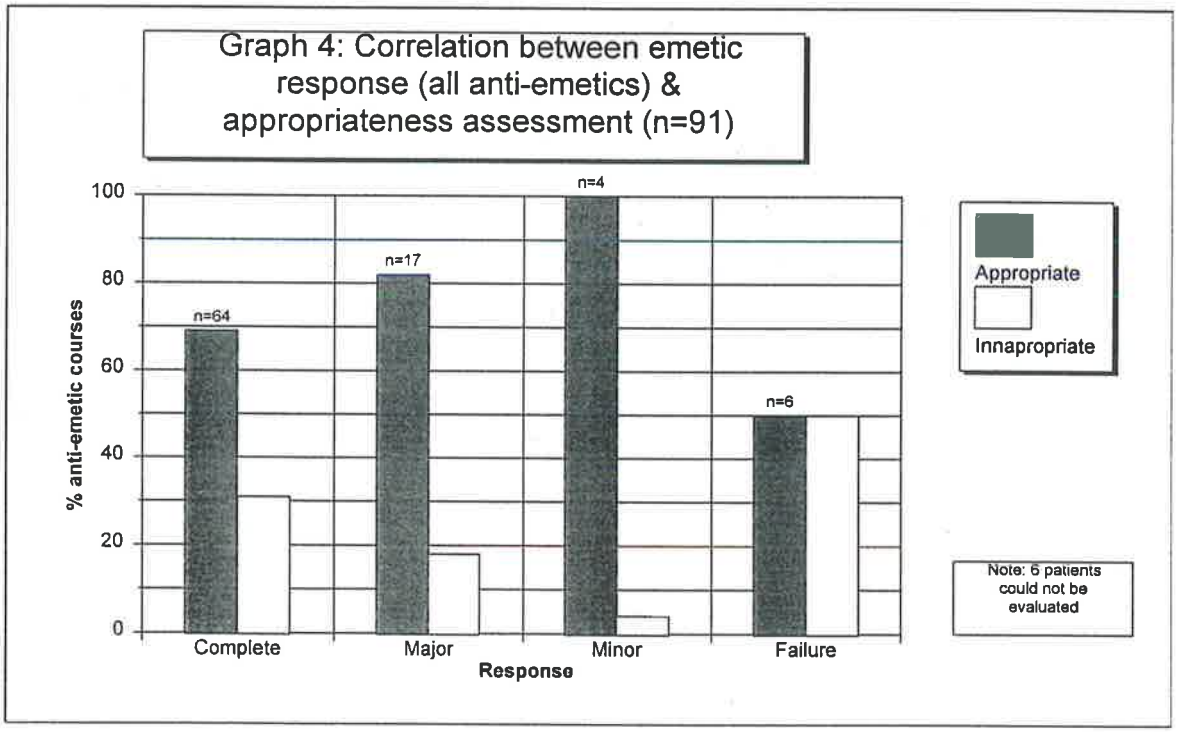
Patterns and quality of antiemetic use varied between clinics (Graphs 1 and 2). Units specialising in management of cancer patients (including active clinical pharmacist involvement in antiemetic selection) faired better than wards where chemotherapy was given intermittently. The Thoracic Medicine Unit 'scored' most poorly, recording no courses which complied with formulary criteria. This was because the antiemetic regimens chosen did not correspond with the emetic potential of the chemotherapy regimens administered (ie. patients were under treated). Overall however, and despite poor compliance with formulary guidelines, patients reported a good response to antiemetics whether prescribed ondansetron or other antiemetics (Graphs 4-7).

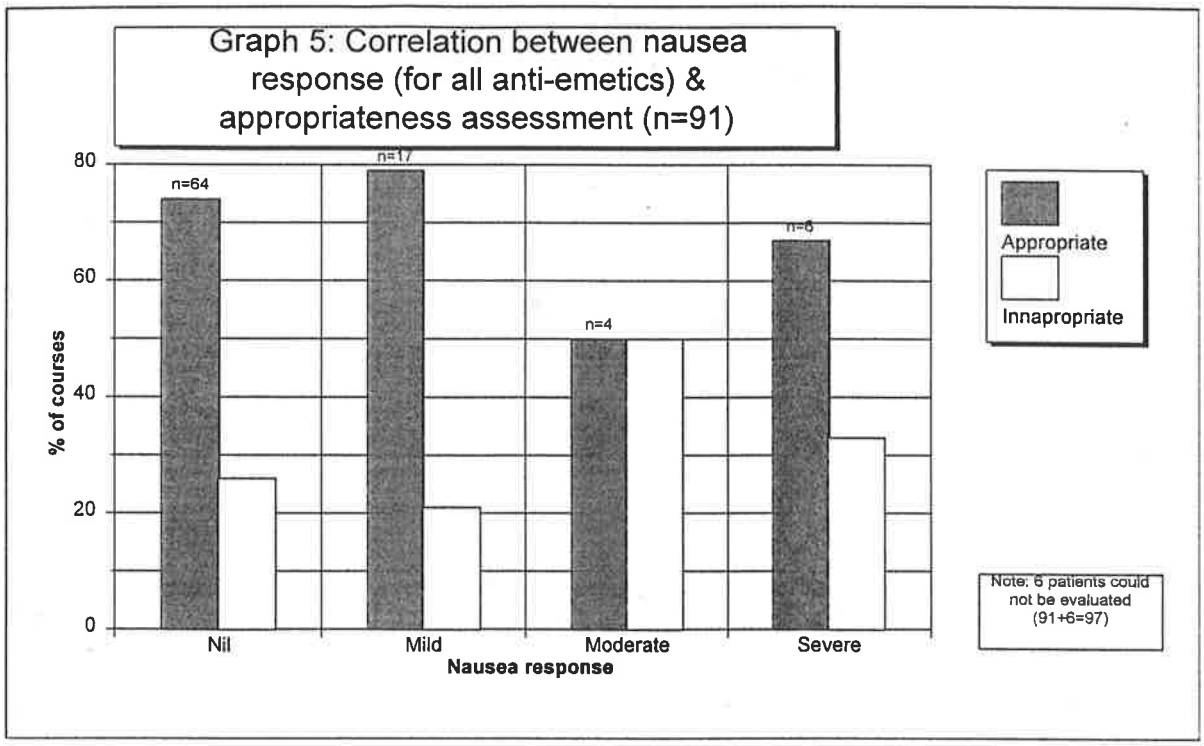
The annual potential cost saving if all antiemetics were used appropriately was were estimated at $32,500 (ondansetron $11,500, others $21,000).

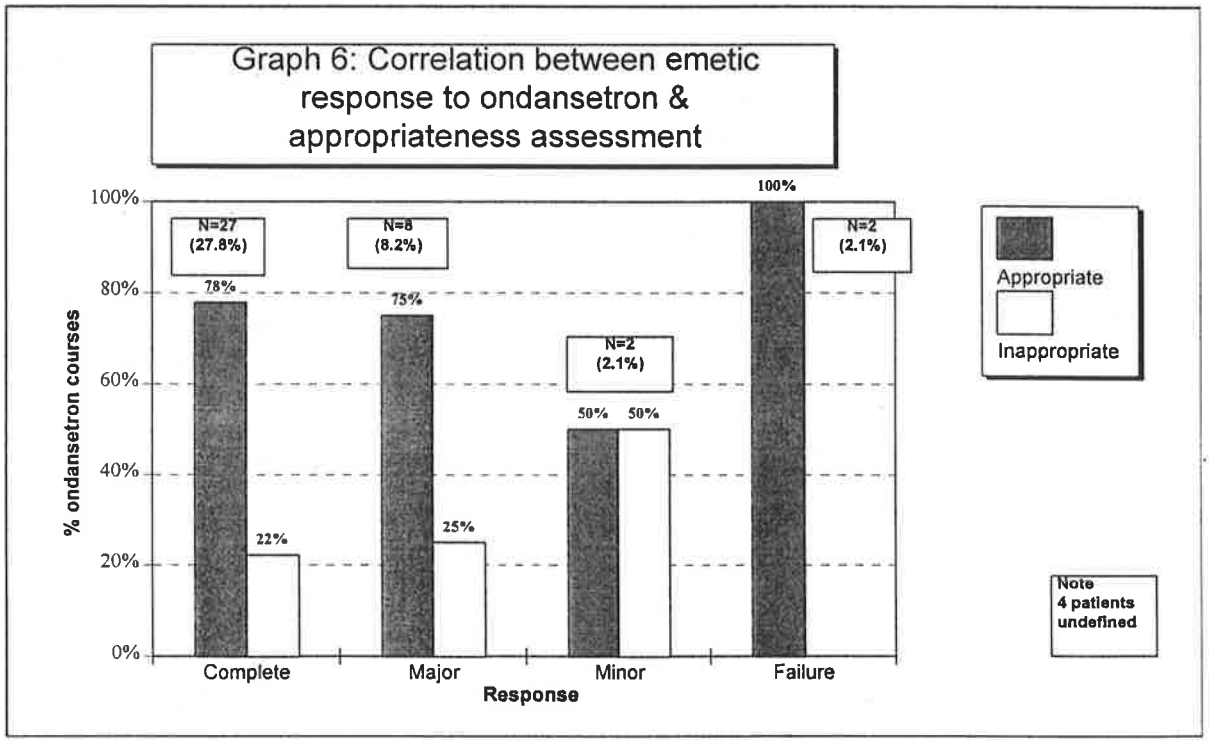

Graph 1: Ward distribution for overall appropriateness assessment
Note: All S2 courses courses inappropriate
n=5
n=23
n=13
n=6
n=9
n=41
100
80
60
40
20
0
% of Courses
Radiation Oncology
Medical Oncology
Haematology
Thoracic Medicine
Gynaecology Oncology
Oncology Day Centre
Ward (Note: Chemotherapy courses only)
Appropriate
Innapropriate
Undefined

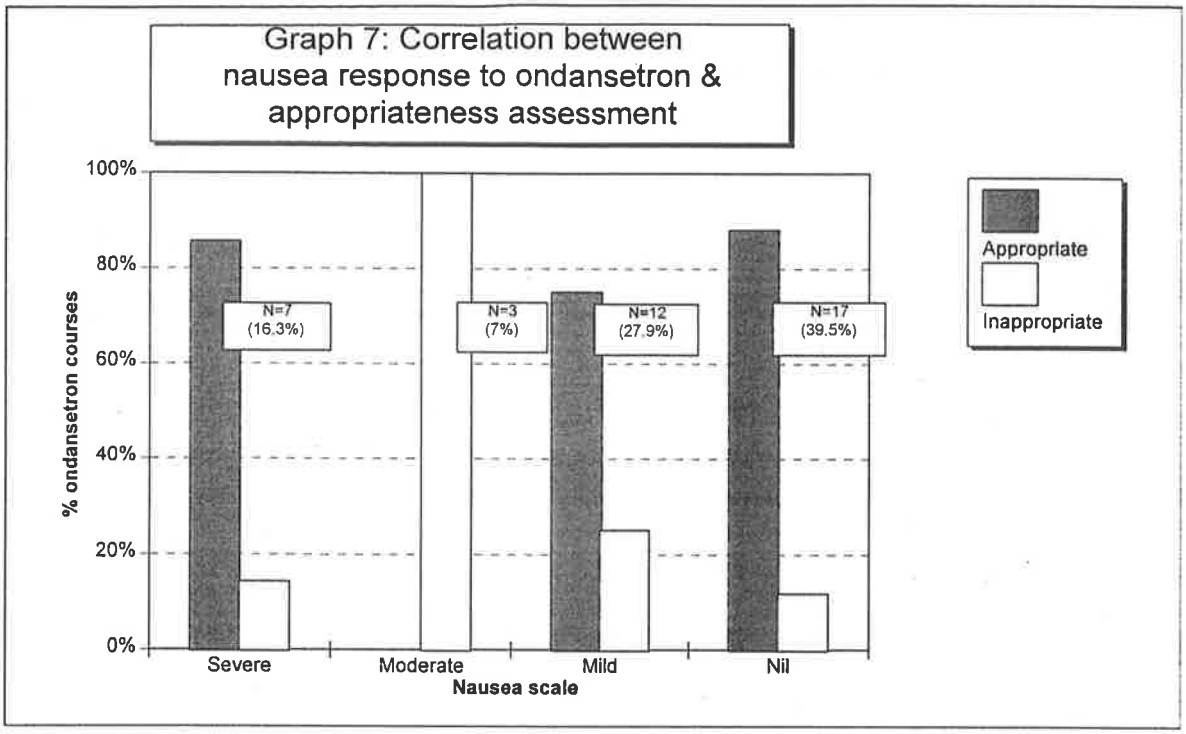

Graph 2: Ward distribution for assessment of anti-emetic drug choice
n=5
n=23
n=13
n=6
n=9
n=41
100
80
60
40
20
0
% of anti-emetic courses
Radiation Oncology
Medical Oncology
Haematology
Thoracic Medicine
Gynaecology Oncology
Oncology Day Centre
Ward
Appropriate
Innapropriate


Graph 3: Distribution of inappropriate process indicators
No. of inappropriate courses
0
1
2
3
4
5
Dose
Frequency
Route
Timing
Duration
Process indicator
n=47
Metoclopramide
n=47
Dexamethasone
n=4
Prochlorperazine
n=45
Ondansetron


Graph 4: Correlation between emetic response (all anti-emetics) & appropriateness assessment (n=91)
% anti-emetic courses
0
20
40
60
80
100
n=64
n=17
n=4
n=6
Complete
Major
Minor
Failure
Response
Appropriate
Innapropriate
Note: 6 patients could not be evaluated


Graph 5: Correlation between nausea response (for all anti-emetics) & appropriateness assessment (n=91)
% of courses
80
60
40
20
0
n=64
n=17
n=4
n=6
Nil
Mild
Moderate
Severe
Nausea response
Appropriate
Innapropriate
Note: 6 patients could not be evaluated (91+6=97)


Graph 6: Correlation between emetic response to ondansetron & appropriateness assessment
% ondansetron courses
100%
80%
60%
40%
20%
0%
N=27 (27.8%)
78%
22%
N=8 (8.2%)
75%
25%
N=2 (2.1%)
50%
50%
100%
N=2 (2.1%)
Complete
Major
Minor
Failure
Response
Appropriate
Inappropriate
Note 4 patients undefined



2.4 Discussion

A number of irrational prescribing practices were observed during this review:

- lower than recommended doses of metoclopramide or prochlorperazine;
- delayed antiemetic regimens were commenced before chemotherapy was administered;
- acute antiemetic doses were administered on days when patients were not receiving chemo- or radiotherapy;
- ondansetron administered in combination with benztropine, diphenhydramine, prochlorperazine and metoclopramide;
- antiemetic regimens not changed even after several days of poor response;
- secondary causes of nausea and vomiting (eg. renal failure, hypercalcaemia) were not recognised.

These factors are relatively easy to address by prospective or concurrent monitoring. In addition by incorporating protocols for different antiemetic regimens as part of the chemotherapy protocols, antiemetic regimens would become standardised. Clinical pharmacists may be helpful to this end.

Of more interest was the correlation between the choice of antiemetic regimen and the patient response to treatment. Efficacy of antiemetic regimens in prevention of nausea or vomiting was assessed by recording emetic episodes, by patient interview and by asking patients to keep a record of their symptoms. As is apparent from Graphs 4 and 6, patients responded variably to antiemetics regardless of whether regimens were assessed as being appropriate by choice, dosage or other indicators. Some patients responded poorly despite appropriate regimens and others did well despite inappropriate regimens. This observation would probably not be affected by reviewing criteria and illustrates the difficulty in attempting to ascribe patient outcomes to drug therapy alone.

This may mean that patient response rather than criteria for drug use should be used as the benchmark for determining appropriateness of therapy in such cases. This would require establishing guidelines for when to change therapy in the event of poor response. Alternative regimens might

still be those described in the formulary guidelines but assessments would accommodate increasing the intensity of antiemetic treatment when patients responded inadequately.

The dilemma however is how to prevent clinicians immediately initiating high intensity regimens (including high dose ondansetron) for patients in the hope that a good response will be obtained from the outset. In fact, this is the type of 'dogma' which the pharmaceutical manufacturer promotes. Even though such regimens will be more expensive and may well be unnecessary for many patients, it is difficult to predict which patients may or not respond to these or regimens of lesser intensity. An individualised approach is therefore warranted, with DUE assessments (unnecessary versus inappropriate) made by taking into account patient response to treatment when regimens do not comply with criteria.

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CHAPTER 19

QUALITATIVE DUE: COMPARATIVE, MODULAR REVIEWS

1. INTRODUCTION

Reviews of this type investigate one or several components of the use of a particular drug rather than all aspects of drug use. Some assumptions may be made for certain elements and criteria only applied to areas of specific interest. For example, the aminoglycoside review below was primarily concerned with establishing whether known differences in aminoglycoside prescribing between the RAH Haematology Unit and the ICU resulted in different incidences of nephrotoxicity. Usage was compared with criteria for loading and maintenance dose recommendations, dosage adjustment in renal impairment, and drug concentration monitoring (TDM). Assessments of the comparative incidence of nephrotoxicity, associated risk factors were also examined. The indication for use of the aminoglycoside was not assessed although it was recorded. The review assumed the indication for and or choice of aminoglycoside was appropriate. It should be noted that this review was undertaken several years before single daily dosage recommendations for aminoglycosides were considered and subsequently implemented at the RAH.

2. AMINOGLYCOSIDE USAGE IN HAEMATOLOGY AND ICU (1991)

2.1 Background and aim

The choice and use of aminoglycoside differed between the hospital Haematology Unit and ICU. Intensive care patients were generally prescribed gentamicin while haematology patients received tobramycin. ICU patients often received short term treatment with close metabolic and other monitoring. This use corresponded with the acute nature of clinical problems in the ICU. Conversely, Haematology patients were treated for prolonged periods - with antibiotics used empirically in the management of neutropenic fever - and with less intensive monitoring. Whether these differences resulted in different toxicity or outcome profiles was of interest. The aim of the review was to investigate this question.

2.2 Method

This was a concurrent, modular, non-interventional review. Aminoglycoside induced nephrotoxicity was the main subject of the review although other process parameters (eg. TDM) were also investigated. The review was conducted over 6 weeks. A range of clinical and other information was recorded. Confounding factors for nephrotoxicity (ie. nephrotoxic drugs, hypotension, hypovolaemia, cardiovascular failure, renal impairment) were recorded; no assessment of the appropriateness of aminoglycoside use was performed.

2.3 Results

Data for 28 courses in 27 patients were recorded. Thirty two percent were for gentamicin (all ICU) and 68% for tobramycin (73% Haematology, 27% ICU). The average duration of treatment in ICU

was 7 days (range 1-15 days) compared with 17 days (range 5-60 days) for Haematology patients. A total of 11 (39%) patients exhibited increases in serum creatinine consistent with criteria (1) for nephrotoxicity (9 in ICU, 2 in Haematology).

Confounding factors for nephrotoxicity were present in 9 of the 11 patients. Time of onset (eg. within 5 days) excluded aminoglycosides as the cause in these patients. In 2 patients nephrotoxicity was attributed to aminoglycosides although 1 patient was also receiving vancomycin and the other amphotericin. Causality could not be definitely assigned to aminoglycosides in any patient although they were contributory in two patients.

Dosage schedules varied. Sixty three percent of haematology courses were for 80 mg 'tds' and 53% of ICU courses were for 120 mg 'bd'. The trend in ICU was to give larger doses less often. Of 19 patients evaluable for appropriateness of dosage, 7 (37%) complied with criteria for initial and maintenance doses and were adjusted for renal impairment where necessary. Of the 19 patients, 26% did not receive a loading dose; maintenance doses were however appropriate in 63%. Dose changes were not correlated with changes in renal function or with plasma concentration monitoring.

In 25% of patients, blood aminoglycoside concentrations were not measured. Thirty four percent of blood samples for aminoglycosides were taken at incorrect times with respect to dosing, with ICU most frequently being non-compliant with recommendations. Sixteen percent of trough levels and 55% of peak concentrations were outside recommended therapeutic blood concentrations. Inappropriate sampling times made interpretation of the significance of these levels difficult.

Table 1 Summary of Aminoglycoside (A/G) DUE results

	ICU	Haematology
No. of patients*	**13**	**14**
No. of A/G courses:	**14**	**14**
• gentamicin	9	0
• tobramycin	5	14
No. of A/G blood concentration measurements:	**92**	**46**
• Trough	72 (78%)	24 (52%)
• Peak	20 (22%)	22 (48%)
Average days between concentration measurements:		
• Trough	1.5 days	11 days
• Peak	5 days	13 days
No. of patients developing nephrotoxicity:	**10**	**3**
• Total	9	2
• Attributable to A/G	1	1

2.4 Conclusion

Nephrotoxicity definitely attributable to aminoglycoside usage occurred infrequently despite variable dosage regimens, extended duration of therapy and poor attention to recommendations for aminoglycoside concentration monitoring. Dosage regimens and dosage adjustments for renal impairment were generally within limits of guidelines. The study was not able to demonstrate differences in toxicity or clinical outcomes as a result of the different patterns of aminoglycoside use in the RAH Haematology or ICU.

2.5 Recommendations

In view of a range of issues relating to sub-optimal dosing, monitoring, attention to risk factors and use of TDM, it was recommended that general promulgation of aminoglycoside guidelines should be undertaken. The encouragement of better use of blood concentration monitoring should be a particular feature of these efforts.

3. BIBLIOGRAPHY

1. Wade WE, McCall CY. Drug usage evaluation of aminoglycoside-induced nephrotoxicity in a community hospital. Hosp Formul. (1990);123 (25):1092-96.

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CHAPTER 20

QUALITATIVE DUE: REVIEW INVOLVING PATIENT ASSESSMENT OF CLINICAL EFFICACY

1. INTRODUCTION

The review described below was one in which a significant part of the data was obtained by patient interview. Assessment of treatment efficacy was based on subjective patient assessment of pain control using visual analogue and other methods of pain assessment.

2. SUSTAINED RELEASE ORAL MORPHINE (SROM) (1993)

2.1 Background and aim:

Sustained release oral morphine (SROM) preparations were introduced into Australia in 1991 and into limited use at the RAH in 1992. Guidelines for chronic cancer pain control had been in place at the RAH for a number of years and were subsequently modified to include use of sustained release preparations. Anecdotally, there was evidence that the use of SROM was sub-optimal and not in accordance with guidelines. This suboptimal use was also thought to be contributing to inadequate pain control in chronic pain patients.

The aims of this DUE were (a) to assess compliance with guidelines for use sustained release morphine and (b) investigate patient assessments of SROM efficacy and side-effects.

2.2 Method

This was a concurrent review conducted over 5 weeks. Patients were identified from Pharmacy Drugs of Dependence (DD) records. Demographic, clinical, indication and dosage details were recorded. Patients were interviewed for assessment of pain control. They were required to complete visual analogue score and other instruments to assess pain control. Degree, duration and rate of onset and decline of pain control were assessed. Need for more than 2 doses of morphine syrup, or parenteral morphine was considered an indicator of inadequate dosage.

The aetiology (eg. neuropathic, visceral, bone pain) of patient pain was not specifically recorded and therefore not assessable in most patients. No assessment of appropriateness of the need for morphine was made.

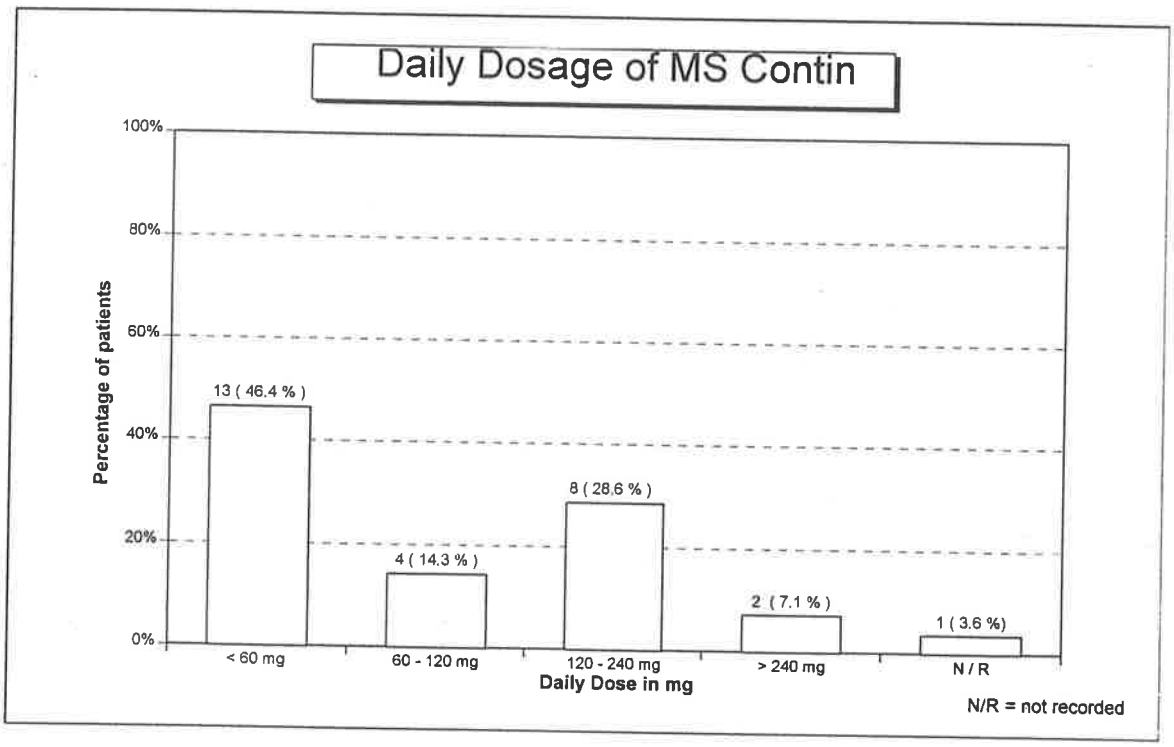
2.3 Results

Thirty three patients were recruited into the study. Evaluable data for 28 patients (10 medical, 9 surgery, 9 medical oncology) were available. In 8 (28.6%) patients, pain control was the primary reason for admission (Graph 3). Seventeen (60.7%) patients commenced morphine therapy outside of hospital.

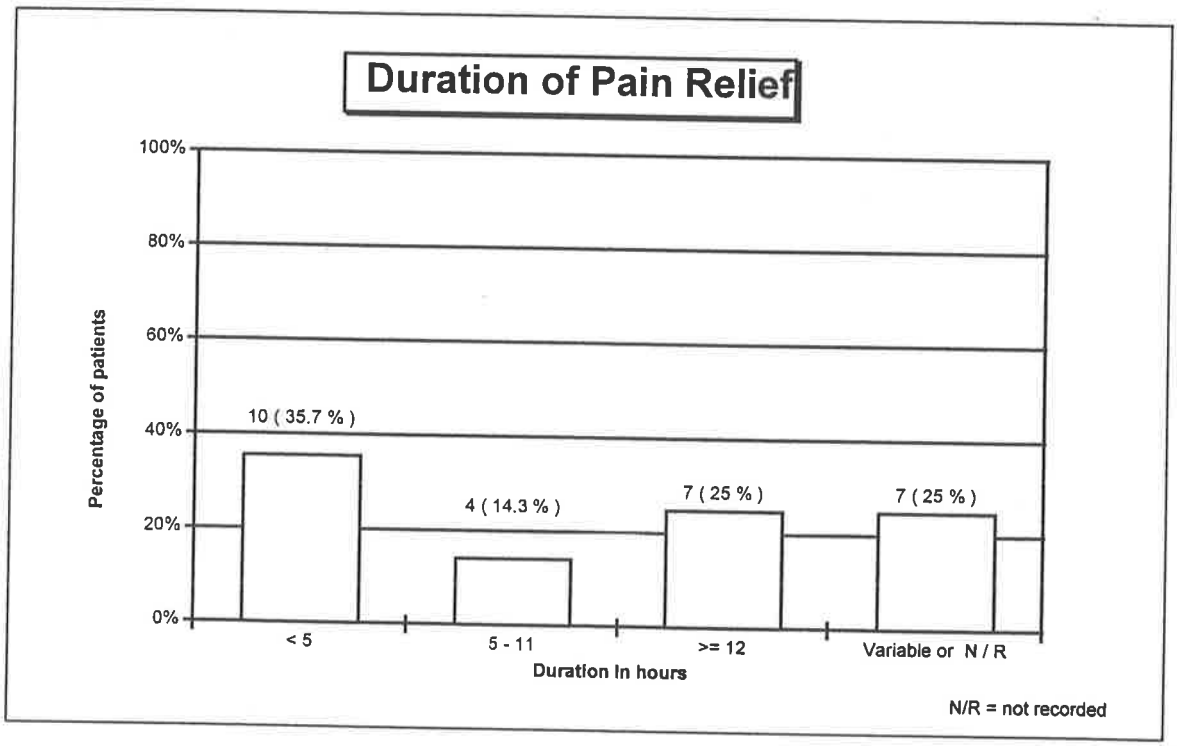
The most common indication for SROM was pain associated with neoplasia; lower back was the most common site. SROM dosage, duration of effect and patient acceptability are illustrated in Graphs 1,2 and 4, respectively.

Eight (28.6%) patients had acceptable pain control by visual analogue and other pain scores. 7 (25%) reported pain relief being adequate for 12 hours. 21 (75%) required supplementary pain medication which in 19% of cases was an indicator of inadequate morphine dosage. Twenty four (85%) patients reported side effects with constipation and drowsiness being most common.

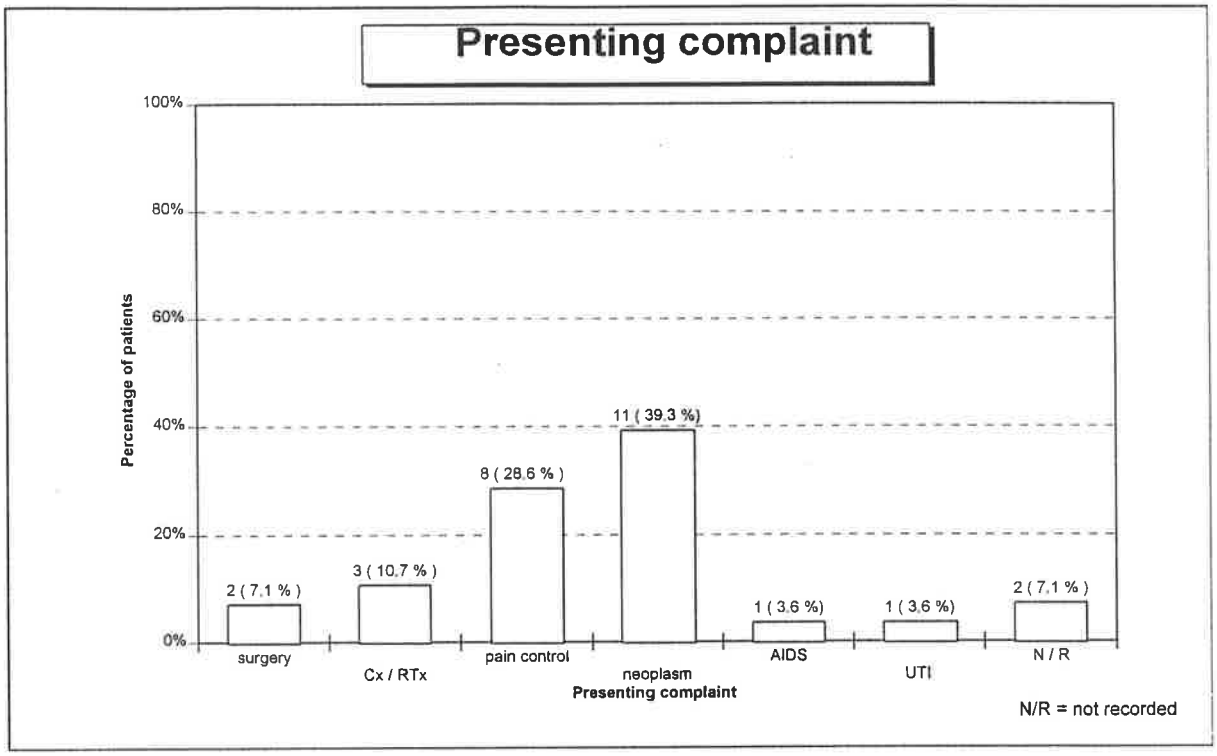
Graph 1 Graph showing distribution of daily dosage of sustained release oral morphine tablets (MS Contin™) for patients studied



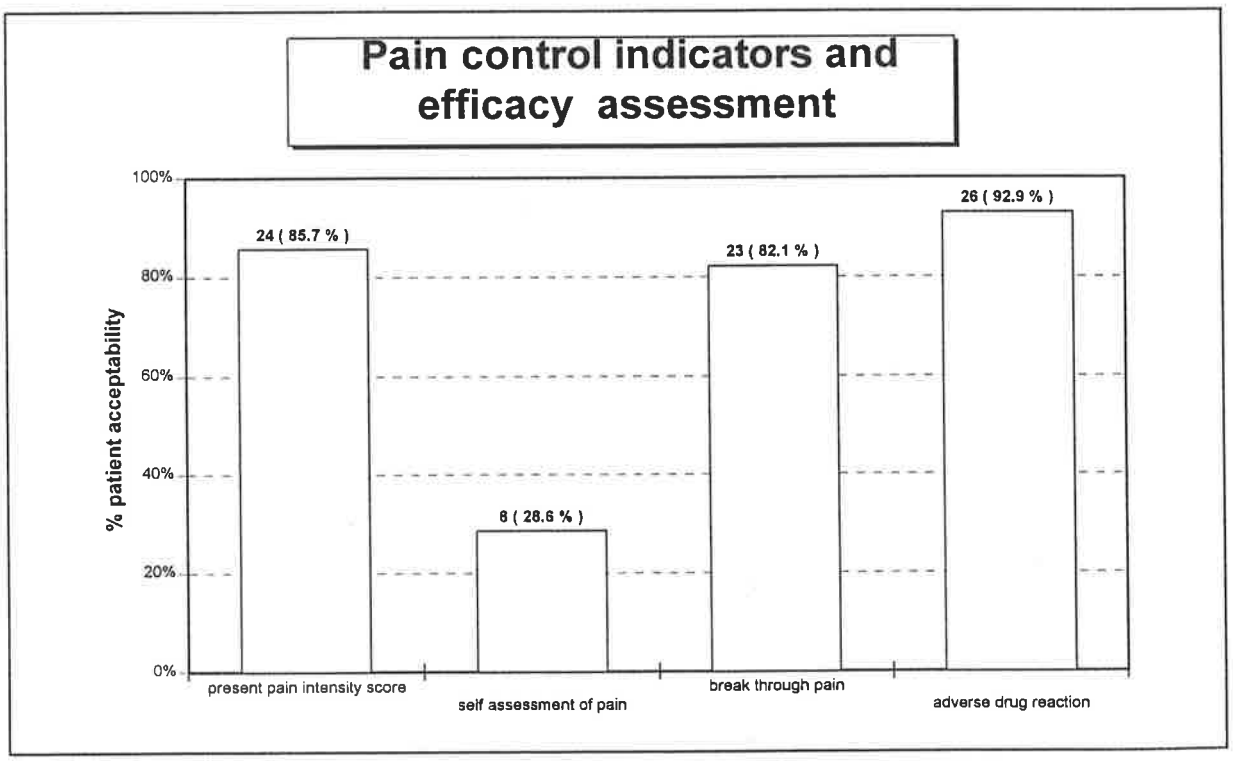
Graph 2 Graph showing distribution of pain relief achieved in patients administered MS Contin



Graph 3 Graph showing distribution of presenting complaints for patients studied



Graph 4 Graph showing distribution of results of MS Contin efficacy using various pain indicators for patients studied



2.5 Conclusion and recommendations

Many patients on SROM had inadequate dosage to provide pain relief. Reasons appeared to include poor understanding of pain origins (& therefore inadequate drug choice), inappropriate dosage and sub-optimal use of sustained release preparations. Recommendations were made to reinforce pain management education, promulgate usage guidelines, and counsel patients at discharge about correct use of SROM.

As a result of the review, revised guidelines were published in the RAH Formulary. Results were also presented to pain clinic and oncology & haematology units. A patient medication information leaflet was also developed.

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CHAPTER 21

QUALITATIVE DUE: OTHER REVIEW RESULTS, DISCUSSION AND SUMMARY

1. INTRODUCTION

Since the inception of the RAH DUE program in 1987/88 a number of other DUEs were undertaken either by me or under my direction and supervision. The subjects, review type, aim, method, results and project outcomes are tabulated below and followed by a general discussion and by a summary.

Table 1 Summary of Individual drug and other DUE results

Amoxycillin with clavulanic acid (Augmentin) DUE (1990)

Review type: comprehensive; criteria audit; non-interventional.
Aim: to evaluate pattern of Augmentin™ use with particular reference to suitability of less expensive alternative drugs.
Method: concurrent review; sampled all inpatients; over 4 weeks; performed in association with microbiologist.
Results: 33 courses reviewed; respiratory infections most common indication (45%); 58% of cases involved inappropriate indication or drug choice; incorrect dosage most common criteria violation (too high in 7, too low in 7); 2 patients prescribed Augmentin because of history of penicillin hypersensitivity !!; 6 (18%) patients no evidence of infection criteria noted; specialist units most often users associated with inappropriate use. Cost of review $650.
Recommendation: Promulgation of guidelines for use of Augmentin; follow-up review to be conducted in 1992.
Estimated savings: $8,000 pa.
Review outcome: Guidelines published in formulary ; review results and guidelines published in Drug Committee Bulletin.

Amoxycillin with clavulanic acid (Augmentin) DUE (1992)

Review type: comprehensive; criteria audit; non-interventional.
Aim: to evaluate pattern of Augmentin use & reason for increased expenditure.
Method: concurrent review; sampled all inpatients; over 5 weeks; performed in association with microbiologist.
Results: 45 courses reviewed; 40% from cardiothoracic unit; major indication was respiratory infection; 62% of courses inappropriate by indication or drug choice; 24 % inappropriate by all indicators; majority of variation in cardio-thoracic surgical unit; incorrect duration and dosage most often inappropriate indicators; 6 patients 7% on concurrent metronidazole (unnecessary and 1 on amoxycillin (same drug); 26% had no evidence of infection; no culture and sensitivity tests performed in half of patients; only 24% appropriate by all parameters.
Recommendation: Review of protocol for Augmentin in cardiac unit.
Estimated savings: $17,000 pa.
Review outcome: Augmentin removed from Cardiac unit imprest; cephalexin now drug of first choice for empiric treatment of chest symptoms post surgery; subsequent minimal use in cardiac unit. $10,000 pa savings realised.

Table 1 ***continued...***

Ceftazidime DUE (1990)
Review type: comprehensive; criteria audit; non-interventional. **Aim:** to evaluate pattern of ceftazidime use in view of increasing expenditure. **Method:** concurrent review; all patients prescribed drug over 16 weeks; performed in association with microbiologist. **Results:** 13 courses reviewed; almost all use was in Cystic Fibrosis (CF) unit and in Haematology unit; divergence from existing CF guidelines; particularly dosage and duration of therapy; drug used in absence of penicillin hypersensitivity or contraindication to aminoglycosides. **Recommendation:** review of protocol with CF unit. **Estimated savings:** $6,000 pa. **Review outcome:** review of CF protocol undertaken; review recommended and supported use of higher doses of ceftazidime for short period. Recommendations to reserve ceftazidime as second line agent; microbiologists only to order ceftazidime in Haematology unit.
Ceftazidime DUE (1991)
Review type: comprehensive; criteria audit; non-interventional. **Aim:** to evaluate pattern of ceftazidime use in view of increasing expenditure. **Method:** concurrent review; all patients prescribed drug over 16 weeks; performed in association with microbiologist. **Results:** 25 treatment courses reviewed; 16 (64%) for cystic fibrosis patients, 4 (16%) for neutropenic fever; 7 (11%) courses inappropriate by indication; dose and frequency inappropriate in 14 (56% of total) of the 16 courses involving cystic fibrosis patients. Almost all use was in cystic fibrosis (CF) unit and in Haematology unit; divergence from existing CF guidelines; particularly dosage and duration of therapy; drug used in absence of penicillin hypersensitivity or contraindication to aminoglycosides. **Recommendation:** review of protocol with CF unit. **Estimated savings:** $23,400 or 27.7 % the total expenditure of $84,400 for ceftazidime. **Review outcome:** the results of the review were communicated to the cystic fibrosis unit and other individual prescribers. Particular elements highlighted were the divergence from established protocol and the resultant avoidable cost overruns. Usage figures for ceftazidime in general and for cystic fibrosis patients in particular continues unabated despite review results. This is partly due to increasing use of ceftazidime in the treatment of neutropenic fever and an increase in numbers of cystic fibrosis patients. To prevent inappropriate usage in other areas of the hospital all requests for ceftazidime (except from thoracic medicine physicians) now require approval from a microbiologist of infectious disease physician.

Table 1 ***continued...***

Ciprofloxacin (1993)

Review type: comprehensive; criteria audit; non-interventional.
Aim: to assess pattern of use; to identify opportunities for substitution with alternative agents.
Method: concurrent review; over 8 weeks; all inpatient courses reviewed; performed in association with microbiologist.
Results: 38 courses reviewed. 19% inappropriate overall; in 68% of these ciprofloxacin was unnecessary and less expensive alternative could have been used. 5% of courses inappropriate by indication. Microbiology/Infectious Diseases consults sought in only 29% of courses; pharmacy control procedures criticised. Culture and sensitivity testing in only 66% of cases.
Recommendation: promotion of therapeutic guidelines including publication in formulary ; use restricted following Microbiology/Infectious Diseases recommendation.
Estimated savings: for courses inappropriate by drug choice 30% of expenditure for ciprofloxacin could have been saved by use of alternative oral agents (6,800 pa). For cases where ciprofloxacin was appropriate, use of intravenous drugs would have resulted in a 4 fold increase in cost.
Review outcome: recommendations implemented; randomised controlled trial of ciprofloxacin versus 'standard 'intravenous therapy undertaken by author in association with Microbiology and Infectious Diseases.

H_2 receptor antagonist DUE (1990)

Review type: comprehensive; criteria audit; non-interventional.
Aim: to assess compliance with literature and Gastroenterology unit recommendations for use of H2 antagonists. Specific areas of concern were: whether peptic ulcer disease was established before commencing treatment, and whether follow-up evaluation of disease post therapy was conducted. Also use of H_2 antagonists in ICU for stress ulcer prophylaxis reviewed.
Method: patients identified from concurrent review of prescriptions; final assessments made retrospectively from case records; performed in association with gastroenterology registrar.
Results: 137 treatment courses reviewed. Indication considered appropriate in 88% of courses. Some variation from guidelines with regard to dose, route, duration or follow-up found in 17.5% of cases reviewed.
Recommendation: promulgation of simple guidelines for management of peptic ulcer disease, in association with Gastroenterology department. Restriction of use of IV ranitidine in ICU to patients at high risk of stress ulcer (major trauma, burns, head injury).
Estimated savings: $10,000 pa from expenditure of $150,000 pa.
Review outcome: follow-up reviews planned.

Table 1 *continued...*

Anti-ulcer drug DUE (1995)

Review type: comprehensive; criteria audit; non-interventional.
Aim: to assess compliance with literature, formulary and Gastroenterology unit recommendations for use of H2 antagonists, omeprazole, sucralfate and misoprostol. Specific areas of concern were: whether peptic ulcer disease was established before commencing treatment, and whether follow-up evaluation of disease post therapy was conducted. Also assessment of patient understanding of drug, indication, dosage and satisfaction with treatment, was made.
Method: patients identified from concurrent review of prescriptions.
Results: treatment courses for case records and drug charts of 210 patients were reviewed (131 male, 79 female; average age 60 and 69 years respectively); assessment of understanding of prescribed drug therapy and satisfaction with treatment was undertaken for 112 (53.3%). All patients met diagnostic criteria; the most common indication was prophylaxis of stress induced ulceration (21%, as most patients came from burns unit or ICU); ranitidine was drug most often prescribed (80.5%; oral=64.8%, IV=15.7%) followed by omeprazole (9%). Overall, 57% of prescriptions failed to meet audit criteria; 20% of patients failed criteria for drug selection; 80% satisfying criteria for choice failed to meet other process criteria; inappropriate dose was most contributory to criteria failure; in patients with inappropriate dosage (46.1%; too high= 42.8%; too low=3.3%) being the main reason; ranitidine was implicated in 82.5% of inappropriate courses.
79% of patients assessed for understanding knew the name of the prescribed drug (generic or brand), 86% understood the reason for the drug (indication) and 68% the dosage regimen. Few patients understood potential side effects (31%) or drug interactions (29%). 89% of patients assessed reported complying regularly with the doctor's instructions for dosage. 76% reported a good response or satisfactory response to treatment; 3.8% complained of side effects.
Conclusion: a case of inappropriate versus unnecessary classifications. Indications were appropriate in all cases; where choice was 'inappropriate', this was either where omeprazole was used before adequate trial of H_2 antagonists or where H_2 antagonists were used instead of misoprostol for prevention of NSAID induced ulceration; also, sucralfate was used for stress ulcer prophylaxis in some cases (few data to support its use for this indication but not necessarily inappropriate). these situations however contravened criteria. Excessive dosage was mainly in IV courses. This has been shown in other literature studies; patient understanding may also be a concern.
Recommendation: review guidelines with Gastroenterology unit; education re: management of peptic ulcer disease; omeprazole to be commenced only on advice of Gastroenterologists and not to be used for outpatients. Try to offer patient medication counselling more often (clinical pharmacists).
Estimated savings: $35,000 through rigid application of current criteria; in practice probably about 25-50% of this.
Review outcome: information to Drug Committee for discussion.

Table 1 ***continued...***

Metronidazole *(1990)*

Review type: comprehensive: criteria audit; non-interventional.
Aim: to evaluate pattern of use of metronidazole.
Method: concurrent review; random sample of inpatients; over 6 weeks; performed in association with microbiologist.
Results: 79 inpatient courses reviewed; 75% of courses appropriate by indication; 50% of courses utilised intravenous therapy; 72% of IV courses could have been given by oral or rectal route obviating need for IV therapy; 49% of courses gave metronidazole as 8 hourly doses when 12 hourly would have sufficed.
Recommendation: restrict use of IV metronidazole. Distribute new guidelines recommending oral or rectal metronidazole instead of IV. Recommend 12 hourly regimen universally except for giardiasis. Withdraw IV metronidazole from all wards except ICU and gastroenterology units. Automatic change of 8 hourly metronidazole orders to 12 hourly by pharmacy; note sent with drug supplies and clinical pharmacists advised to change all orders at ward level.
Estimated savings: $30,000 pa.
Review outcome: all recommendations implemented. Savings of $30,000 pa realised.

Norfloxacin *(1990)*

Review type: comprehensive; criteria audit; non-interventional.
Aim: to determine pattern of use of norfloxacin, with a particular emphasis in identifying opportunities for use of less expensive alternative drugs.
Method: concurrent review; of all patients prescribed drug; over 4 weeks; performed in association with microbiologist.
Results: 42% of courses inappropriate by indication or drug choice; less expensive alternatives suitable in all inappropriate courses; significant divergence from guidelines noted for duration of therapy and administration times.
Recommendation: therapeutic guidelines published in Pharmacy Bulletin and formulary . Norfloxacin only reported on Microbiology reports when Pseudomonas cultured or resistance to other antibiotics demonstrated.
Estimated savings: $7,000 pa.
Review outcome: recommendations implemented.

Table 1 *continued...*

Norfloxacin (1994)

Review type: comprehensive; criteria audit (including drug interactions); interventional.
Aim: to assess pattern of use and compliance with criteria; arose from concern of widespread use inducing development of resistant organisms.
Method: concurrent review; over 6 weeks; Haematology patients excluded (norfloxacin used for 'gut' sterilisation). Inpatient and discharge prescriptions reviewed; performed in association with microbiologist.
Results: 80 courses reviewed; major user was Urology unit. 67% were for surgical or other prophylaxis. 81% of courses inappropriate overall; 66% of inappropriate courses prescribed by Urology unit (who were involved with development of guidelines). 98% of Urology unit courses inappropriate by indication; only 2 of 54 patients had documented evidence of infection and these were considered non-significant; 78% of Urology unit patients had sterile urine. All surgical prophylaxis courses given for longer than 24 hours - therefore inappropriate; pharmacist intervention resulted in changes to therapy in 5 therapeutic courses.
Recommendation: present results of review to Urology unit with recommendation to review protocols for TURP and other 'clean' urological procedures. Promote sensitivity data for urine isolates and cost data for antibiotics in UTI to entire hospital.
Estimated savings: $8,400 pa.
Review outcome: recommendations implemented.

Omeprazole (1991)

Review type: comprehensive; criteria audit; non-interventional.
Aim: to assess prescriber compliance with guidelines and identify areas for potential cost savings.
Method: concurrent review; criteria based; over 5 weeks; inpatient and outpatient therapy reviewed.
Results: 19 courses reviewed; majority of prescriptions complied with guidelines; some divergence noted in some areas (eg. initial dose too high). Most variations from guidelines occurred in course initiated outside of RAH.
Recommendation: review of guidelines undertaken, with particular reference to prophylaxis in recurrent oesophagitis. Supply of omeprazole restricted to inpatients only. Outpatients referred to local doctor for supplies under PBS schedule.
Estimated savings: $42,000 pa.
Review outcome: recommendations implemented. Savings in excess of $30,000 pa realised.

Table 1 *continued...*

Ticarcillin/clavulanic acid (Timentin™) (1990)

Review type: comprehensive; criteria audit; non-interventional.
Aim: to assess pattern of use of Timentin™ and assess opportunities for cost savings.
Method: concurrent review; over 16 weeks; Haematology patients excluded (Timentin used as empiric therapy (in combination with tobramycin for neutropenic fever); all other inpatient courses reviewed; performed in association with microbiologist.
Results: 21 courses; 25% of courses inappropriate by indication or drug choice; compliance with guidelines for dose, frequency and duration generally good.
Recommendation: restrict prescribing to microbiology or infectious diseases units only.
Estimated savings: $4,000 pa.
Review outcome: recommendations implemented. Spot checks indicate general compliance with restriction.

Tobramycin (1990)

Review type: comprehensive; criteria audit; non-interventional.
Aim: to assess pattern of use; to identify opportunities for substitution with gentamicin.
Method: concurrent review; over 16 weeks; Haematology patients excluded (tobramycin used as empiric therapy (in combination with Timentin for neutropenic fever); all other inpatient courses reviewed; performed in association with microbiologist.
Results: 31 courses reviewed; 45% of courses considered inappropriate based on drug choice; gentamicin being equally suitable in most cases.
Recommendation: substitution of gentamicin for tobramycin in Oncology unit; tobramycin prescribing restricted to Microbiology or Infectious Disease unit (except Haematology and Respiratory unit (Cystic fibrosis)
Estimated savings: $5,000 pa.
Review outcome: recommendations implemented; savings realised.

Review of low molecular weight heparin (LMH)(1994)

Review type: comprehensive; with audit criteria; non-interventional.
Aim: to assess use of low molecular weight heparin (Fragmin™).
Method: concurrent review; over 5 weeks; haematologist involved.
Results: 31 courses reviewed; main users included orthopaedics and neurology; only one course considered appropriate by all criteria; 17 (55%, neurosurgery) and 43% inappropriate by indication and process indicators (dose (92%), timing (92%), duration (40%), respectively; no reported adverse effects.
Estimated savings: $1,200 pa for low molecular weight heparin; $15,000 if cost of other anticoagulants and monitoring were included.
Review outcome: study highlighted evolving evidence on use of LMH. Guidelines reviewed in association with orthopaedic, neurology and transfusion service; included recommendation for use of anti-thromboembolic stockings for orthopaedic patients. Protocols adopted in respective units.

Table *1 continued...*

Large volume IV fluids (1992)
Review type: descriptive; no audit criteria; non-interventional.
Aim: to assess pattern of use of large volume (ie. greater then 100 mL) intravenous (IV) fluids either as fluid (and electrolyte) replacement, plasma expanders, as carrier vehicles for drugs and associated complications.
Method: Concurrent review; over 5 weeks, patients randomly selected from medical, surgical, orthopaedic, medical and radiation oncology, burns unit, ICU and neurosurgery wards; non-interventional; parenteral nutrition fluids (TPN) excluded; demographic and clinical data recorded; availability of oral route; indication; fluid type; packs per day; type of administration (continuous or intermittent) volume per day; IV additives; complications also assessed.
Results: 102 (26.9%) of 379 patients reviewed on IV therapy; 100% of ICU, 21% medical, 24% surgical, 82% oncology on IV respectively; 2082 bags of fluid costing $2982 were used during review (sodium chloride 0.9% (64.5%; $1664 (55.8%)), glucose/saline (21.5%; $420 (14%)), Haemaccel™ (2%; $642 (21.5%)); sodium chloride 100 mL accounted for 858 bags (41.2%; $1200 (40.2%)) and was mainly used for administration of IV antibiotics or for 'keeping lines open'. Medical wards, the ICU and oncology wards accounted for 31.7%, 23.6% and 16.9% of total bag use respectively. Haemaccel was used most often in the ICU (53.3%) and sodium chloride 100 mL in medical wards (44.6%). 46.1% of all patients on IV fluids only, rest on IV and oral fluids; 82.4% of IV therapy was administered continuously; average duration of IV therapy = 8.2 days, average inpatient stay for same patients = 15.3 days; all patients on IV had fluid balance chart, 10.8% were incomplete; biochemistry ordered for 89.2%; 52% weighed at least once during hospitalisation. Most common indications for IV therapy were fluid replacement (28.3%) and drug therapy (39.2%; chemotherapy 17.6%, IV antibiotics; 21.6%); 50% of patients received IV additives (eg. potassium, magnesium). 9 (8.8%) patients reported complications associated with IV therapy, including pain (25%), bacteraemia (5%), skin reactions (15%).
Conclusion: IV fluids are widely used throughout the RAH. In many cases IV fluids were used when patients were taking oral fluids. Large usage of sodium chloride 100 mL and Haemaccel solutions was evident and is probably excessive; these fluids are significantly more expensive than large volume (ie. 500 and 1000 mL solutions) crystalloid solutions. Use of alternative solutions and use of IV fluids only when the oral route was not available would significantly reduce fluid use and corresponding costs and the incidence of complications.
Review outcome: Results provided to Drug Committee. No recommendations about how to tackle problem on a broad scale; defer for future consideration

2. OTHER RESULTS

Some specific findings from the above studies presented according to general process parameters are provided below. This format highlights certain findings which provide insight into major issues of qualitative use of medicines at the RAH. The findings exemplify aspects of drug use which have been consistently identified during the various review activities. Some results have also been described in previous chapters

Table 2 Summary of selected DUE study findings highlighting sub-optimal aspects of drug use (Note: Groups are not mutually exclusive)

Indicator: Was drug therapy required ?		**Estimated savings:**
ceftriaxone	14% of patients surveyed had no evidence of infection	$10,600 pa.
Augmentin™	9% of patients surveyed had no evidence of infection	$600 pa.
norfloxacin	22% of patients had no evidence of infection	$1,100 pa.
octreotide	efficacy in healing of post-surgical non-pancreatic fistulae unproven	$3-500 per patient per week
omeprazole	role of omeprazole versus surgery in selected patients with severe oesophagitis questioned	$80-320 per patient per month
tissue plasminogen activator	60% of patients did not meet audit criteria for use of drug	$1,350 per course
Indicator: Was choice of drug appropriate ?		**Estimated savings**
topical thrombin powder	no demonstrable benefit over saline soaks in wound care	$30,000 pa.
ceftazidime	23% of patients did not have Pseudomonas infections where aminoglycosides were contraindicated or where resistance had been demonstrated	$6,000 pa.
ceftriaxone	40% of patients could have had alternative (less expensive antibiotics)	$30,000 pa.
vancomycin	should only be used for MRSA or other resistance demonstrated	$6,000 pa.
Augmentin	• Less expensive, equi-effective antibiotics could have been used in 40% of patients. • 6% of patients received Augmentin when history of penicillin hypersensitivity was present	$8,000
norfloxacin	Less expensive, equi-effective antibiotics could have been used in 27% of patients.	$7,000
colorectal surgical antibiotic prophylaxis	75% of patients could have used metronidazole, tinidazole, gentamicin in preference to cefoxitin.	$50,000 pa.
methylprednisolone	no proven advantage over oral dexamethasone in acute myeloid leukaemia	$30,000 pa.
omeprazole	should only be used for patients unresponsive to adequate trial of H_2 antagonist therapy	$50-200 per patient per month

Table 3 continued...

Indicator: Drug regimen appropriate ?	
ceftriaxone	• 1g versus 2g dosage - 5% of courses inappropriate. • single versus 2 or more daily doses - 40% inappropriate. • excessive duration of therapy - 27% of courses. • other inappropriate process indicators - 45% of courses
colorectal surgical antibiotic prophylaxis	• 45% of patients inappropriate process indicators: dosage, duration of therapy. • 15% of patients under-treated
acyclovir	• unnecessary use of IV therapy in immunocompetent patients. • unproven HSV infections treated for more than 5 days
vancomycin	• 20% of 'treatment' courses and all prophylaxis courses exceed recommended duration. • unnecessary use of 250 g dose (instead of 125 mg) for antibiotic associated colitis
norfloxacin	47% of courses meeting indication criteria failed process criteria (administration times, duration of treatment)
Indicator: Were drug administration / consumption appropriate ?	
metronidazole	72% of intravenous therapy courses could have been administered by the enteral route.
acyclovir	• IV used instead of oral treatment in immunocompetent patients. • some doses given 3 x day instead of 5 x day (ie. under- treatment)
vancomycin	IV vancomycin given for *C difficile* colitis when it is known that secretion does not achieve sufficient levels in gut lumen. some doses infused over less than I hour - reports of hypotension and 'red man syndrome'
aminoglycoside	69% of patients did not receive loading doses
tinidazole	30% of prophylaxis doses administered more than 15 hours before surgery
metronidazole	• rectal doses given more than 4 hours before surgery. • some prophylactic doses given post-surgery
norfloxacin	25% of doses administered with food

3. DISCUSSION.

The qualitative component of the RAH DUE program has provided objective information about the pattern and quality of the use of certain drugs at the RAH. Criteria audits have given the best indication of specific problems. Comparison of ward practices with explicit criteria, combined with expert clinical evaluations, provide the most informative assessments. This combination establishes DUE as a peer review activity rather than a simple audit tool.

Treatments classified as inappropriate only by comparison with audit criteria always leave a doubt as to whether all clinical factors had been taken into account. When evaluations do not involve a relevant clinical specialist, or subtle clinical findings are not immediately evident to investigators from documentation, certain results may be dismissed by user groups as being invalid or incomplete. Thus, the value of a clinician reviewing 'doubtful' courses is that when an 'inappropriate' or 'unnecessary' assessment is made, the determination is based on audit criteria and relevant clinical standards. Consequently, the results are more difficult to dismiss.

The value of DUE in delivering objective information should not be understated. Often a doctor's belief of how he/she practises does not correspond with objective assessment. However, without

objective evidence, it is not easy to convince prescribers that their practices can be improved. Conversely, if objective evidence of poor utilisation is provided constructively and in a non-punitive environment, change is more easily effected. Different approaches may be required when inappropriate use occurs on a wider scale or when certain difficulties arise (eg. vancomycin review).

In my experience, DUE findings were generally viewed constructively and recommendations were supported by the general hospital prescribing community. In the occasional instances where improvements were not evident following re-evaluation (eg. norfloxacin), administrative actions were necessary to effect changes.

Failure to show improvement in utilisation from general education measures following DUE activities was explained in part by the movement of medical staff throughout the hospital. Clinics responsible for unnecessary or inappropriate use were generally consulted following each review. Junior medical staff were generally happy to comply with recommendations, except when they were under different general direction from senior staff. However, with junior medical staff rotations occurring every 3-6 months, staff involved in the initial review process regularly moved to other clinics where different protocols may have been in place. New staff would often be unfamiliar with specific Drug Committee recommendations regarding particular practices. Consequently, if special instruction or supervision was not given by senior staff, sub-optimal practices would resurface over time and become evident by the time of the next review.

Correspondingly, the most effective changes in utilisation occurred when the relevant senior staff took responsibility for the results of the review (eg. cefoxitin). Consultant staff are in a position to 'dictate' policy to house staff. When protocol changes are implemented from the 'top', immediate effects on utilisation are demonstrable. Such effects are often permanent, require little reinforcement or monitoring and remain in place until protocols are changed (eg. DOFMS review).

For this reason, there has been an emphasis on providing continuity of access to usage guidelines by placing guidelines in the RAH Formulary . The Drug Committee has also provided the VMPF Antibiotic Guidelines free of charge to all interns, residents and registrars in an effort to improve antibiotic prescribing in the broad context. In other instances, administrative control measures (eg. required consultations or restricting prescribing of drugs to certain clinics) have been implemented to reduce inappropriate prescribing.

Certain findings (eg. unnecessary use of antibiotics) have not been dissimilar to literature reports. In all instances, review results were compared with similar studies from the literature, mostly from the US or Canada. Such comparisons demonstrated that the RAH program was at least equivalent to any program under way in those countries. Importantly however, these comparisons also showed that problems with drug utilisation are common to hospitals over the world. Correspondingly, methods to investigate, correct and monitor the impact of changes are also similar.

In other instances, the methods applied at the RAH have differed from the majority of those described overseas. This is most apparent in 2 areas. Firstly, in the US, most DUEs do not assess the indication for use or the need for a drug (18). They often assume the need and indication for a drug is appropriate. The focus of efforts are at the process indicator level (eg. dose, duration, route, administration and TDM). Secondly, the inquiry into outcomes as a measure of quality use of medi-

cines has only become evident in recent times, particularly since the advent of activities in 'pharmaceutical care' (1-5).

My activity in this area has been consistent with recent US experience, focussing on patient outcomes as well as other measurements of drug utilisation. Importantly also, I have attempted to include measurements of the clinical and outcomes of particular intervention strategies (eg. ceftriaxone, vancomycin, colorectal surgery prophylaxis). Examination of these indices has not demonstrated deterioration in any aspect of care resulting from changes to (often less expensive) drugs therapy compared with practices in operation previously.

This chapter has shown that a range of methods can be used to assess the success or otherwise of corrective actions resulting from review findings. Reductions in expenditure may be used as a measure of improvement (eg. cefoxitin review). This becomes most useful when drugs are no longer used (eg. thrombin topical powder or r-tPA).

Other more subtle alterations can have similar effects. For example, a reduction in the average duration of therapy by 1 day (for a relatively inexpensive but widely used drug) may have significant financial repercussions (eg. ceftriaxone).

Monitoring expenditure alone may mask improvements in utilisation. For example, vancomycin and ceftriaxone expenditure has increased over the years but when use was examined more closely, improvements in usage were noted compared with previous reviews. With ceftriaxone for example, when the cost of inappropriate use as a percentage of total expenditure was used as a measure of utilisation, improvements were evident.

For other reasons, cost should not be the sole measure of improvements in the quality of use. When sub-optimal therapy is due to under treatment (eg. acyclovir review) there is more wastage (and therefore cost) associated with poor treatment than with correct treatment. In the acyclovir review, wastage from lower than recommended doses was estimated at $10,000, whereas correct treatment would have only cost an additional $7,000. Correct dosage may cost more, but savings perhaps can be measured in terms of improvement in rates of recrudescence or readmission. The latter premise however, has not been tested.

Assigning causality directly to the DUE process has been difficult because of the many factors that can influence the way drugs are used. In the dynamic and continually changing clinical environment of the RAH - where patient mix, procedures, medical, nursing and pharmacy staff change regularly - it is not always possible to attribute changes (positive or otherwise) to drug policy initiatives. To compound matters, the 'playing field' also changes with time. Guidelines or recommendations for the use of a particular drug or for disease management, change as new information becomes available. A recommendation applicable during one review, may not be applicable during subsequent reviews. Although it is important to review guidelines regularly and ensure that they reflect current therapy trends, care should be taken to identify where apparent changes in utilisation reflect changes to criteria rather than changes to practice.

In some instances, application of criteria to assess treatment is insufficient to properly assess quality. An assessment of patient response to treatment may also be warranted. Modification of drug choice or dosage regimens may be appropriate when faced with unexpected or inadequate patient

response. Initial use of high intensity or more expensive regimens in simple treatment cases should be discouraged. However, some criteria should accommodate changes in treatment based on objective outcome assessments.

One element in this milieu does however remain constant. This is the utility of DUE as a tool to measure the quality of drug use and identify where the utilisation process is sub-optimal. Many aspects of drug use, for many drugs studied, did not meet locally produced audit criteria or other best practice guidelines. In all cases, these findings provided valuable insight into which aspects of the drug use process education or other remedial actions should be targeted.

4. SUMMARY

Many types of reviews for many drugs have been described in the preceding pages. Different methods have been used to examine different elements of drug use. Activities have ranged from reviews of aspects of use of selected drugs through to expansive reviews of drug groups. Most often, DUEs have involved a comprehensive examination of many aspects of drug use. Assessments of 'whether a drug was needed in the first place ?' through to measurements of clinical outcomes, have been made. Some drugs have been revisited several times over the years.

DUE methods have been explored for single drugs, drugs in the management of a single disease, drug components of a procedure, and the influence of procedures on the use of drugs. Sampling has included all of a specific patient type, all patients with a specific disease, all patients receiving a specific drug and random or 'snapshots' of a broader patient population.

The quality of drug use found by the various studies was variable. For most drugs studied, appropriate use was noted in 50-75% of patients by one or more criteria assessed. However, for many drugs, evidence of misuse was worrying.

Some drugs (eg. H_2 receptor antagonists) were generally found to be used for the right reasons. For other drugs (eg. antibiotics, r-tPA), the indication for drug use was questionable. Other common findings associated with drug misuse included:

- antibiotics used when there was no objective evidence of infection;
- unnecessary use of expensive antibiotics (eg. norfloxacin);
- excessive drug dosage or frequency of administration (eg. Augmentin™);
- inadequate dose or frequency of administration (eg. acyclovir);
- prolonged duration of therapy (eg. surgical antibiotic prophylaxis);
- unnecessary use of IV therapy (eg. metronidazole);
- drugs administered when patients had prior history of hypersensitivity (eg. Augmentin™);
- inappropriate route of administration (eg. IV vancomycin for *C. difficile*);
- poor awareness of drug interactions (eg. norfloxacin given with food);
- failure to consult hospital or other guidelines before commencing empirical antibiotic treatment;
- failure to change therapy despite objective evidence that alternative, less expensive therapy was warranted (eg. blood culture review);
- inappropriate use of plasma concentration monitoring (eg. aminoglycoside review);
- failure to modify therapy despite inadequate patient response.

Interestingly, despite this 'misuse', adverse patient outcomes directly attributable to drug therapy were not common.

In most instances, poor understanding of general prescribing principles for antibiotics or other drugs was thought to be the main reason for inappropriate use. To this end, educational interventions were commonly used to enhance prescribing. Other strategies included:

- user feedback with recommendations for improvements to prescribing;
- promulgation of audit criteria guidelines for general consumption;
- verbal presentation of findings at clinical meetings;.
- review of criteria in association with user groups, in an effort to educate clinicians in the DUE process and in rational therapeutics;
- formulary or other procedural controls (eg. required consultations);
- administrative measures (eg. restricting availability of certain drugs to inpatients only).

Total savings offered by correction of this misuse were estimated in excess of $300,000.

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CHAPTER 22

A PUBLIC HOSPITAL DRUG UTILISATION DATA COLLECTION FEASIBILITY STUDY

1. INTRODUCTION

Studies of drug utilisation in public hospitals are generally performed at the local level. Quantitative or qualitative measures of drug use are undertaken to assist hospitals, drug committees and pharmacists in establishing usage patterns and identifying potential areas of concern. In the community context, drug utilisation data can assist in achieving a number of objectives. Data can be used to monitor the progression of drugs from the hospital setting into the community and the effects of drugs on the natural course of disease. In particular, studies of drug utilisation may indicate how actual drug usage patterns deviate from the indications for which they were originally developed and studied for approval by regulatory authorities. To satisfy these objectives, accurate information on prescribing and drug utilisation patterns must be available. This includes utilisation within the public health system in general and public hospitals in particular.

This project arose from a concern over a lack of centralised information on individual drug use from the public hospital system. Correspondingly, the aim was to investigate the feasibility of establishing a comprehensive, central database for routine collection and reporting of individual drug usage data from public hospitals.

2. BACKGROUND

Total expenditure for Australia's public hospital system is estimated at approximately $12 billion. Drugs and pharmaceuticals account for approximately 3% ($340 million) and approximately 16% of total non-salary costs (1). Expenditure for a range of highly specialised drugs alone is estimated to be over $50 million (2). A complete data set for Australia - which would include PBS, private prescription and public hospital drug statistics - would provide a useful perspective on prescribing patterns and allow meaningful comparisons of Australian drug utilisation with other countries (3,4,5,6,7). Except for aggregate figures maintained by some State and Commonwealth authorities, almost no information about public hospital drug utilisation is accessible from centralised databases.

Successful models for routine collection of drug use data are described in the literature. They include the Australian PBS/RPBS project coordinated by the Commonwealth Drug Utilisation Subcommittee (DUSC), the Medicaid drug utilisation review project recently established under the American Federal Omnibus Reconciliation Act 1990 (8,9,10,11,12,13,14), the Nordic Council of Medicines (13), and the Florida Medicaid Program (16). There has been no published assessment of the feasibility of establishing such a model for public hospital drug data in Australia.

The issue of lack of Australian public hospital drug utilisation data is not new. In 1984, Plumridge (3) noted an urgent need for State health authorities together with health professional bodies to establish useful and comprehensive databases to aid in assuring rational and cost-effective drug ther-

apy. In 1989, Hurley (4) stated that Australian drug utilisation data were completely inadequate for epidemiological purposes. These criticisms applied to both PBS and hospital reporting. The Commonwealth (19) has also recommended the creation of pharmacoepidemiological databases to improve the scientific understanding of drug use and outcomes, to assist in the monitoring of adverse drug reactions, and to evaluate alternative methods of providing drug services.

3. EXISTING DATA

3.1 Surveys

A survey of cardiovascular drug use in Australian hospitals was conducted by the Society of Hospital Pharmacists of Australia (SHPA) and the Australian Institute of Health (AIH) in 1990 (20). Survey objectives included determination of the availability of computer information systems in hospital pharmacies and estimation of the total use and expenditure for a range of cardiovascular drugs. The results indicated that many pharmacies were able to provide detailed drug utilisation information at an agency level and that some of this information was available from computer systems. These findings were confirmed by my project which also demonstrated that although utilisation information was contained within computer applications, the information was disparate in format and not easily accessible.

The Australian Society of Microbiology has conducted limited surveys of antibiotic use in Australian hospitals during 1986 and 1991. This information is presently being analysed and may be published in 1997 (21). The SHPA National 'Casemix' Study (22), has generated a 'snapshot' of information regarding drug usage in Australian hospitals. This study is ongoing, remains unpublished, and has achieved only limited circulation to date.

3.2 Commonwealth data

3.2.1 Hospital Utilisation and Costs Study (HUCS)

The Hospital Utilisation and Costs Study 1991-92, provides published aggregated information for salary and non salary costs for public hospitals. Data describe 'macro' drug and other hospital expenditure figures for each State, provides totals for Australia and are collated following annual receipt of data from State and Territory health departments.

Data are presented in aggregated form, separated for States and are organised by major hospital classifications for each State and Territory. Drug utilisation data are tabulated under the section titled *Average Annual Recurrent Expenditure - Non Salary* and are expressed as dollars per 1,000 population.

Departments submit data 6 to 9 months following the close of the financial year. The cumulative Australian data set is not published for a further 12 months. The level of detail and the associated lag time before information becomes available limits the use of this data.

HUCS data must also be interpreted cautiously due to rapid changes in health system structures (eg. closing of hospitals or transfer from Commonwealth to State jurisdictions). Drug and other data are also limited by the quality and consistency of data submitted by respective health authorities. Average drug utilisation figures for similar hospital types vary widely between States. This indicates either incomplete data, differences in hospital classification systems, or differences in definitions of

drug expenditure within and between States. In addition, the HUCS does not contain a complete data set for public psychiatric hospitals, so figures understate drug expenditure by this sector.

Individual hospital data are maintained in the HUCS database but are not generally available or published. Unpublished data cannot be released until approval has been obtained from individual State health departments and/or individual hospitals respectively. For my study, 1993/94 drug expenditure data for NSW and Queensland were obtained following a special extraction request. The published report was used to establish denominator figures for hospital types and average bed numbers for all States.

3.2.2 Drug Utilisation Sub-committee (DUSC)

The Commonwealth Drug Utilisation Subcommittee (DUSC) maintains and publishes the Australian Statistics on Medicines (ASM). This publication summarises information from PBS and RPBS benefit prescriptions processed by the Health Insurance Commission. Utilisation statistics for private prescriptions obtained through sampling approximately 300 Guild pharmacies across Australia, are also reported. The database does not collect information for prescriptions from public hospitals or for over-the-counter medications.

3.2.3 Department of Veterans' Affairs (DVA)

There has been substantial restructuring of the hospitals which previously were under the jurisdiction of the Department of Veterans' Affairs (DVA) in recent years. At the time of preparing this report, all but one of nine previously DVA hospitals had been either subsumed by State health departments or had been privatised. As a result, drug and other utilisation data obtainable from the Department are limited. Complete, aggregate drug utilisation figures for all previously classified DVA hospitals are available up to 1992-93.

In the future, data for DVA hospitals which have transferred to State authorities will be collated in HUCS reports but under headings other than DVA, making historical comparisons difficult. DVA patient data will still be available to the Department but general access to data is limited due to privacy considerations. These data will be captured by DUSC. Data for non-DVA patients, including DVA hospitals now under private management, will be lost to HUCS (and other public hospital databases) but should be sampled through the Guild survey process described previously.

3.2.4 Therapeutic goods administration (TGA)

3.2.4.1 Register of Therapeutic Goods and Devices

Drugs and therapeutic devices are classified as therapeutic goods under the Commonwealth Therapeutic Goods Act 1989 and regulations to the Act. They cannot be supplied in Australia until there have been included in the Australian Register of Therapeutic Goods (ARTG) or are exempt goods under the Act. These registers include descriptive information for the listed or registered drugs but do not contain utilisation statistics.

3.2.4.2 Trial Drugs

Data for investigational and trial drugs are maintained by the Therapeutic Goods Administration. A register detailing importation and distribution of non-approved drugs is maintained by the Department. In addition, clinical trial sites must maintain detailed information concerning trial drug receipts and issues as a requirement of National Medical Health Research Council (NMHRC) Code of

Clinical Trials Practice. Such information is subsequently utilised in the evaluation and approval process for the respective drugs. However, information is "commercial in-confidence" and data are not available outside the relevant departments or trial sites.

3.2.4.3 Antibiotic Import Data

Data for antibiotic imports into Australia are maintained on behalf of the NHMRC by the chemistry section of TGA. Gross tonnage figures (for both active raw materials and pre-packaged formulations; already labelled or ready for label) are available for all antibiotic groups. These data are further stratified into antibiotics imported for human use, veterinary use and for use in animal stock feeds. The data are applied in epidemiological research in an effort to gain a better understanding of the impact of gross usage of antibiotics on the antimicrobial resistance patterns of bacteria and other pathogenic organisms. These data are not disaggregated to descriptions of individual products or points of distribution. Therefore, such data are not useful for describing hospital drug utilisation patterns. Data on individual antibiotics and aggregated data for antibiotic classes are available by special request to the TGA or the NMHRC Expert Panel on Antibiotics.

3.2.5 Highly Specialised Drugs Working Party

A small range of expensive drugs come under the jurisdiction of the Highly Specialised Drugs Working Party (HSDWP) of the Commonwealth Department of Health and Family Services. Drugs include:

- clozapine
- cyclosporin
- desferrioxamine
- didanosine
- erythropoeitin
- filgrastim
- fluconazole
- foscarnet
- ganciclovir
- interferon
- zalcitabine
- zidovudine

The total expenditure for these drugs in 1993-94 was approximately $56.5 million. Special funding for these drugs is provided by the Commonwealth to the States under Section 100 provisions of the Pharmaceutical Benefits Scheme (PBS).

States/Territories are required to submit regular acquittal statements to the Commonwealth describing utilisation of these drugs. These annual figures form the basis for continuation of funding and State reimbursement. To date, statements have been required at least 6-monthly. The recommendation by the Working Party in May 1995 was that the acquittal statements be provided quarterly and be lodged not later than three months following the end of each quarter.

Data reported by States include information on the number of units issued, the number of patients treated and the total cost of items distributed under these provisions. State health departments maintain more detailed data including hospital identifiers and some treatment indication data, but these are not currently reported to the Commonwealth.

The present Commonwealth proposal is to determine whether treatment is cost-effective by collecting individual patient indication, dosage, monthly treatment costs and therapeutic outcome data. This is to be achieved for a sample of drugs each year with all Section 100 drugs being reviewed over a 3-year period. Data of this nature would be the most comprehensive of any data maintained centrally for any group of drugs in Australia.

3.3 State/Territory data

3.3.1 Disaggregated data

3.3.1.1 General

Of all States and Territory health departments, only Queensland - under a central purchasing system together with a central Formulary - maintains accessible records for utilisation of individual drugs in addition to those covered under Section 100 provisions of the PBS. Purchase data for individual drugs and hospitals are maintained in a central database. Information is available to government departments and contributing hospitals. Special requests for data are considered on a case basis with release of data being at the discretion of the Department.

South Australia, through its State Supply Tender system, also accumulates purchase information from public hospitals for drug items available on government tender. These items account for approximately two-thirds of drugs and pharmaceuticals used by the public hospitals. Information for non-contract items is not available. Information includes aggregated purchase figures for each of the major metropolitan hospitals and larger country centres, together with State totals. Data is collated for individual drug products and includes units purchased and corresponding cost and expenditure figures. Utilisation information is maintained as "commercial in-confidence" and is not available except to participating hospitals at the time of tender contract negotiation.

Victoria, through the Victorian Hospitals Association Trading Company (VHA Trade), also operates a predominantly centralised purchasing system for public hospitals. This information however is not generally available due to contractual arrangements between VHA Trade and IMS (see Section 3.4).

Aggregated data from the State sources are not directly comparable and should be interpreted with caution. Definitions for expenditure categories, including drugs, differ within and between States. It is difficult to ascertain the detail which comprise the various figures. Moreover, the quality of data provided to State health departments or Commonwealth authorities is very much dependent on the quality of hospital information systems and information definitions. In addition, different databases are often used to obtain different data elements and cross-checking of data often reveals inconsistencies. For example, in a number of instances, data I obtained from centralised sources failed to match similar data obtained directly from hospital pharmacy or finance departments.

3.3.1.2 Controlled Substances

Detailed data for individual drugs classified under the relevant Controlled Substances Act are maintained by all States and Territory health departments. These Acts govern opiates, amphetamines and other substances of abuse. Legislative requirements for monthly acquittal statements by hospitals and community pharmacies result in very detailed data for these drugs. This includes information on drug names, form and strength, the number of units supplied, patient numbers, name and address details and details of the prescribing doctor. These data are not generally available outside the respective State or Territory health departments. Since these data are relatively consistent between States, the Commonwealth could conceivably come to an arrangement with the States to obtain access to aggregated information from these databases. To date this has not been done.

3.3.2 Aggregated Data

3.3.2.1 Queensland, South Australia and Victoria

Aggregated drug utilisation data for individual hospitals are available from published sources for Queensland, South Australia and Victoria in:

- Rainbow Hospital Indicators, Victorian Hospital Comparative Data 1992/93 - 1993/94;
- South Australian Public Hospital Summary Activity Statistics, 1993/94 (SAHC - Blue Book);
- Queensland Public Hospitals Residential and Related Facilities Finance and Activity 1992/93 and Queensland Acute Public Hospital Summary Activity Statistics 1990/91 to 1993/94.

These publications describe hospital activity, revenue, drug and non-drug expenditure, for all public hospitals in the respective region. Only the Queensland and South Australian publications include expenditure for psychiatric hospitals. Information for nursing homes is variable. Each of the respective documents is available within six months of the completion of the financial year. This timing generally corresponds to the time of submission of hospital activity and financial data to HUCS. As such, they represent an interim data source while awaiting publication of national figures.

3.3.2.2 Tasmania, ACT and Northern Territory

Other States and Territories do not have public documents which detail drug utilisation or other hospital activity figures. Some information may be obtained from the Annual Reports of individual hospitals for hospitals which have a Board of Directors but these reports are not easily obtained.

Data for Northern Territory and the Australian Capital Territory are readily available by contacting the respective health departments. By contrast, in Tasmania, data are not maintained by the Health Department, but may be requested directly from Pharmacy Departments or Finance Departments of the individual hospitals.

Western Australia and New South Wales operate decentralised health systems comprising thirty or more regional health authorities. The respective Departments of Health do not maintain centralised drug expenditure data for these regions or for individual hospitals. These regional centres supply aggregated data to the HUCS database but do not make data available to other groups. Information on drug expenditure is thus more easily obtained from HUCS rather than the regional authorities. Release of this information from HUCS, however, is subject to approval as described previously (see Section 3.2.1).

3.4 Industry data

3.4.1 IMS (International Medical Statistics) Australia Pty. Ltd.

IMS Australia collects drug utilisation data for both retail and hospital sectors. The Australian Hospital Index (AHI) is a survey of sales of medical products including drugs to hospitals. The AHI data are combined from direct sales, distributor sales and a sample of hospital purchases. These data are used to make market projections and are reported for subscribers in a number of formats.

AHI data are available to subscribers in printed form, on computer disk or 'on-line'. Data are generally only available to subscribers (manufacturers and wholesalers) and are subject to commercial confidence. Any release of data to non-subscribers requires prior written request and subsequent consent of subscribers within any markets encompassed. General or group data are usually avail-

able, including group market information (eg. IMS, Therapeutic Categories), or data requested by molecule (eg. amoxycillin).

A number of Australian hospitals contribute purchasing information for individual drug products to the AHI for which they receive remuneration from IMS. IMS process these data and provide quarterly summaries back to the respective hospitals. These reports are classified by product, products within a therapeutic class and products within manufacturer. Drugs are usually described by trade name in reports although the AHI also contains generic name data. The use of trade name and manufacturer information reflects the different application of the utilisation figures reported (eg. marketing and promotion) compared with that proposed for the current project.

The major limitation of the IMS data is their limited availability to non-subscribers. In addition, IMS will not indicate the extent of the data sample which is reported. Projections for States and for Australia are made from these samples according to the statistical calculations performed by the parent company. No information is available concerning the basis of these projections. Data therefore must be used and interpreted with caution.

3.4.2 Victorian Hospital Association Trading Company (VHA Trade)

VHA Trade is the major supplier of drugs and pharmaceuticals for Victorian public hospitals. Its operation is highly computerised and so VHA databases contain comprehensive data for drugs purchased by the Victorian public hospitals. However, VHA Trade currently has contractual obligations with IMS which prevent the provision of trading data to parties other than the manufacturers themselves, and to IMS.

3.5 Other data

3.5.1 The Melbourne Teaching Hospitals Group (MTHG)

The Melbourne Teaching Hospitals Group comprises representatives from Pharmacy Departments, Departments of Clinical Pharmacology and hospital Drug Committees from Melbourne's teaching hospitals. The group meets regularly to review issues of drug policy, funding and access to specific drugs. Periodic reviews of drugs or drug groups are undertaken when information regarding specific aspects of drug utilisation are of interest. The MTHG has access to a range of information through its contacts in the major teaching hospitals. This includes drug usage data and the results of drug usage evaluations. The group, however, lacks the resources to undertake regular review or general reporting for even a small group of drugs. Thus, drug utilisation statistics of the type proposed by this project are not available.

3.5.2 South Australian Drug Usage Advisory Group (SADUAG)

SADUAG is similar to the MTHG and is comprised of representatives from metropolitan public hospitals, hospital Drug Committees and the SA Health Commission. The Group meets regularly to consider common issues of drug policy, drug availability, access, and other matters. The Group does not collect drug utilisation statistics.

3.5.3 The New South Wales Therapeutic Assessment Group (NSW-TAG)

The NSW-TAG also comprises representatives from major teaching hospitals, Drug Committees, departments of clinical pharmacology and health authorities. This group is partly resourced by the New South Wales Department of Health and was formed to encourage and promote rational and

cost-effective drug use. The major activity of this group is to develop consensus position statements on particular drugs or drug groups. The NSW-TAG also collects utilisation data for a small group of expensive drugs used for a variety of indications by participating and affiliated hospitals:

- botulinum toxin
- cyclosporin (non-transplant)
- filgrastim
- ganciclovir
- the interferons
- lenograstim
- molgramostim
- nimodipine
- octreotide
- paclitaxel
- tissue plasminogen activator

Information collected for this range of drugs includes indication for use, number of patients and accumulative drug expenditure. Information is provided for each contributing hospital. This information is confidential and is only available by special request from the NSW-TAG. Information for other drugs is generally not available.

3.5.4 NSW Public Hospitals Goods and Services Index

The NSW Public Hospitals Index was developed for the NSW Department of Health to measure movements in the cost of goods and services supplied to NSW public hospitals. The index comprises a sample of sixty hospitals including all teaching hospitals, and a geographic spread of hospitals throughout metropolitan Sydney and country NSW. Information is obtained to compile a set of weights and list of items for construction of an index for most categories within the Chart of Accounts. This index includes drug price information (rather than utilisation figures) for approximately sixty drugs and pharmaceuticals available in NSW hospitals. These data are collected at regular intervals over financial years to establish price movements over time which are compared with movements in the consumer price index. Data for aggregated or individual drug expenditure are not available.

4. PROJECT AIMS

Data of the types described above represent only a small sample of drug use in the wider public hospital community. They are clealy not able to describe broad drug utilisation patterns and information for individual drugs is even more limited. My research arose from concern over this lack of drug utilisation data. My aim was to investigate the feasibility of establishing a comprehensive, central database for routine collection and reporting of individual drug usage data from the public hospital system. The project was funded by a grant from the Commonwealth Pharmaceutical Benefits Scheme Education Program and was undertaken from July to November 1995:

The overall objectives of this project were to:

1. review the type and extent of drug utilisation data available from public hospitals;
2. obtain and test pilot data;
3. provide recommendations for data formats;
4. prepare a cost analysis for the establishment of a centre to collect data.

5. METHODS

The project involved 3 phases. The first involved a survey to characterise the type and extent of drug utilisation data currently available from public hospitals. The second phase involved obtaining

data from several hospitals to undertake sample data modelling and reporting. The final phase of the project was to determine the logistical and cost considerations for establishing a centre to collect drug utilisation data for public hospitals routinely.

5.1 Public hospital survey

A survey (Appendix 4) was distributed to determine:

- the extent of computerisation of hospital pharmacy departments;
- the type of information available from computerised systems;
- the reporting capabilities of these systems;
- the data formats and coding systems available from these systems;
- the availability of demographic information to assist in interpreting hospital drug usage figures.

The mailing list for questionnaires was determined primarily from the SHPA Resource Directory 1994-1995 combined with a hospital index list provided by the then Commonwealth Department of Human Services and Health. Survey forms were distributed with a covering letter, a project information sheet, a self-addressed envelope, and a facsimile cover sheet. If questionnaires (Appendix 5) had not been returned within one month, a second request for survey data was made by phone/fax.

When the project began, an information sheet was circulated to State health departments, relevant professional bodies (VDUAC, NSW-TAG, ASIG, ASCEPT, DUSC, SADUAG - *see list of abbreviations at front of thesis*) and all public hospital pharmacy departments (via the SHPA Newsletter).

5.2 Sample data

The objectives of obtaining sample data were to determine the problems inherent in combining data from different hardware and software platforms and to prepare report formats consistent with the ASM. The minimum data fields requested were: generic name; strength; dose form; number of units purchased/issued for the period; and the corresponding cost of purchase/issue for the period.

Following the return of surveys, selected hospitals were approached to provide pilot data for the project. Purchase and/or issue data for antibiotics for the period April 1 to June 30, 1995 were requested in ASCII or other format (eg. XBase, MS Excel). Separation of utilisation figures into different patient types (eg. inpatient, non-inpatient) was requested together with an indication of whether data represented drug purchases or issues. Information regarding file type, field delimiter used, field structure, field length and offset was requested to assist data parsing. Hospital activity/demographic data were also requested.

5.3 Data analysis

Data were parsed using MS Access and MS Excel with the assistance of a contract computer consultant. Visual Basic Application Code (VBA) and MS Access and MS Excel macro languages were used to extract specific components of submitted records. Wherever possible drug codes or drug descriptions were matched to ATC, SHPA, PBS and AHFS codes for reporting purposes. Maps for SHPA to ATC, and PBS to ATC codes were provided by the DUSC. Utilisation data were ultimately converted to mass units and expressed as Defined Daily Dose (DDD) per 100 occupied bed days or per 100 occasions of patient service, depending on nature (purchase versus issue) of submitted data. Report formats developed were based on those published in the ASM (Inclusion E).

Computer platforms included 486 DX 66 IBM compatible computers operating under Windows for Work Groups™ 3.11 and MS-DOS 6.22. Hospital data were coded so as not to identify participating hospitals. Data were encrypted to prevent unauthorised access. Data back-ups were maintained on streaming tape and were stored off site for security purposes.

6. RESULTS

6.1 Phase 1 - Public Hospital survey

6.1.1 Demographic data

The best estimate I was able to derive for the number of public hospitals in Australia was 684. This figure underestimates the actual number of hospitals as not all figures for psychiatric hospitals, government funded nursing homes, small rural health centres or outpatient centres were available. The combined estimated average bed and drug expenditure figures from those available were 64,706 and $450 million respectively. The overall average per bed expenditure was $6,953.

New South Wales had the most public hospitals and the largest drug expenditure followed by Victoria, Queensland, Western Australia, South Australia, Tasmania, Northern Territory and the Australian Capital Territory. Teaching hospitals accounted for the largest proportion of hospital beds and drug expenditure with New South Wales having the largest number of teaching hospitals. The Territories have no teaching hospitals (Inclusion A).

6.1.2 Returns

Two hundred fifty two hospitals were surveyed, representing 36.8% of all public hospitals in Australia. Replies were received from 165 (65.5%) surveyed hospitals of which 164 (65.1%) were eligible for analysis. The one survey not included in the data analysis was a private hospital which was sent a survey questionnaire in error. Two other hospitals returned questionnaires unanswered but were still included in the results. Questionnaires were returned by 84.6% of all teaching hospitals surveyed, 58.5% of other metropolitan hospitals and 62.1% of non-metropolitan hospitals. These represented 84%, 58.3% and 79.9% of total (for Australia) estimated available beds and 75%, 74.5% and 72.9% of total Australian drug expenditure for each hospital type. The 164 hospitals accounted for 61% of available beds and 72% of estimated total drug expenditure for all public hospitals (Inclusion A).

These figures indicate that the survey responses were well representative of teaching hospital bed numbers (84%), but represented an average of only 51% of other available beds. This is probably a survey artefact. Non-metropolitan hospitals accounted for 70.8% of all hospitals (33.5% of available beds and 18.8% of drug expenditure) of which only 25.6% were surveyed compared to 84% of metropolitan hospitals (including teaching hospitals). Survey return rates were comparable averaging 68.2% for metropolitan hospitals (including teaching hospitals) and 62.1% for non-metropolitan hospitals.

The figures for drug expenditure were more consistent, with approximately 72 and 75% (non-metropolitan and metropolitan, respectively) of each hospital type being represented. Those figures were also consistent with the figure of 72% of total hospital expenditure being accounted for by hospitals responding to the survey. This indicates that although a disproportionate number of non-metropolitan hospitals were surveyed compared to metropolitan, the ones that were surveyed ac-

counted for the larger portion of drug expenditure. Since this survey was measuring utilisation, the dollar figures were most important as indicators of how representative the survey population was of the total population.

6.1.3 Extent of computerisation

One hundred fifty one (92%) of survey respondents indicated they had computerised pharmacy dispensing or inventory systems. Several sites still rely on manual ordering and dispensing methods. Some sites reported current upgrades to hardware or pharmacy software.

The most common dispensing systems included:

- Amfac-Medrecord 20%
- McDonnell Douglas Information System 13%
- Stocca (Paramedical Software) 8%
- Queensland Regional Base Systems 8% (Queensland only)
- RxVision (Health Care Systems) 6%
- Datagaard 5%
- Merlin (Sanderson-Pickware) 3%
- Detente 2%
- Data Design Hi-Soft 1%

6.1.4 Purchase data

Eighty nine (54.3%) hospitals reported being able to provide all of the purchase data elements requested. These included:

- drug code;
- generic name;
- drug strength;
- dose form;
- pack size;
- pack/unit purchase price;
- pack/unit/volume cost;

These hospitals accounted for 57.5% of average available beds surveyed and 35% of total Australian average public hospital beds. The corresponding dollar drug expenditure figures were 60.5% and 44.3% of surveyed and total Australian hospital expenditure respectively. One hundred forty six (89%) hospitals could report generic name, 151 (92.1%) drug strength, 147 (89.6%) dose form, 148 (90.24%) pack size, 144 (87.8%) the number of packs or units purchased and 150 (91.5%) the cost of packs/units purchased over a given period. Eighty three (50.6%) hospitals indicated a capacity to report purchase data proportionately for inpatients, and 75 (45.7%) for non-inpatients (eg. outpatients, casualty). Fifty two (31.7%) reported being able to further disaggregate data into other patient types, although some of these types could well be defined as in-patients (Inclusion B).

6.1.5 Issue data

Eighty nine (54.3%) of survey respondents reported the ability to express all requested drug issue data elements (Inclusion C). These elements were the same as those listed in the section for purchase data. These hospitals represented 63.7% of surveyed beds and 39.3% of total estimated Australian beds. These hospitals accounted for 70.3% and 51.4% of surveyed hospital drug expenditure

and Australian expenditure respectively. One hundred forty three (87.2%) hospitals reported the capacity to provide generic drug name data, 142 (86.6%) drug strength, 140 (85.4%) dose form, 120 (73.2%) pack size, 132 (80.5%) the quantity of drug issued and 136 (82.9%) the cost associated with the issue quantity (Inclusion C). One hundred thirteen (68.9%) hospitals indicated a capacity to report issue data proportionately for inpatients, and 103 (62.8%) for non-inpatients (eg. outpatients, casualty). Seventy four (45.1%) reported being able to further disaggregate data into other patient types, although as with purchase data, some of these types could also be defined as in-patients (Inclusion C).

Seventy hospitals were able to report all requested data elements for both drug purchase and drug issue data. These hospitals represented 42.7% of surveyed hospitals and 41.5% and 44.9% of surveyed beds and surveyed drug expenditure respectively (Inclusion D).

These findings were generally consistent with figures for purchase data above. Figures for generic name, strength and dose were consistently 4-5 percentage points lower than purchase data figures, indicating more hospitals have computerised purchasing systems than have dispensing systems. Fewer hospitals were able to report pack size for issues than for purchases suggesting that issues are by units rather than packs. This was consistent with usual dispensing practice in most hospital pharmacies compared to community pharmacy where drugs are most often supplied in original manufacturers packs. If drug codes were excluded as a necessary reporting element, available data accounted for 70.3% of surveyed hospital drug expenditure and 44.3% of all public hospital drug expenditure.

6.1.6 Drug codes

Eighty nine (54.3%) hospitals reported having a unique drug code linked to drug purchases and 89 (54.3%) to issue data (Inclusion C). Only 1/3 of these codes are of a hierarchical nature (SHPA), with the remainder being based on drug name or other structure. The SHPA code or some internal variant was the most common standard coding system used (30%). Other codes were usually in-house (13%), system dependent or were based on the drug name (50%).

When drug codes were excluded from the requested essential data elements, the number of hospitals able to report all data elements increased from 89 (54.3%) to 131 (79.9%) for drug purchases. Similarly, the ability to report drug issues[i] increased from 89 (54.3%) to 131 (79.9%), when the requirement for a drug code was excluded. Hospitals able to report both purchasing and issue data elements by excluding a drug code as a reporting requirement, increased from 70 (42.7%) to 106 (64.6%) of surveyed hospitals.

Correspondingly, the number of surveyed beds and percentage of drug expenditure represented when the drug code was excluded as a reporting element increased to 85.4% (beds), 91.1% (expenditure) for drug purchases; 83.2% (beds) and 89.7% (drug expenditure) for drug issues; and 63.4% (beds) and 68.5% (drug expenditure) for combined data elements. This represents an increase of 48.5% (beds), 50.6% (expenditure) for drug purchases; 30.6% (beds), 27.6% (expenditure) for

[i] The concurrence of these figures is coincidental.

drug issues; and 52.8% (beds), 52.5% (expenditure) for combined data elements, respectively, when compared with figures for reporting of data including a drug code. (Inclusion B, Inclusion C).

If data were manually entered into a central database from printed reports, this lack of a consistent drug code would not present major problems. The development of automated systems will however be hampered by lack of a unique identifier which links data from various sources.

6.1.7 Data availability

6.1.7.1 Printed reports

One hundred twenty eight (78% of returns) hospitals had a printed utilisation report available representing 81% of surveyed beds and 85.9% of hospital drug expenditure. Seventy nine (48.2%) hospitals able to report all purchase data elements including drug codes, could produce printed reports (Inclusion B). One hundred nine (66.5%) surveyed hospitals could report purchase data excluding a unique drug code (Inclusion B). Eighty one (49.4%) hospitals able to report issue data elements, including drug codes, indicated the availability of printed reports (Inclusion C). This compared with 111 (67.7%) hospitals which had a printed report of drug issue data without unique drug codes (Inclusion C). Sixty four (39%) hospitals compared with 93 (56.7%) were able to report and print both purchase and issue data with and without unique drug codes, respectively (Inclusion D).

6.1.7.2 Computer reports

Purchase data

Twenty five (15.2%) hospitals (19.3% beds, 23.1% expenditure) were able to access ASCII or other file types for providing purchase data elements including unique drug codes. Eleven (6.7%) of these indicated the current availability of a computer file from which these elements could be extracted. These hospitals accounted for 8.2 % of surveyed beds and 7.4% of surveyed expenditure (Inclusion B).

When hospitals unable to provide unique drug codes were included, the number of hospitals able to access ASCII or other file types increased to 41 (25%), representing 36.5% of surveyed beds and 46.9% of drug expenditure. Of these, 21 (12.8%) had a computer file currently available from which purchase data elements could be extracted. These hospitals represented 17.8% of surveyed beds and 19.7% of estimated expenditure (Inclusion B).

Issue data

Twenty eight (17.1%) surveyed hospitals were able to access ASCII or other file types with unique drug codes, representing 24.4% and 29.9% of surveyed beds and drug expenditure respectively. This increased to 35 (21.3%) hospitals when the requirement for unique drug code was excluded. The corresponding bed numbers and drug expenditure figures increased to 28.3% and 36.8% respectively. Only 11 (6.7%) hospitals had a computer report currently available containing a drug code, representing 8% of available beds and 8% of drug expenditure. When codes were excluded, 15 (9.1%) hospitals said they were currently able to supply computer files without drug codes (9.7% beds, 9.6% expenditure) (Inclusion C).

Combined data

Overall 68 (41.5%) hospitals were able to access computer files for either purchase and/or issue

data, including drug codes. These represented 40.6% of all surveyed hospital beds and 44.6% of all surveyed hospital drug expenditure. Thirteen (7.9%) hospitals had access to a computer file at the time of the survey which could provide the required data elements. These hospitals represented 7.9% of available beds and 6% of drug expenditure (Inclusion D).

When drug codes were excluded, 104 (63.4%) hospitals were able to access computer files for either purchase or issue data. These represented 63.4% of all surveyed 62.5% of hospital beds and 68% of all surveyed hospital drug expenditure. Twenty five (15.2%) hospitals had access to a computer file at the time which could have provided the required data elements. These hospitals represented 14.2% of available beds and 13.2% of drug expenditure (Inclusion D).

Hospital demographic data

Data for bed numbers, percent occupancy, number of occupied bed days, number of inpatient separations, and outpatient (and other patient type) occasions of service, were generally available from finance or medical records departments. All data required were available from 109 of the 164 survey respondents. Only 5 hospitals indicated that requested data were not available.

6.1.7.3 Long term data

Seventy (42.7%) hospitals indicated they would supply quarterly data to a central database. These accounted for 49.2% and 59% of surveyed beds and expenditure respectively. Sixty seven (40.9%) hospitals indicated that they could provide these data in printed format. These hospitals accounted for 44.4% of surveyed beds and 51.4% of drug expenditure. These figures corresponded with 27.2% and 37% of total beds and total drug expenditure for Australia respectively. Thirty nine (23.8%) hospitals willing to supply data had access to a computer file of some type. These corresponded to 61.2% and 72.3% of surveyed hospital beds and expenditure. Teaching hospitals were well represented.

A further 28 hospitals indicated an interest in supplying data but that a range of issues would need to be negotiated before submission of data would be approved. Twenty nine (17.7%) hospitals indicated that they would not provide data.

6.1.7.4 IMS Australian Hospital Index database

Twenty five (15.2%) of the hospitals surveyed contributed to the IMS Australian Hospital Index database. These hospitals accounted for 24.9% of surveyed beds and (15.3% of total Australian average beds) and 34.6% of surveyed hospital drug expenditure (25.3% of total expenditure).

6.2 Phase 2 - Sample data phase

Twenty seven hospitals (16.5%) indicated a potential to provide pilot data. Of these, 23 could provide data in printed format and 20 as an ASCII or other file type. Ten hospitals indicated files were readily available. All were invited to submit sample data.

Sample data were received from 6 sites (Fairfield Hospital, Victoria; Kalgoorlie Regional Hospital, W. A. ; Maroondah Hospital, Victoria; Royal Adelaide Hospital, SA. ; St. Vincent's Hospital, NSW; Tamworth Hospital, NSW). Files were either character delimited ASCII, fixed length format (eg. dBase) or text files of printed reports. All files presented problems when generating final report formats. Files delivered in XBase (eg. dBase, FoxPro) were easiest to manage.

To produce final report formats (Inclusion E), data were subjected to the following processes :

- importing data into one or other of MS Access or MS Excel;
- data parsing, stripping off leading and trailing blanks and other extraneous characters/symbols;
- correcting spelling;
- normalisation of descriptions to the standard descriptors for drug name (including case conversion), strength, strength unit, dose form, number of units issued and issue unit;
- matching drug descriptions to ATC and corresponding DDD units;
- calculating total mass units and converting these to the corresponding activity index figures;
- developing and printing reports.

Approximately 15 hours per site were required to produce the final reports.

6.2.1 Recommendations for a minimum data set

The problems encountered with pilot data manipulation indicated several steps towards standardisation of data structures and formats would be required before processes could be automated. These include development of a uniform set of drug descriptions for all participating centres. The corresponding information in the central data base would include:

- standard code linked to:
  - a standard drug description (generic name);
  - strength;
  - dose form;
  - DDD unit;
  - mass unit (eg. mg, mL);
  - standard unit of issue description (eg. mL, tab, vial).

This could be used as the basis for an Australian 'standard drug code'. As a consequence, only the drug code and unit of issue in the standard form would be required from participating sites to match drug utilisation data with descriptors in the central data base. Subsequent automated calculations would derive the number of DDDs and other drug use indicators.

Thus the minimum data set required from participating hospitals would include:

- standard drug code;
- number of units issued or purchased;
- a description of the unit of issue;
- the cost of that issue or purchase;
- a "flag" distinguishing inpatient from non-inpatient data;
- a hospital identifier.

Utilisation data submitted to this standard would eliminate inconsistencies apparent with current sources and facilitate automation of reporting.

6.2.2 Data transmission

To facilitate transmission of data and to ensure timely reporting, data could be forwarded using floppy disc, streaming tape or via modem or eMail. Alternatively, the central data base could maintain a closed electronic bulletin board service (BBS) which would facilitate electronic data inter-

change.

6.3 Phase 3 - Options and cost for establishing a central data base

The final determinants for establishing a centre to collect drug utilisation data will depend on the structure of the data, the way they are submitted (ie. electronically or as printed reports), and the degree of standardisation adopted by contributing hospitals. These factors will also determine the cost of such a proposal. I propose several options:

6.3.1 Option 1

Expand the current operations of DUSC or HUCS to include coordination of public hospital data collection to the level of individual drugs.

Both groups have some of the expertise to accomplish such a task. Both groups are also limited by resources. My discussions with both groups indicated that additional resources would be required before such expansion could be contemplated. In addition, pre-processing of data would be required so that the relevant department was working with aggregated data in a standard format. An arrangement with a subcontractor (see Option 4) to provide such data together with development of standards would still be required.

6.3.2 Option 2.

Expand the collection of current public hospital data by State or Commonwealth authorities to include more detailed data on individual drugs.

Detailed drug data are already collected for Section 100 drugs. This program could be expanded to include a range of other drugs at a relatively minimal cost to the Commonwealth. However, State/Territory health departments and hospitals would not be enthusiastic about the impost of producing yet more data, unless resources or other incentives (eg. rebates) to undertake such work were provided.

The responsibility for collating and reporting data would sensibly fall under the jurisdiction of HUCS or DUSC. The disadvantage with centralising data collection at this level will be the timeliness of information. Even at the aggregated level, current reporting has a lag time of 12-18 months, which is inadequate for measuring rapid changes in drug utilisation patterns.

As discussed previously, the major impediment would be the lack of an Australian standard for drug utilisation data formats, drug codes or drug descriptors. Without such standards, manual collation of data would be required. This approach would limit the scope of data which would be collected. Thus before Option 2 could be explored seriously, a commitment to the establishment of these standards would be required.

6.3.3 Option 3.

A commercial venture with IMS to expand the current AHI and to provide required data to the Commonwealth.

Approximately 15% of surveyed hospitals already contribute to the IMS data base. Since IMS have well established systems, this opportunity should be explored. A number of criteria would need to be satisfied (access to data, commercial arrangements) before this could ensue. Of interest is that the primary objective of the Commonwealth and of the IMS would seem diametrically opposed. The

Commonwealth's objectives are to promote quality use of medicines and to minimise drug use and expenditure, while those of IMS are to provide information to industry subscribers, which facilitates expansion of drug marketing and sales figures. In the past, IMS has not been prepared to make data available to DUSC, even on a commercial basis. Successful negotiations to this end would therefore seem unlikely. However, if negotiations were reopened in a more positive vein, and concluded to the satisfaction of both parties, the IMS route may well prove a practical and efficient option.

6.3.4 Option 4.

Sub-contract the project to an independent group the professional objectives of which do not conflict with those of the Commonwealth.

Such activity would include responsibility for all aspects of the project from:

- consulting on the requirements of the standard drug code and drug descriptors;
- establishing, maintaining and distributing the standards;
- assisting hospitals in developing systems to provide data;
- collecting, analysing and reporting data to the Commonwealth according to a predetermined specification;
- preparing summary reports back to States/Territories health departments and to contributing hospitals.

A number of external computing consultants or other groups may be interested in undertaking such work for the Commonwealth. These include AmFac-ChemData Pty Ltd. (an IMS subsidiary) which currently process Guild survey data for DUSC. DUSC currently pays approximately $11,000 a month for this processing. Similarly, the SHPA who have undertaken work for the Commonwealth to map SHPA to ATC codes, may also be interested.

The Australian Medicines Handbook Pty. Ltd. (AMH), recently established with a Commonwealth seeding grant to develop a concise drug information compendium of all drugs available in Australia, has an obvious interest in drug utilisation and Quality Use Of Medicines (QUM) issues. Thus the AMH may be a suitable avenue for collecting such data. This group has developed a therapeutic drug classification system for use in the *Handbook* . This stems from a desire to develop an electronic version of the *Handbook* which will link with other medical information systems. This system will accommodate links to other coding systems thereby creating a map between existing terminologies for use by existing pharmacy software packages and software developers. These maps would facilitate communication between different computer platforms which may be particularly relevant as this group evaluates the impact of the AMH on the use of medicines throughout Australia.

6.3.5 Cost of establishing and operating a central database facility

A proposal for consultation, establishment and maintenance of a centre described under Option 4 is provided in Inclusion F. It is anticipated that such a program would incorporate 4 phases, which are described below. The staff resources will depend on the final approach to submission of data.

This author believes this is the preferred option to establish the program. The costs include reporting of data but not the publication of the reports in book(let) form. It could also be anticipated that pub-

lic hospital utilisation reports would be incorporated into one or other of the ASM or HUCS documents.

If an electronic approach was contemplated from the outset, then the costs will be as described. If manual data entry is the preferred approach then less consultation of stake-holders and computer consultants would be required initially. Some key consultations including the SHPA, AMH, DUSC, and the TGA, to produce at least a standard approach to the core utilisation data code structure (eg. drug name, form and strength, strength unit, issue unit), would still be needed. An additional 2 data processing operators (cost: $25-30,000 each per annum), would be required. The operators would each require a computer/data terminal to input data. This would incur an additional cost of approximately $1500-2500 for disk-less work stations or up to $3000-4000 for suitable PC configurations.

If a combination of approaches were required, which is probably the preferred short term approach, the costing for option 4 should include provision for additional data processing operator resource. This would enable progress towards automation of data collation and reporting over the anticipated 5 year time frame, together with early availability (by submission of printed reports) of reasonably broad public hospital utilisation statistics.

6.3.5.1 Phase 1 - Consultation.

This phase would be coordinated by a project manager. Consultation of relevant stake-holders regarding development (or extension of a standard drug code and drug descriptors) would be required. A key feature would be to create a link between the ATC code and another standard code if the ATC code does not form the basis for the standard code. Following this consultation process the relevant standards and maps would need to be developed. This could be done by the project team or through a sub-contracting arrangement.

6.3.5.2 Phase 2 - Establishment.

The next phase would be the establishment of project infra structure including office accommodation, staffing, plant and equipment and general operating costs. This phase would include employment of consultants and other specialist advice.

6.3.5.3 Phase 3 - Recruitment.

Phase 3 would involve recruitment of contributing hospitals to the project. This would require site visits and the provision of assistance to establish data systems for contributors when necessary.

6.3.5.4 Phase 4 - Data collection, analysis, reporting and maintenance.

This would be the implementation phase of the project. Provision of general operating costs, together with a possible incentive of $5,000 -$6,000 per annum for contributing hospitals, would be required.

6.3.5.5 Total cost

The total proposed cost to establish and operate the project including incentive payments for 150 hospitals is approximately $1.4 million (Inclusion F). This figure is minimal in the context of annual Australian public hospital drug expenditure of approximately $450 million. A 1% saving over 1 year, generated through this program would fund all the establishment and subsequent operating costs for the project for several years.

Since the major costs incorporated in the proposal are the hospital incentives, an alternative incentive scheme could markedly alter the cost of operation of this centre. It should be noted that these costs are based on 150 participating hospitals which is optimistic in the light of survey results. It should also be remembered that it would not be possible to recruit a large number of hospitals from the commencement of the program. A more conservative figure is for 10-20 hospitals initially accruing at a rate of 10-20 per year.

One approach would be to target the Type A hospitals (eg. teaching hospitals) firstly. These hospitals account for 60% of overall public hospital drug expenditure. Teaching hospitals which responded to the survey accounted for 75% of this expenditure or 44% of total Australian expenditure. Achievement of even this level of data collection would add significantly to the current knowledge of public hospital and consequently, overall community drug usage patterns and still easily fund establishment and operating costs.

Another approach might be to centralise the information which is already available and make national projections based on these data. Specifically data might be gathered from the:

- Victorian Hospitals Association database;
- IMS - Australian Hospitals Index database;
- Queensland Department of Health Pharmaceutical Purchasing System;
- SA Government State Supply Tender Board;
- Highly Specialised Drugs Working Party;
- Therapeutics Goods Branch of the State/Territory Health Departments (for Controlled Substances utilisation data).

The Commonwealth may be able to obtain these data with little effort (and at minimal cost) through negotiations between the Commonwealth and the various State authorities, VHA and IMS. The above data sources, although not uniformly representative of national figures, would provide a broad range of utilisation data from public hospitals and a reasonable starting point for national projections. Importantly, this information would provide useful information for the eastern seaboard. The remaining data could be obtained from other sources over time. The present PBS/RPBS/Guild - DUSC endeavour has taken 7 to 8 years to achieve. It would be reasonable to expect that recruitment of a representative sample of hospitals would take a similar time period.

7. INCLUSIONS

The following pages contain data tables and other information related to this roject. The following legend applies to selected sections.

Code	Hospital type
A.	Teaching
B.	Base / Referral - Metropolitan
C.	Base / Referral - Non-metropolitan
D.	Community - Metropolitan
E.	Community - Non-metropolitan
P.	Psychiatric
R.	Veteran's Affairs

Inclusion A

Average Beds and Drug Expenditure

Data sources:

Commonwealth Department of Human Services & Health
State/Territory Health Departments
Individual Hospitals

AUSTRALIAN TOTALS

		Totals for States / Territories				Totals for Surveys returned								
						Hospitals surveyed		Surveys returned		Beds		Estimated Drug Expenditure		
	Hospital type	Number of Public Hospitals	Estimated Average Beds	Estimated Total Drug Expenditure	Expenditure per bed	Number of hospital type surveyed	As percentage of hospital type	Number	As percentage of hospital type surveyed	Number	As percentage of total average beds for hospital type	Dollars	As percentage of total expenditure for hospital type	per bed expenditure
A.	Teaching	42	19,040	$ 263,436,854	$ 13,836	39	92.9%	33	84.6%	15,993	84.0%	$ 198,482,740	75%	$ 12,411
B.	Base / Referral - Metropolitan	22	6,962	$ 39,607,243	$ 5,689	20	90.9%	14	70.0%	4,884	70.2%	$ 35,312,004	89%	$ 7,230
C.	Base / Referral - Non-metropolitan	34	7,865	$ 44,310,483	$ 5,685	34	100.0%	27	79.4%	6,480	82.4%	$ 39,029,357	88%	$ 6,004
D.	Community - Metropolitan	83	7,322	$ 24,998,311	$ 3,414	45	54.2%	24	53.3%	3,444	47.0%	$ 12,845,306	51%	$ 3,655
E.	Community Non-metropolitan	450	13,843	$ 40,274,600	$ 2,909	89	19.8%	50	56.2%	4,392	31.7%	$ 22,699,477	56%	$ 5,344
P.	Psychiatric	45	7,266	$ 15,584,388	$ 2,145	20	44.4%	12	60.0%	3,127	43.0%	$ 6,515,287	42%	$ 2,084
R.	Veterans Affairs	8	2,479	$ 21,722,380	$ 8,763	5	62.5%	4	80.0%	1,183	47.7%	$ 8,482,368	39%	$ 7,170
	Total	**684**	**64,777**	**$ 449,934,259**	**$ 6,954**	**252**	**36.8%**	**164**	**65.1%**	**39,503**	**61.0%**	**$ 323,366,539**	**72%**	**$ 8,186**

Note: Australian totals reflect inconsistencies in figures derived from Central sources (eg HUCS) and individual hospitals for some States/Territories.

Inclusion B

Drug Purchase Data

Data source:

- Survey returns

Table 1. All requested purchase elements available

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	28	2	8	3	4	36	7	89	54%
No. of average beds	634	7042	341	2478	781	1430	7770	2292	22768	57%
Drug expenditure	$ 6,211,000	$ 46,562,146	$ 2,191,000	$ 20,845,004	$ 9,634,070	$ 10,759,333	$ 75,933,015	$ 23,641,072	$ 195,776,640	60%

Table 2. All requested purchase elements available, in a printed report

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	25	0	8	3	4	31	7	79	48%
No. of average beds	634	5853	0	2478	781	1430	7210	2292	20678	52%
Drug expenditure	$ 6,211,000	$ 38,496,181	$ -	$ 20,845,004	$ 9,634,070	$ 10,759,333	$ 73,721,874	$ 23,641,072	$ 183,308,534	57%

Table 3. All requested purchase elements available, in an electronic form

	State									As % of
Data	NSW	NT	QLD	SA	TAS	VIC	WA	ACT	Grand Total	survey returns
No. of hospitals	4	1	1	2	2	10	5	0	25	15%
No. of average beds	1830	281	31	521	992	2103	1865	0	7623	19%
Drug expenditure	$ 15,037,408	$ 1,771,000	$ 122,760	$ 7,664,070	$ 7,737,600	$ 22,695,753	$ 19,609,136	$ -	$ 74,637,727	23%

Table 4. All requested purchase elements available, in an electronic form, & with data currently available

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	0	4	1	1	1	1	3	0	11	7%
No. of average beds	0	1830	281	31	103	477	530	0	3252	8%
Drug expenditure	$ -	$ 15,037,408	$ 1,771,000	$ 122,760	$ 278,070	$ 3,663,150	$ 3,059,000	$ -	$ 23,931,388	7%

Table 5. All requested purchase elements available, except a unique drug code

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	45	2	21	7	4	38	13	131	80%
No. of average beds	634	12030	341	6035	2588	1430	7943	2805	33806	85%
Drug expenditure	$ 6,211,000	$ 92,085,645	$ 2,191,000	$ 54,168,119	$ 27,106,723	$ 10,759,333	$ 76,326,161	$ 26,079,679	$ 294,927,660	91%

Table 6. All requested purchase elements available, except a unique drug code, & a printed report available

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	36	0	18	5	4	32	13	109	66%
No. of average beds	634	9320	0	5308	1682	1430	7300	2805	28479	72%
Drug expenditure	$ 6,211,000	$ 71,290,034	$ -	$ 44,836,319	$ 20,453,723	$ 10,759,333	$ 73,943,874	$ 26,079,679	$ 253,573,962	78%

Table 7. All requested purchase elements available, except unique drug code, in an electronic form

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	0	10	1	8	4	2	10	6	41	25%
No. of average beds	0	4734	281	2579	1784	992	2103	1968	14441	36%
Drug expenditure	$ -	$ 47,690,427	$ 1,771,000	$ 27,705,309	$ 23,859,070	$ 7,737,600	$ 22,695,753	$ 20,219,136	$ 151,678,295	47%

Table 8. All requested purchase elements available, except unique drug code, in an electronic form, and a computer file available

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	0	7	1	5	3	1	3	1	21	13%
No. of average beds	0	3147	281	1161	1366	477	530	103	7065	18%
Drug expenditure	$ -	$ 28,674,517	$ 1,771,000	$ 9,495,179	$ 16,473,070	$ 3,663,150	$ 3,059,000	$ 610,000	$ 63,745,916	20%

Table 9. Hospitals reporting availability of unique drug codes

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	31	2	8	3	4	38	7	94	57%
No. of average beds	634	7626	341	2478	781	1430	8031	2292	23613	60%
Drug expenditure	$ 6,211,000	$ 48,896,136	$ 2,191,000	$ 20,845,004	$ 9,634,070	$ 10,759,333	$ 77,157,015	$ 23,641,072	$ 199,334,630	62%

Table 10. Hospitals reporting availability of generic name

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	50	3	25	10	5	38	14	146	89%
No. of average beds	634	12701	371	7153	3190	1490	7943	2893	36375	92%
Drug expenditure	$ 6,211,000	$ 94,659,193	$ 2,249,000	$ 57,196,611	$ 31,007,652	$ 11,040,253	$ 76,326,161	$ 26,497,679	$ 305,187,549	94%

Table 11. Hospitals reporting availability of strength

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	52	3	25	10	5	41	14	151	92%
No. of average beds	634	12930	371	7153	3190	1490	8259	2893	36920	93%
Drug expenditure	$ 6,211,000	$ 95,471,696	$ 2,249,000	$ 57,196,611	$ 31,007,652	$ 11,040,253	$ 77,883,673	$ 26,497,679	$ 307,557,564	95%

Table 12. Hospitals reporting availability of dose form

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	51	2	25	8	5	41	14	147	90%
No. of average beds	634	12755	341	7153	2943	1490	8259	2893	36468	92%
Drug expenditure	$ 6,211,000	$ 94,680,408	$ 2,191,000	$ 57,196,611	$ 29,729,820	$ 11,040,253	$ 77,883,673	$ 26,497,679	$ 305,430,444	94%

Table 13. Hospitals reporting availability of pack size

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	51	3	25	9	4	41	14	148	90%
No. of average beds	634	12854	371	7153	2835	1430	8259	2893	36429	92%
Drug expenditure	$ 6,211,000	$ 95,185,024	$ 2,249,000	$ 57,196,611	$ 28,384,555	$ 10,759,333	$ 77,883,673	$ 26,497,679	$ 304,366,875	94%

Table 14. Hospitals reporting availability of units/packs purchased

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	49	3	22	10	5	41	13	144	88%
No. of average beds	634	12510	371	6420	3190	1490	8259	2805	35679	90%
Drug expenditure	$ 6,211,000	$ 93,976,108	$ 2,249,000	$ 56,057,911	$ 31,007,652	$ 11,040,253	$ 77,883,673	$ 26,079,679	$ 304,505,276	94%

Table 15. Hospitals reporting availability of cost of units/packs purchased

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	52	3	24	10	5	41	14	150	91%
No. of average beds	634	12930	371	7079	3190	1490	8259	2893	36846	93%
Drug expenditure	$ 6,211,000	$ 95,471,696	$ 2,249,000	$ 56,874,861	$ 31,007,652	$ 11,040,253	$ 77,883,673	$ 26,497,679	$ 307,235,814	95%

Table 16. Hospitals able to report puchase data for inpatients

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	25	2	12	4	5	23	11	83	51%
No. of average beds	634	5528	341	2349	1518	1490	4270	2693	18823	48%
Drug expenditure	$ 6,211,000	$ 34,737,513	$ 2,191,000	$ 15,465,171	$ 13,711,000	$ 11,040,253	$ 39,735,676	$ 32,627,879	$ 155,719,492	48%

Table 17. Hospitals able to report puchase data for non-inpatients

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	21	2	11	3	5	22	10	75	46%
No. of average beds	634	5139	341	2157	1457	1490	4261	2542	18021	46%
Drug expenditure	$ 6,211,000	$ 33,306,997	$ 2,191,000	$ 14,657,111	$ 13,538,000	$ 11,040,253	$ 39,684,676	$ 31,801,154	$ 152,430,191	47%

Hospitals able to report purchase data for other patient types

		State									As % of
DPD-DrugUtilisation-Other-Text	Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
	No. of hospitals	1	9	0	4	0	1	6	2	2300%	14.0%
	No. of average bed	634	2443	0	988	0	515	1238	130	594600%	15.0%
	Drug expenditure	$ 6,211,000	$ 18,574,491	$ -	$ 6,662,552	$ -	$ 4,074,450	$ 12,466,102	$ 533,585	4852218000%	15.0%
"Same day" classed with inpatients	No. of hospitals	0	0	0	1	0	0	0	0	100%	0.6%
	No. of average bed	0	0	0	281	0	0	0	0	28100%	0.7%
	Drug expenditure	$ -	$ -	$ -	$ 1,523,893	$ -	$ -	$ -	$ -	152389300%	0.5%
A & E yes, Same Day no.	No. of hospitals	0	0	0	0	1	0	0	0	100%	0.6%
	No. of average bed	0	0	0	0	777	0	0	0	77700%	2.0%
	Drug expenditure	$ -	$ -	$ -	$ -	$ 10,555,000	$ -	$ -	$ -	1055500000%	3.3%
A & E, Hospital in the home	No. of hospitals	0	0	0	0	0	0	1	0	100%	0.6%
	No. of average bed	0	0	0	0	0	0	184	0	18400%	0.5%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,467,000	$ -	146700000%	0.5%
All cost centres	No. of hospitals	0	0	0	0	0	1	0	0	100%	0.6%
	No. of average bed	0	0	0	0	0	340	0	0	34000%	0.9%
	Drug expenditure	0	0	0	0	0	2703174	0	0	270317400%	0.8%
Casualty	No. of hospitals	0	1	0	0	0	0	0	1	200%	1.2%
	No. of average bed	0	42	0	0	0	0	0	106	14800%	0.4%
	Drug expenditure	$ -	$ 196,644	$ -	$ -	$ -	$ -	$ -	$ 750,222	94686600%	0.3%
Casualty, Home Care, Same Day all classed as o/p	No. of hospitals	0	1	0	0	0	0	0	0	100%	0.6%
	No. of average bed	0	24	0	0	0	0	0	0	2400%	0.1%
	Drug expenditure	$ -	$ 400,000	$ -	$ -	$ -	$ -	$ -	$ -	40000000%	0.1%
Casualty, Home Health Care	No. of hospitals	0	1	0	0	0	0	0	0	100%	0.6%
	No. of average bed	0	82	0	0	0	0	0	0	9200%	0.2%
	Drug expenditure	$ -	$ 147,580	$ -	$ -	$ -	$ -	$ -	$ -	14758000%	0.0%
Casualty, Hospital in the home	No. of hospitals	0	0	0	0	0	0	1	0	100%	0.6%
	No. of average bed	0	0	0	0	0	0	290	0	29000%	0.7%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,367,000	$ -	136700000%	0.4%
Casualty, Rehabilitation, Outreach	No. of hospitals	0	0	0	0	1	0	0	0	100%	0.6%
	No. of average bed	0	0	0	0	420	0	0	0	42000%	1.1%
	Drug expenditure	$ -	$ -	$ -	$ -	$ 1,013,000	$ -	$ -	$ -	101300000%	0.3%
Casualty, Staff	No. of hospitals	0	0	0	0	0	0	1	0	100%	0.6%
	No. of average bed	0	0	0	0	0	0	93	0	9300%	0.2%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 281,399	$ -	28139900%	0.1%
Clinic separation - psychiatric, orthopaedic	No. of hospitals	0	0	0	0	0	0	1	0	100%	0.6%
	No. of average bed	0	0	0	0	0	0	140	0	14000%	0.4%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 858,000	$ -	85800000%	0.3%
Community Health	No. of hospitals	0	1	0	0	0	0	0	0	100%	0.6%
	No. of average bed	0	338	0	0	0	0	0	0	33800%	0.9%
	Drug expenditure	$ -	$ 2,179,762	$ -	$ -	$ -	$ -	$ -	$ -	217976200%	0.7%
Discharge, external clinics, internal cost centres	No. of hospitals	0	0	0	1	0	0	0	0	100%	0.6%
	No. of average bed	0	0	0	379	0	0	0	0	37900%	1.0%
	Drug expenditure	$ -	$ -	$ -	$ 3,300,000	$ -	$ -	$ -	$ -	330000000%	1.0%
Drug usage for ward possible	No. of hospitals	0	1	0	0	0	0	0	0	100%	0.6%
	No. of average bed	0	152	0	0	0	0	0	0	15200%	0.4%
	Drug expenditure	$ -	$ 715,283	$ -	$ -	$ -	$ -	$ -	$ -	71528300%	0.2%
Each ward of hospital	No. of hospitals	0	0	0	1	0	0	0	0	100%	0.6%
	No. of average bed	0	0	0	192	0	0	0	0	19200%	0.5%
	Drug expenditure	$ -	$ -	$ -	$ 808,000	$ -	$ -	$ -	$ -	80806000%	0.2%
Emergency	No. of hospitals	0	1	0	0	0	0	0	0	100%	0.6%
	No. of average bed	0	175	0	0	0	0	0	0	17500%	0.4%
	Drug expenditure	0	791288	0	0	0	0	0	0	79128800%	0.2%
Home health care, Radiology, OT	No. of hospitals	0	0	0	0	0	0	1	0	100%	0.6%
	No. of average bed	0	0	0	0	0	0	185	0	18500%	0.5%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 454,141	$ -	45414100%	0.1%
Hospital in the home	No. of hospitals	0	0	0	0	0	0	1	0	100%	0.6%
	No. of average bed	0	0	0	0	0	0	133	0	13300%	0.3%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,849,000	$ -	184900000%	0.6%
Hospital in the home, Casualty	No. of hospitals	0	0	0	0	0	0	1	0	100%	0.6%
	No. of average bed	0	0	0	0	0	0	56	0	5600%	0.1%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 225,000	$ -	22500000%	0.1%
Nursing Home	No. of hospitals	0	0	0	0	0	0	1	0	100%	0.6%
	No. of average bed	0	0	0	0	0	0	98	0	9800%	0.2%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 304,000	$ -	30400000%	0.1%
Other hospital, nursing home	No. of hospitals	0	1	0	0	0	0	0	0	100%	0.6%
	No. of average bed	0	97	0	0	0	0	0	0	9700%	0.2%
	Drug expenditure	$ -	$ 457,347	$ -	$ -	$ -	$ -	$ -	$ -	45734700%	0.1%
Regional Dispensing	No. of hospitals	0	0	1	0	0	0	0	0	100%	0.6%
	No. of average bed	0	0	281	0	0	0	0	0	28100%	0.7%
	Drug expenditure	$ -	$ -	$ 1,771,000	$ -	$ -	$ -	$ -	$ -	177100000%	0.5%
Regional Outposts	No. of hospitals	0	0	0	0	0	0	0	1	100%	0.6%
	No. of average bed	0	0	0	0	0	0	0	88	8800%	0.2%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 331,936	33193600%	0.1%
Ward issue, Discharge	No. of hospitals	0	0	0	0	1	0	0	0	100%	0.6%
	No. of average bed	0	0	0	0	260	0	0	0	26000%	0.7%
	Drug expenditure	$ -	$ -	$ -	$ -	$ 1,970,000	$ -	$ -	$ -	197000000%	0.6%
wards	No. of hospitals	0	1	0	0	0	0	0	1	200%	1.2%
	No. of average bed	0	208	0	0	0	0	0	125	33300%	0.9%
	Drug expenditure	$ -	$ 812,000	$ -	$ -	$ -	$ -	$ -	$ 385,000	119700000%	0.4%
Wards, clinics, paramedical & non-medical depts.	No. of hospitals	0	0	0	0	0	0	0	1	100%	0.6%
	No. of average bed	0	0	0	0	0	0	0	88	8800%	0.2%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 418,000	41800000%	0.1%
Weekend Leave	No. of hospitals	0	0	0	0	0	0	1	0	100%	0.6%
	No. of average bed	0	0	0	0	0	0	134	0	13400%	0.3%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,932,000	$ -	393200000%	1.2%
Total No. of hospitals		1	17	1	7	3	2	15	6	5200%	31.7%
Total No. of average beds		634	3561	281	1838	1457	855	2551	537	1171400%	29.6%
Total Drug expenditure		$ 6,211,000	$ 24,274,395	$ 1,771,000	$ 12,294,505	$ 13,538,000	$ 6,777,624	$ 23,183,642	$ 2,418,743	9046890900%	27.9%

Inclusion C

Drug Issue Data

Data source:

- Survey returns

Table 1. All requested issue elements available

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	31	2	11	4	4	30	6	89	54.3%
No. of average beds	634	8732	341	3753	1267	1430	7119	1953	25229	63.7%
Drug expenditure	$ 6,211,000	$65,272,310	$ 2,191,000	$33,456,073	$15,274,070	$10,759,333	$73,910,944	$19,941,072	$227,015,802	70.1%

Table 2. All requested issue elements available, in a printed report

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	29	0	11	3	4	27	6	81	49.4%
No. of average beds	634	7731	0	3753	781	1430	6842	1953	23124	58.4%
Drug expenditure	$ 6,211,000	$53,715,152	$ -	$33,456,073	$ 9,634,070	$10,759,333	$72,426,944	$19,941,072	$206,143,644	63.7%

Table 3. All requested issue elements available, except a unique drug code

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	40	2	21	9	6	34	13	126	76.8%
No. of average beds	634	10224	341	6222	3004	1850	7548	3112	32935	83.2%
Drug expenditure	$ 6,211,000	$80,647,975	$ 2,191,000	$51,953,269	$29,902,820	$11,343,763	$74,629,090	$33,379,679	$290,458,596	89.7%

Table 4. All requested issue elements available, except a unique drug code, in a printed report

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	36	0	20	7	4	30	13	111	67.7%
No. of average beds	634	9115	0	5967	2098	1430	7188	3112	29544	74.6%
Drug expenditure	$ 6,211,000	$68,540,817	$ -	$45,653,269	$23,249,820	$10,759,333	$73,173,944	$33,379,679	$260,967,862	80.6%

Table 5. Hospitals reporting availabilty of drug code

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	34	2	11	4	4	33	6	95	57.9%
No. of average beds	634	9234	341	3753	1267	1430	7452	1953	26064	65.8%
Drug expenditure	$ 6,211,000	$68,086,735	$ 2,191,000	$33,456,073	$15,274,070	$10,759,333	$75,850,874	$19,941,072	$231,770,157	71.6%

Table 6. Hospitals reporting availabilty of generic name

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	48	3	23	10	6	38	14	143	87.2%
No. of average beds	634	12449	371	6681	3190	1850	7979	3200	36354	91.8%
Drug expenditure	$ 6,211,000	$92,855,720	$ 2,249,000	$54,164,811	$31,007,652	$11,343,763	$77,042,020	$33,797,679	$308,671,645	95.4%

Table 7. Hospitals reporting availabilty of strength

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	47	3	23	10	6	38	14	142	86.6%
No. of average beds	634	12229	371	6681	3190	1850	7936	3200	36091	91.1%
Drug expenditure	$ 6,211,000	$91,033,930	$ 2,249,000	$54,164,811	$31,007,652	$11,343,763	$77,102,532	$33,797,679	$306,910,367	94.8%

Table 8. Hospitals reporting availabilty of dose form

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	46	3	23	9	6	38	14	140	85.4%
No. of average beds	634	12076	371	6681	3004	1850	7936	3200	35752	90.3%
Drug expenditure	$ 6,211,000	$90,580,260	$ 2,249,000	$54,164,811	$29,902,820	$11,343,763	$77,102,532	$33,797,679	$305,351,865	94.3%

Table 9. Hospitals reporting availabilty of pack size

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	36	2	20	7	4	36	14	120	73.2%
No. of average beds	634	7849	341	5086	1572	1430	7654	3200	27766	70.1%
Drug expenditure	$ 6,211,000	$57,528,452	$ 2,191,000	$40,435,019	$12,189,555	$10,759,333	$76,561,532	$33,797,679	$239,673,570	74.0%

Table 10. Hospitals reporting availability of Unit/Pack price

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	46	2	21	10	6	36	14	136	82.9%
No. of average beds	634	11249	341	6222	3190	1850	7787	3200	34473	87.0%
Drug expenditure	$ 6,211,000	$84,624,897	$ 2,191,000	$51,953,269	$31,007,652	$11,343,763	$76,629,602	$33,797,679	$297,758,862	92.0%

Table 11. Hospitals reporting availability of Unit/Packs issued

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	42	3	22	10	6	35	13	132	0.3%
No. of average beds	634	10671	371	6607	3190	1850	7603	3112	34038	0.0%
Drug expenditure	$ 6,211,000	$83,557,665	$ 2,249,000	$53,843,061	$31,007,652	$11,343,763	$75,162,602	$33,379,679	$296,754,422	

Table 12. All requested issue elements available, except unique drug code, in an electronic form

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	0	6	1	8	2	2	10	6	35	21.3%
No. of average beds	0	2776	281	2579	521	992	2103	1968	11220	28.3%
Drug expenditure	$ -	$31,265,377	$ 1,771,000	$27,705,309	$ 7,664,070	$ 7,737,600	$22,695,753	$20,219,136	$119,058,245	36.8%

Table 13. All requested issue elements available, except unique drug code, in an electronic form, and a computer file available

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	0	3	1	5	1	1	3	1	15	9.1%
No. of average beds	0	1189	281	1161	103	477	530	103	3844	9.7%
Drug expenditure	$ -	$12,249,467	$ 1,771,000	$ 9,495,179	$ 278,070	$ 3,663,150	$ 3,059,000	$ 610,000	$ 31,125,866	9.6%

Table 14. All requested issue elements available, in an electronic form

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	0	4	1	4	2	2	10	5	28	17.1%
No. of average beds	0	2191	281	1713	521	992	2103	1865	9666	24.4%
Drug expenditure	$ -	$20,943,550	$ 1,771,000	$16,445,179	$ 7,664,070	$ 7,737,600	$22,695,753	$19,609,136	$ 96,866,288	29.9%

Table 15. All requested issue elements available, in an electronic form, and a computer file available

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	0	2	1	3	1	1	3	0	11	6.7%
No. of average beds	0	1092	281	692	103	477	530	0	3175	8.0%
Drug expenditure	$ -	$11,792,120	$ 1,771,000	$ 5,445,179	$ 278,070	$ 3,663,150	$ 3,059,000	$ -	$ 26,008,519	8.0%

Table 16. Hospitals able to report issue data for non-inpatients

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	33	1	19	6	5	27	11	103	62.8%
No. of average beds	634	8529	281	4901	2464	1790	5885	2897	27381	69.1%
Drug expenditure	$ 6,211,000	$65,782,976	$ 1,771,000	$38,463,898	$26,842,070	$11,062,843	$57,474,399	$32,201,154	$239,809,340	74.1%

Table 17. Hospitals able to report issue data for inpatients

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	37	2	19	7	5	30	12	113	68.9%
No. of average beds	634	9047	341	4901	2525	1790	6217	3048	28503	72.0%
Drug expenditure	$ 6,211,000	$67,267,162	$ 2,191,000	$38,463,898	$27,015,070	$11,062,843	$59,787,798	$33,027,879	$245,026,650	75.7%

Hospitals able to report issue data for other patient types

DID-Totalissued-Other_test	Data	State ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	As % of survey returns
	No. of hospitals	1	16	1	7	2	1	12	1	41	25.0%
	No. of average beds	634	3829	30	1991	521	516	2908	90	10518	26.6%
	Drug expenditure	$ 6,211,000	$28,305,810	$ 58,000	$21,908,626	$ 7,664,070	$ 4,074,450	$29,844,501	$ 431,585	$ 98,498,042	30.4%
A & E yes, Same Day no.	No. of hospitals	0	0	0	0	1	0	0	0	1	0.6%
	No. of average beds	0	0	0	0	777	0	0	0	777	2.0%
	Drug expenditure	$ -	$ -	$ -	$ -	$10,556,000	$ -	$ -	$ -	$ 10,556,000	3.3%
A & E. Home Health Care, Private Prescriptions	No. of hospitals	0	0	0	0	0	0	1	0	1	0.6%
	No. of average beds	0	0	0	0	0	0	201	0	201	0.5%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,138,000	$ -	$ 1,138,000	0.4%
All cost centres	No. of hospitals	0	0	0	0	0	1	0	0	1	0.6%
	No. of average beds	0	0	0	0	0	340	0	0	340	0.9%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ 2,703,174	$ -	$ -	$ 2,703,174	0.8%
As above	No. of hospitals	0	1	0	1	0	0	0	0	2	1.2%
	No. of average beds	0	97	0	379	0	0	0	0	476	1.2%
	Drug expenditure	0	457347	0	3300000	0	0	0	0	3757347	1.2%
Can be done on an individual ward basis	No. of hospitals	0	1	0	0	0	0	0	0	1	0.6%
	No. of average beds	0	450	0	0	0	0	0	0	450	1.1%
	Drug expenditure	$ -	$ 4,667,100	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,667,100	1.4%
Casualty	No. of hospitals	0	0	0	0	0	0	0	1	1	0.6%
	No. of average beds	0	0	0	0	0	0	0	108	108	0.3%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 750,222	$ 750,222	0.2%
Casualty and other wards	No. of hospitals	0	1	0	0	0	0	0	0	1	0.6%
	No. of average beds	0	318	0	0	0	0	0	0	318	0.8%
	Drug expenditure	$ -	$ 1,284,202	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,284,202	0.4%
Casualty,	No. of hospitals	0	1	0	0	0	0	0	0	1	0.6%
	No. of average beds	0	421	0	0	0	0	0	0	421	1.1%
	Drug expenditure	$ -	$ 3,162,500	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,162,500	1.0%
Casualty, Home Health (HACE) Care	No. of hospitals	0	1	0	0	0	0	0	0	1	0.6%
	No. of average beds	0	82	0	0	0	0	0	0	82	0.2%
	Drug expenditure	$ -	$ 147,580	$ -	$ -	$ -	$ -	$ -	$ -	$ 147,580	0.0%
Casualty, Hospital in the home	No. of hospitals	0	0	0	0	0	0	1	0	1	0.6%
	No. of average beds	0	0	0	0	0	0	290	0	290	0.7%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,367,000	$ -	$ 1,367,000	0.4%
Casualty, Rehabilitation, Outreach	No. of hospitals	0	0	0	0	1	0	0	0	1	0.6%
	No. of average beds	0	0	0	0	420	0	0	0	420	1.1%
	Drug expenditure	$ -	$ -	$ -	$ -	$ 1,013,000	$ -	$ -	$ -	$ 1,013,000	0.3%
Cost centres	No. of hospitals	0	0	0	2	0	0	0	0	2	1.2%
	No. of average beds	0	0	0	938	0	0	0	0	938	2.4%
	Drug expenditure	$ -	$ -	$ -	$ 7,921,542	$ -	$ -	$ -	$ -	$ 7,921,542	2.4%
Dental - other hospitals	No. of hospitals	0	0	0	1	0	0	0	0	1	0.6%
	No. of average beds	0	0	0	50	0	0	0	0	50	0.1%
	Drug expenditure	$ -	$ -	$ -	$ 147,800	$ -	$ -	$ -	$ -	$ 147,800	0.0%
Discharge patients	No. of hospitals	0	1	0	0	0	0	0	0	1	0.6%
	No. of average beds	0	320	0	0	0	0	0	0	320	0.8%
	Drug expenditure	$ -	$ 669,840	$ -	$ -	$ -	$ -	$ -	$ -	$ 669,840	0.2%
Discharge patients, W/O, Controlled drugs, imprest	No. of hospitals	0	0	0	0	1	0	0	0	1	0.6%
	No. of average beds	0	0	0	0	486	0	0	0	486	1.2%
	Drug expenditure	$ -	$ -	$ -	$ -	$ 5,640,000	$ -	$ -	$ -	$ 5,640,000	1.7%
Discharge, weekend leave, self-medication.	No. of hospitals	0	0	0	1	0	0	0	0	1	0.6%
	No. of average beds	0	0	0	578	0	0	0	0	578	1.5%
	Drug expenditure	$ -	$ -	$ -	$ 528,300	$ -	$ -	$ -	$ -	$ 528,300	0.2%
Drug usage for wards	No. of hospitals	0	1	0	0	0	0	0	0	1	0.6%
	No. of average beds	0	152	0	0	0	0	0	0	152	0.4%
	Drug expenditure	$ -	$ 715,283	$ -	$ -	$ -	$ -	$ -	$ -	$ 715,283	0.2%
Hospital in the home	No. of hospitals	0	0	0	0	0	0	1	0	1	0.6%
	No. of average beds	0	0	0	0	0	0	133	0	133	0.3%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,849,000	$ -	$ 1,849,000	0.6%
Hospital in the home, Casualty	No. of hospitals	0	0	0	0	0	0	1	0	1	0.6%
	No. of average beds	0	0	0	0	0	0	56	0	56	0.1%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 225,000	$ -	$ 225,000	0.1%
Methadone/Oncology/Wards/Sec 100/Discharges/TB	No. of hospitals	0	0	0	0	0	0	1	0	1	0.6%
	No. of average beds	0	0	0	0	0	0	86	0	86	0.2%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 378,000	$ -	$ 378,000	0.1%
Nursing Home	No. of hospitals	0	0	0	0	0	0	2	0	2	1.2%
	No. of average beds	0	0	0	0	0	0	166	0	166	0.4%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 489,000	$ -	$ 489,000	0.2%
Regional Dispensing	No. of hospitals	0	0	1	0	0	0	0	0	1	0.6%
	No. of average beds	0	0	281	0	0	0	0	0	281	0.7%
	Drug expenditure	$ -	$ -	$ 1,771,000	$ -	$ -	$ -	$ -	$ -	$ 1,771,000	0.5%
Regional Outposts	No. of hospitals	0	0	0	0	0	0	0	1	1	0.6%
	No. of average beds	0	0	0	0	0	0	0	88	88	0.2%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 331,936	$ 331,936	0.1%
Section 100/SAS	No. of hospitals	0	1	0	0	0	0	0	0	1	0.6%
	No. of average beds	0	338	0	0	0	0	0	0	338	0.9%
	Drug expenditure	$ -	$ 2,179,762	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,179,762	0.7%
to UR Nos: & wards - though with difficulty	No. of hospitals	0	0	0	0	1	0	0	0	1	0.6%
	No. of average beds	0	0	0	0	186	0	0	0	186	0.5%
	Drug expenditure	$ -	$ -	$ -	$ -	$ 1,104,832	$ -	$ -	$ -	$ 1,104,832	0.3%
Wards	No. of hospitals	0	0	0	0	0	0	0	1	1	0.6%
	No. of average beds	0	0	0	0	0	0	0	125	125	0.3%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 386,000	$ 386,000	0.1%
Wards, Clinics	No. of hospitals	0	1	0	0	0	0	0	0	1	0.6%
	No. of average beds	0	488	0	0	0	0	0	0	488	1.2%
	Drug expenditure	$ -	$ 9,864,480	$ -	$ -	$ -	$ -	$ -	$ -	$ 9,864,480	3.0%
Wards, clinics, paramedical & non medical depts.	No. of hospitals	0	0	0	0	0	0	0	1	1	0.6%
	No. of average beds	0	0	0	0	0	0	0	88	88	0.2%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 418,000	$ 418,000	0.1%
Wards, Discharge	No. of hospitals	0	0	0	0	1	0	0	0	1	0.6%
	No. of average beds	0	0	0	0	280	0	0	0	280	0.7%
	Drug expenditure	$ -	$ -	$ -	$ -	$ 1,970,000	$ -	$ -	$ -	$ 1,970,000	0.6%
Weekend Leave	No. of hospitals	0	0	0	0	0	0	1	0	1	0.6%
	No. of average beds	0	0	0	0	0	0	134	0	134	0.3%
	Drug expenditure	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,932,000	$ -	$ 3,932,000	1.2%
	Total No. of hospitals	1	26	2	12	7	2	20	5	74	45.1%
	Total No. of average beds	634	6495	311	3936	2650	856	3974	497	19352	49.9%
	Total Drug expenditure	$ 6,211,000	$51,443,904	$ 1,829,000	$33,806,268	$27,946,902	$ 6,777,624	$39,222,501	$ 2,316,743	$ 169,553,942	52.4%

Inclusion D

Combined Drug Purchase and Issue Data

Data source:

- Survey returns

Table 1. Hospitals able to report all purchase and issue elements, except unique drug code

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	32	2	17	5	4	33	12	106	64.6%
No. of average beds	634	7248	341	4353	1325	1430	7309	2466	25106	63.4%
Drug expenditure	$ 6,211,000	$ 55,213,904	$ 2,191,000	$ 39,296,319	$ 10,911,723	$ 10,759,333	$ 74,703,090	$ 22,379,679	$ 221,666,048	68.5%

Table 2. Hospitals able to report all purchase and issue elements

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	20	2	5	3	4	29	6	70	42.7%
No. of average beds	634	3510	341	780	781	1430	7012	1953	16441	41.5%
Drug expenditure	$ 6,211,000	$ 17,488,913	$ 2,191,000	$ 5,005,004	$ 9,634,070	$ 10,759,333	$ 74,017,944	$ 19,941,072	$ 145,248,336	44.9%

Table 3. Hospitals able to report all purchase and issue elements in a printed report

	State								As % of
Data	ACT	NSW	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	19	5	3	4	26	6	64	39.0%
No. of average beds	634	3391	780	781	1430	6735	1953	15704	39.7%
Drug expenditure	$ 6,211,000	$ 16,931,755	$ 5,005,004	$ 9,634,070	$ 10,759,333	$ 72,533,944	$ 19,941,072	$ 141,016,178	43.6%

Table 4. Hospitals able to report all purchase and issue elements, except unique drug code, in a printed report

	State								As % of
Data	ACT	NSW	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	27	16	4	4	29	12	93	56.7%
No. of average beds	634	6019	4098	905	1430	6949	2466	22501	56.8%
Drug expenditure	$ 6,211,000	$ 42,863,746	$ 32,996,319	$ 9,898,723	$ 10,759,333	$ 73,047,944	$ 22,379,679	$ 198,156,744	61.2%

Table 5. All purchase/issue elements available, except unique drug code, in an electronic form

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	31	2	16	5	4	33	12	104	63.4%
No. of average beds	634	6930	341	4303	1325	1430	7309	2466	24738	62.5%
Drug expenditure	$ 6,211,000	$ 53,929,702	$ 2,191,000	$ 39,148,519	$ 10,911,723	$ 10,759,333	$ 74,703,090	$ 22,379,679	$ 220,234,046	68.0%

Table 6. All purchase/issue elements available, except unique drug code, in an electronic form, and computer file available

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	0	4	1	7	1	1	8	3	25	15.2%
No. of average beds	0	1244	281	1383	103	477	1873	249	5610	14.2%
Drug expenditure	$ -	$ 12,340,467	$ 1,771,000	$ 10,533,552	$ 278,070	$ 3,663,150	$ 12,840,076	$ 1,462,222	$ 42,888,537	13.2%

Table 7 All purchase/issue elements available, in an electronic form

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	1	19	2	4	3	4	29	6	68	41.5%
No. of average beds	634	3192	341	730	781	1430	7012	1953	16073	40.6%
Drug expenditure	$ 6,211,000	$ 16,204,711	$ 2,191,000	$ 4,857,204	$ 9,634,070	$ 10,759,333	$ 74,017,944	$ 19,941,072	$ 143,816,334	44.4%

Table 8. All purchase/issue elements available, in an electronic form, and computer file available

	State									As % of
Data	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Grand Total	survey returns
No. of hospitals	0	2	1	1	1	1	7	0	13	7.9%
No. of average beds	0	265	281	31	103	477	1805	0	2962	7.5%
Drug expenditure	$ -	$ 883,120	$ 1,771,000	$ 122,760	$ 278,070	$ 3,663,150	$ 12,655,076	$ -	$ 19,373,176	6.0%

Inclusion E

Sample Hospital Utilisation Data Reports

Data sources:

Pharmacy Pilot Data - Anti-infective Drugs (April 1 - June 30, 1995) from :

Fairfield Hospital, VIC.

Kalgoorlie Regional Hospital, WA

Maroondah and District Hospital, VIC.

Royal Adelaide Hospital, SA

St Vincent's Hospital, NSW

Tamworth Base Hospital, NSW

Figure 1: Inpatient and non-inpatient activity linked expenditure and DDD data for drug, dose form form and strength, by ATC code.

ATC Code & Chemical Class	Drug	Form	Strength		DDD gm's	Total Mas Units- mg	Inpatient Cost($)	Total Inpatient DDDs	Inpatient DDDs per 100 occupied bed days	DDD's per 100 inpatient occasions of service	Non-Inpatient Drug cost ($)	Total Non-Inpatient DDDs	DDD's per 100 non-inpatient occasions of service	Total Drug Cost ($)	Total DDDs	Total DDD per 100 patient services
J01A																
	J01AA01	demeclocycline (demethylchlortetracycline)														
		capsule	150	mg	0.6	4,500	$8.19	7.50	0.0401	0.1686	$51.66	47.3118	0.1288	$59.85	54.8118	0.2974
	J01AA02	doxycycline														
		encapsulated pellets	100	mg	0.1	52,650	$85.74	526.50	2.8166	11.8341	$540.87	3,321.2908	9.0407	$626.61	3,847.7906	20.8748
		encapsulated pellets	100	mg	0.1	54,600	$159.12	546.00	2.9209	12.2724	$1,003.77	3,444.3013	9.3756	$1,162.89	3,990.3013	21.6480
		encapsulated pellets	100	mg	0.1	447,300	$1,194.93	4,473.00	23.9287	100.5394	$7,537.91	28,216.7763	76.8075	$8,732.84	32,689.7763	177.3470
		encapsulated pellets	50	mg	0.1	10,275	$15.62	102.75	0.5497	2.3095	$98.50	648.1721	1.7644	$114.12	750.9221	4.0739
		oral suspension	100	mg/10ml	0.1	1,500	$15.00	15.00	0.0802	0.3372				$15.00	15.0000	0.3372
	J01AA08	minocycline														
		capsule	100	mg	0.2	3,300	$11.82	16.50	0.0883	0.3709	$74.56	104.0860	0.2833	$86.38	120.5860	0.6542
		injection,powder for dil.	100	mg	0.2	2,250	$151.88	11.25	0.0602	0.2529				$151.88	11.2500	0.2529
		tablet	50	mg	0.2	4,500	$16.11	22.50	0.1204	0.5057	$101.63	141.9355	0.3864	$117.74	164.4355	0.8921
J01B																
	J01BA01	chloramphenicol														
		capsule	250	mg	3	7,500	$10.62	2.50	0.0134	0.0562	$66.99	15.7706	0.0429	$77.61	18.2706	0.0991
		injection,powder for dil.	12	g	3	1,134,000	$1,915.47	378.00	2.0221	8.4963				$1,915.47	378.0000	8.4963
J01C																
	J01CA04	amoxycillin														
		capsule	250	mg	1	367,500	$124.95	367.50	1.9660	8.2603	$788.22	2,318.2797	6.3105	$913.17	2,685.7797	14.5708
		capsule	500	mg	1	2,361,750	$803.00	2,361.75	12.6344	53.0850	$5,065.49	14,898.4957	40.5545	$5,868.48	17,260.2457	93.6394
		capsule	500	mg	1	2,625,000	$1,840.13	2,625.00	14.0427	59.0020	$11,607.96	16,559.1410	45.0748	$13,448.08	19,184.1410	104.0769
		injection,powder for dil.	1	g	1	1,605,000	$3,531.00	1,605.00	8.5861	36.0755				$3,531.00	1,605.0000	36.0755
		injection,powder for dil.	500	mg	1	297,750	$714.60	297.75	1.5928	6.6925				$714.60	297.7500	6.6925
		oral syrup	250	mg/5ml	1	45,000	$21.30	45.00	0.2407	1.0115	$134.37	283.8710	0.7727	$155.67	328.8710	1.7842
	J01CA12	piperacillin														
		injection,powder for dil.	3	g	14	1,746,000	$6,285.60	124.71	0.6672	2.8032				$6,285.60	124.7143	2.8032
	J01CA13	ticarcillin														
		injection,powder for dil.	3	g	15	220,500	$724.71	14.70	0.0786	0.3304				$724.71	14.7000	0.3304
	J01CE01	benzylpenicillin (penicillin g)														
		injection,powder for dil.	3	gram	3.6	436,500	$541.26	121.25	0.6486	2.7253				$541.26	121.2500	2.7253
		injection,powder for dil.	600	mg	3.6	2,245,500	$4,865.25	623.75	3.3368	14.0200				$4,865.25	623.7500	14.0200
	J01CF05	flucloxacillin														
		capsule	250	mg	2	217,500	$113.10	108.75	0.5818	2.4444	$713.46	686.0216	1.8674	$826.56	794.7716	4.3118
		capsule	500	mg	2	1,782,000	$855.36	891.00	4.7665	20.0270	$5,395.82	5,620.6456	15.2997	$6,251.18	6,511.6456	35.3267
		capsule	500	mg	2	2,542,500	$1,920.44	1,271.25	6.8007	28.5738	$12,114.57	8,019.3554	21.8291	$14,035.01	9,290.6054	50.4029
		injection,powder for dil.	1	g	2	465,000	$1,088.10	232.50	1.2438	5.2259				$1,088.10	232.5000	5.2259
		injection,powder for dil.	1	gram	2	2,304,000	$5,391.36	1,152.00	6.1627	25.8935				$5,391.36	1,152.0000	25.8935
		injection,powder for dil.	500	mg	2	195,750	$508.95	97.88	0.5238	2.1999				$508.95	97.8750	2.1999
		mixture	250	mg/5ml	2	30,000	$47.40	15.00	0.0802	0.3372	$299.01	94.6237	0.2576	$346.41	109.6237	0.5947
J01D																
	J01DA01	cephalexin														
		capsule	250	mg	2	20,625	$11.55	10.31	0.0552	0.2318	$72.86	65.0538	0.1771	$84.41	75.3663	0.4089
		capsule	500	mg	2	1,480,500	$866.26	740.25	3.9600	16.6386	$4,202.90	4,669.6778	12.7111	$4,869.15	5,409.9278	29.3497
		capsule	500	mg	2	525,000	$388.50	262.50	1.4043	5.9002	$2,450.75	1,855.9141	4.5075	$2,839.25	1,918.4141	10.4077
		oral syrup	250	mg/5ml	2	82,500	$109.73	41.25	0.2207	0.9272	$692.17	260.2151	0.7083	$801.90	301.4651	1.6355
	J01DA03	cephalothin														
		injection,powder for dil.	1	g	4	8,421,000	$19,046.16	2,105.25	11.2622	47.3196				$19,046.16	2,105.2500	47.3196
	J01DA05	cefoxitin														
		injection,powder for dil.	1	g	6	123,000	$1,201.71	20.50	0.1097	0.4608				$1,201.71	20.5000	0.4608
		injection,powder for dil.	2	g	6	69,000	$663.09	11.50	0.0615	0.2585				$663.09	11.5000	0.2585

ATC Code & Chemical Class	Drug	Form	Strength		DDD gm's	Total Mas Units- mg	Inpatient Cost($)	Total Inpatient DDDs	Inpatient DDDs per 100 occupied bed days	DDD's per 100 inpatient occasions of service	Non-Inpatient Drug cost ($)	Total Non-Inpatient DDDs	DDD's per 100 non-inpatient occasions of service	Total Drug Cost ($)	Total DDDs	Total DDD per 100 patient services
J01DA08	cefaclor															
		capsule	250	mg	1.5	22,500	$49.38	15.00	0.0802	0.3372				$49.38	15.0000	0.3372
J01DA11	ceftazidime															
		injection,powder for dil.	1	g	6	109,500	$1,885.59	18.25	0.0976	0.4102	$11,894.76	115.1255	0.3134	$13,780.35	133.3755	0.7236
		injection,powder for dil.	2	g	6	213,000	$3,667.86	35.50	0.1899	0.7979	$23,137.76	223.9427	0.6096	$26,805.62	259.4427	1.4075
J01DA13	ceftriaxone															
		injection,powder for dil.	1	g	2	1,950,000	$36,582.00	975.00	5.2159	21.9150				$36,582.00	975.0000	21.9150
		injection,powder for dil.	2	g	2	6,000	$110.55	3.00	0.0160	0.0674				$110.55	3.0000	0.0674
		injection,powder for dil.	250	mg	2	2,250	$78.66	1.13	0.0060	0.0253	$496.21	7.0968	0.0193	$574.87	8.2218	0.0446
J01DA14	cefotetan															
		injection,powder for dil.	1	g	4	1,500	$15.00	0.38	0.0020	0.0084				$15.00	0.3750	0.0084
J01E																
J01EA01	trimethoprim															
		oral suspension	300	mg/10ml	0.4	4,500	$9.90	11.25	0.0602	0.2529	$62.45	70.9677	0.1932	$72.35	82.2177	0.4460
		tablet	300	mg	0.4	204,750	$347.10	511.88	2.7383	11.5054	$2,189.59	3,229.0325	8.7896	$2,536.69	3,740.9075	20.2950
		tablet	300	mg	0.4	383,300	$374.58	983.25	5.2600	22.1005	$2,362.94	6,202.5811	16.8837	$2,737.52	7,185.8311	38.9842
J01F																
J01FA01	erythromycin (inc. salts)															
		encapsulated pellets	250	mg	1	15,000	$7.80	15.00	0.0802	0.3372	$49.20	94.6237	0.2576	$57.00	109.6237	0.5947
		encapsulated pellets	250	mg	1	382,500	$324.36	382.50	2.0462	8.5974	$2,046.14	2,412.9034	6.5680	$2,370.50	2,795.4034	15.1655
		encapsulated pellets	250	mg	1	49,500	$74.91	49.50	0.2648	1.1126	$472.55	312.2581	0.8500	$547.46	361.7581	1.9626
		injection,powder for dil.	1	g	1	231,000	$1,328.25	231.00	1.2358	5.1922				$1,328.25	231.0000	5.1922
		injection,powder for dil.	300	mg	1	40,500	$405.00	40.50	0.2167	0.9103				$405.00	40.5000	0.9103
		oral suspension	250	mg/5ml	1	30,000	$33.90	30.00	0.1605	0.6743	$213.85	189.2473	0.5151	$247.75	219.2473	1.1894
J01FA06	roxithromycin															
		tablet	150	mg	0.3	15,750	$112.77	52.50	0.2809	1.1800	$711.38	331.1828	0.9015	$824.15	383.6828	2.0815
		tablet	150	mg	0.3	31,500	$228.69	105.00	0.5617	2.3601	$1,442.83	662.3656	1.8030	$1,671.32	767.3656	4.1631
		tablet	150	mg	0.3	22,950	$101.75	76.50	0.4092	1.7195	$641.83	482.5807	1.3136	$743.58	559.0807	3.0331
J01FA09	clarithromycin															
		tablet,film coated	250	mg	0.5	596,250	$4,770.00	1,192.50	6.3794	26.8038	$30,090.32	7,522.5812	20.4769	$34,860.32	8,715.0812	47.2806
J01FF01	clindamycin															
		capsule	150	mg	1.2	1,350	$2.93	1.13	0.0060	0.0253	$18.45	7.0968	0.0193	$21.38	8.2218	0.0446
J01FF02	lincomycin															
		injection solution	600	mg/2ml	1.8	4,500	$13.40	2.50	0.0134	0.0562				$13.40	2.5000	0.0562
J01G																
J01GB01	tobramycin															
		injection solution	80	mg/2ml	0.24	120,840	$4,380.45	503.50	2.6935	11.3171	$27,632.95	3,176.2010	8.6458	$32,013.40	3,679.7010	19.9629
J01GB03	gentamicin															
		injection solution	10	mg/1ml	0.24	60	$11.40	0.25	0.0013	0.0056				$11.40	0.2500	0.0056
		injection solution	80	mg/2ml	0.24	341,640	$1,708.50	1,423.50	7.6152	31.9960				$1,708.50	1,423.5000	31.9960
J01M																
J01MA02	ciprofloxacin															
		injection solution	200	mg/100m	1	40,200	$6,490.29	40.20	0.2151	0.9036				$6,490.29	40.2000	0.9036
		oral suspension	500	mg/10ml	1	30,000	$245.28	30.00	0.1605	0.6743	$1,547.29	189.2473	0.5151	$1,792.57	219.2473	1.1894
		tablet,film coated	500	mg	1	1,026,000	$7,255.34	1,026.00	5.4887	23.0614	$45,768.42	6,472.2585	17.6178	$53,023.76	7,498.2585	40.6792
		tablet,film coated	750	mg	1	360,000	$2,641.73	360.00	1.9259	8.0917	$16,664.65	2,270.9679	6.1817	$19,306.37	2,630.9679	14.2734
J01MA06	norfloxacin															
		capsule,powd.for n/e mix.	400	mg	0.8	12,000	$37.58	15.00	0.0802	0.3372	$237.03	94.6237	0.2576	$274.61	109.6237	0.5947
		tablet	400	mg	0.8	487,800	$1,236.93	609.75	3.2619	13.7053	$7,802.86	3,846.4519	10.4702	$9,039.79	4,456.2019	24.1756
J01X																
J01XA01	vancomycin															
		capsule	125	mg	2	15,000	$630.00	7.50	0.0401	0.1686	$3,974.19	47.3118	0.1288	$4,604.19	54.8118	0.2974
		injection,powder for dil.	500	mg	2	297,000	$6,005.82	148.50	0.7944	3.3378				$6,005.82	148.5000	3.3378

ATC Code & Chemical Class	Drug	Form	Strength		DDD gm's	Total Mas Units- mg	Inpatient Cost($)	Total Inpatient DDDs	Inpatient DDDs per 100 occupied bed days	DDD's per 100 inpatient occasions of service	Non-Inpatient Drug cost ($)	Total Non-Inpatient DDDs	DDD's per 100 non-inpatient occasions of service	Total Drug Cost ($)	Total DDDs	Total DDD per 100 patient services
J01XB01	colistin															
		injection,powder for dil.	150	mg	3	35,775	$9,714.11	11.93	0.0638	0.2680	$61,278.95	75.2258	0.2048	$70,993.05	87.1508	0.4726
J01XD01	metronidazole															
		injection solution	500	mg/100m	1.5	1,660,500	$7,315.61	1,107.00	5.9220	24.8820				$7,315.61	1,107.0000	24.8820
		oral suspension	200	mg/5ml	1.5	18,000	$35.01	12.00	0.0642	0.2697	$220.85	75.6989	0.2061	$255.86	87.6989	0.4758
		tablet	200	mg	1.5	315,000	$228.00	210.00	1.1234	4.7202	$1,438.28	1,324.7313	3.6060	$1,666.28	1,534.7313	8.3261
		tablet	200	mg	1.5	15,600	$5.57	10.40	0.0556	0.2338	$35.11	65.6057	0.1786	$40.67	76.0057	0.4123
		tablet	400	mg	1.5	312,000	$198.56	208.00	1.1127	4.6752	$1,239.85	1,312.1148	3.5716	$1,436.51	1,520.1148	8.2469
		tablet	400	mg	1.5	266,400	$63.38	177.60	0.9501	3.9919	$399.78	1,120.3442	3.0496	$463.16	1,297.9442	7.0415
J01XD02	tinidazole															
		tablet,film coated	500	mg	1.5	42,000	$89.96	28.00	0.1498	0.6294	$630.57	176.6308	0.4808	$730.53	204.6308	1.1102
		tablet,film coated	500	mg	1.5	33,000	$87.32	22.00	0.1177	0.4945	$424.67	138.7814	0.3778	$491.99	160.7814	0.8723
J01XX04	spectinomycin															
		injection,powder for dil.	2	gram	3	12,000	$60.30	4.00	0.0214	0.0899				$60.30	4.0000	0.0899
J02A																
J02AA01	amphotericin															
		lozenge	10	mg	35	3,000	$31.95	0.09	0.0005	0.0019	$201.55	0.5407	0.0015	$233.50	0.6264	0.0034
J02AB07	ketoconazole															
		tablet	200	mg	0.2	12,000	$38.40	60.00	0.3210	1.3486	$242.24	376.4947	1.0303	$280.64	436.4947	2.3789
J02AC01	fluconazole															
		capsule	100	mg	0.2	11,400	$1,121.10	57.00	0.3049	1.2812	$7,072.17	359.5699	0.9788	$8,193.27	416.5699	2.2600
		capsule	200	mg	0.2	6,000	$574.74	30.00	0.1605	0.6743	$3,625.60	189.2473	0.5151	$4,200.34	219.2473	1.1894
		capsule	50	mg	0.2	675	$68.15	3.38	0.0181	0.0759	$429.88	21.2903	0.0580	$498.02	24.6653	0.1338
		injection solution	100	mg/50ml	0.2	450	$87.08	2.25	0.0120	0.0506				$87.08	2.2500	0.0506
		injection solution	200	mg/100m	0.2	9,000	$1,725.30	45.00	0.2407	1.0115				$1,725.30	45.0000	1.0115
J02AC02	itraconazole															
		capsule	100	mg	0.2	48,000	$1,258.89	240.00	1.2839	5.3945	$7,941.39	1,513.9786	4.1211	$9,200.28	1,753.9786	9.5156
J04A																
J04AA01	aminosalicylates (inc. calcium, phenyl, potassium or sodium)															
		tablet,film coated	250	mg	14	180,000	$1,094.84	12.86	0.0688	0.2890	$6,906.49	81.1060	0.2208	$8,001.32	93.9631	0.5098
J04AB01	cycloserine															
		capsule	250	mg	0.75	90,000	$576.00	120.00	0.6420	2.6972	$3,633.55	756.9893	2.0606	$4,209.55	876.9893	4.7578
J04AB02	rifampicin															
		capsule	150	mg	0.6	912,150	$608.10	1,520.25	8.1327	34.1706	$3,836.04	9,590.1082	26.1048	$4,444.14	11,110.3582	60.2754
		capsule	300	mg	0.6	2,377,800	$1,585.20	3,963.00	21.2004	89.0782	$9,999.83	24,999.5718	68.0501	$11,585.03	28,962.5718	157.1263
		injection,powder for dil.	600	mg	0.6	9,000	$1,350.00	15.00	0.0802	0.3372	$8,516.13	94.6237	0.2576	$9,866.13	109.6237	0.5947
		tablet	600	mg	0.6	18,000	$34.44	30.00	0.1605	0.6743	$217.26	189.2473	0.5151	$251.70	219.2473	1.1894
J04AB30	capreomycin															
		injection intramuscular	1	g	1	72,000	$1,728.00	72.00	0.3852	1.6183	$10,900.65	454.1938	1.2363	$12,628.65	526.1938	2.8547
J04AC01	isoniazid															
		oral solution	200	mg/10ml	0.3	9,000	$19.94	30.00	0.1605	0.6743				$19.94	30.0000	0.6743
		tablet	100	mg	0.3	3,051,000	$939.03	10,170.00	54.4054	228.5907	$5,923.63	64,154.8435	174.6328	$6,862.66	74,324.8435	403.2235
		tablet	100	mg	0.3	180,000	$69.80	600.00	3.2098	13.4862	$439.05	3,784.9465	10.3028	$508.65	4,384.9465	23.7890
		tablet	100	mg	0.3	702,000	$222.30	2,340.00	12.5181	52.5961	$1,402.32	14,761.2914	40.1810	$1,624.62	17,101.2914	92.7771
		tablet	100	mg	0.3	2,219,700	$367.17	7,399.00	39.5817	166.3070	$2,316.20	46,674.6988	127.0509	$2,683.37	54,073.6988	293.3580
J04AK01	pyrazinamide															
		tablet	500	mg	1.5	1,506,000	$1,933.70	1,004.00	5.3710	22.5689	$12,198.22	6,333.4772	17.2401	$14,131.92	7,337.4772	39.8069
J04AK02	ethambutol															
		tablet	100	mg	1.2	91,050	$126.56	75.88	0.4059	1.7054	$798.34	478.6380	1.3029	$924.89	554.5130	3.0083
		tablet	400	mg	1.2	1,585,200	$2,110.34	1,321.00	7.0668	29.6921	$13,312.51	8,333.1906	22.6834	$15,422.84	9,654.1906	52.3754
J04B																
J04BA01	clofazimine															
		capsule	100	mg	0.1	36,000	$44.16	360.00	1.9259	8.0917	$278.57	2,270.9679	6.1817	$322.73	2,630.9679	14.2734

ATC Code & Chemical Class	Drug	Form	Strength		DDD gm's	Total Mas Units- mg	Inpatient Cost($)	Total Inpatient DDDs	Inpatient DDDs per 100 occupied bed days	DDD's per 100 inpatient occasions of service	Non-Inpatient Drug cost ($)	Total Non-Inpatient DDDs	DDD's per 100 non-inpatient occasions of service	Total Drug Cost ($)	Total DDDs	Total DDD per 100 patient services
J05A																
J05AB01	acyclovir															
		injection,powder for dil.	250	mg	1	66,750	$8,907.12	66.75	0.3571	1.5003				$8,907.12	66.7500	1.5003
		injection,powder for dil.	500	mg	1	618,750	$87,481.62	618.75	3.3101	13.9076				$87,481.62	618.7500	13.9076
		tablet	200	mg	1	94,500	$854.90	94.50	0.5055	2.1241	$5,392.89	596.1291	1.6227	$6,247.78	690.6291	3.7468
		tablet	400	mg	1	45,000	$390.99	45.00	0.2407	1.0115	$2,466.46	283.8710	0.7727	$2,857.45	328.8710	1.7842
		tablet	800	mg	1	30,000	$244.85	30.00	0.1605	0.6743	$376.72	46.1579	0.1256	$621.56	76.1579	0.8000
J05AD01	foscarnet (trisodium formate)															
		injection solution	12	g/500ml	6.5	18,000	$187.50	2.77	0.0148	0.0622				$187.50	2.7692	0.0622
		injection solution	6	g/250ml	6.5	9,000	$98.75	1.38	0.0074	0.0311				$98.75	1.3846	0.0311
Antiinfectives - Total							$269,882.31				$406,566.77			$676,449.08		

Inclusion F

Costing for a Facility to Collect Drug Utilisation Data from Public Hospitals

Estimated costs for establishing and operating a unit to collect and report individual drug utilisation data from Australian public hospitals

Phase 1 & 2:

Objectives:

1. Consultation process for development of standard extended drug codes and descriptors
2. Development of standard extended drug codes and descriptors

Time required: 4 - 6 months

OPERATING COSTS

	Salary p.a.	F.T.E	No. of months	Cost
Staff				
Pharmacist	$ 50,000	2.0	6	$ 50,000
Programmer / database administrator	$ 50,000	1.0	3	$ 12,500
Statistics/epidemiology	$ 50,000	0.5	2	$ 4,167
Data entry operator	$ 25,000	0.5	2	$ 2,083
Clerical officer	$ 25,000	0.5	4	$ 4,167
				$ 72,917
On costs (26%)				$ 18,958
Subtotal				**$ 91,875**
Travel & accommodation (incl. stakeholder meetings)				$ 25,000
Subtotal				**$ 25,000**
Teleconferences				$ 2,000
Subtotal				**$ 2,000**
Office rental				$ 4,500
Outgoings				$ 5,000
Plant / equipment hire (computers, printers, fax/modem, furniture)				$ 40,000
Phone/Fax				$ 2,000
Consumables				$ 2,500
Photcopy /Printing				$ 2,500
Insurance				$ 1,500
Subtotal				**$ 58,000**
Contigency (10%)				**$ 17,688**
Phase 1 & 2 Total				**$ 194,563**

Estimated costs for establishing and operating a unit to collect and report individual drug utilisation data from Australian public hospitals

Phase 3 & 4:

Objectives:

1. Establishment of permanent office accommodation
2. Purchase of office furniture, office and electronic equipment
3. Recruitment of contributing hospitals
4. Site visits, MIS assistance to facilitate on-site data extraction

Time required: Establishment 3 - 6 months depending on n. of hospitals, then ongoing.

ESTABLISHMENT COSTS

Electronic equipment & furniture	Unit cost	No.	Total cost
PCs	$ 4,000	2	$ 8,000
PC Server	$ 10,000	1	$ 10,000
Bulletin Board equipment & software	$ 3,000	1	$ 3,000
Modems	$ 500	4	$ 2,000
Printer	$ 1,500	1	$ 1,500
Tape back-up unit	$ 1,200	1	$ 1,200
Uninterrupted power supply (UPS)	$ 750	1	$ 750
Facsimile	$ 1,500	1	$ 1,500
Photocopier	$ 7,500	1	$ 7,500
Telephones	$ 150	5	$ 750
Mobile phones	$ 1,000	2	$ 2,000
Office fit-out	$ 15,000	-	$ 15,000
Office furniture	$ 12,000	-	$ 12,000
Subtotal			**$ 65,200**

OPERATING COSTS (p.a.)

	Salary p.a.	F.T.E		Cost
Staff				
Pharmacist	$ 50,000	2.0		$ 100,000
Programmer / database administrator	$ 50,000	1.0		$ 50,000
Data entry operator	$ 25,000	1.0		$ 25,000
Clerical	$ 25,000	1.0		$ 25,000
				$ 200,000
On costs (26%)				$ 48,750
Subtotal				**$ 248,750**
Travel & accommodation (for site visits)				$ 25,000
Subtotal				**$ 25,000**
Teleconferences				$ 2,000
Subtotal				**$ 2,000**
Office rental (p.a.)	$ 10,000			$ 10,000
Outgoings (p.a.)	$ 5,000			$ 5,000
Phone/Fax (p.a.)	$ 5,000			$ 5,000
Consumables (p.a.)	$ 5,000			$ 5,000
Photcopy /Printing (p.a.)	$ 5,000			$ 5,000
Insurance (p.a.)	$ 2,500			$ 2,500
Subtotal				**$ 32,500**
Hospital incentive payments (p.a.)	$ 6,000	x	150	$ 900,000
Subtotal				**$ 900,000**
Contigency (10%)				**$ 127,345**
Total Phase 3 & 4 (p.a.)				**$ 1,375,795**
Grand total				**$ 1,570,358**

8. DISCUSSION

8.1 Submitting and reporting data

Most hospitals have a printed report containing one or more of the data elements required for utilisation reporting. Many hospitals have access to suitable format computer files which would facilitate electronic transmission. Sixty five percent of total Australian public hospital utilisation information may be available for capture. When this is combined with information already available for Section 100 drugs, a significant proportion of public hospital drug utilisation is represented.

The data most suitable for collection will be determined by the program objectives and the funds available. Data sources include purchase and/or issue data for both inpatient and non-inpatient samples. Purchase data are more readily available than issue data. Individual patient data would not be available due to privacy considerations.

Using data from different sources may cause problems in interpretation of utilisation figures. Purchase data, which should be reflective of drug issues, may be influenced by unusual buying patterns which do not reflect patient use. In these instances, issue data may more accurately reflect utilisation. The frequency of submission and reporting of data will also influence the interpretation of results. Very frequent reporting (eg. monthly) will be subject to influence from seasonal purchase patterns and other variations. Data submitted quarterly will, over time, minimise seasonal and other fluctuations. This would seem the most optimistic time frame for reporting but will be dependent on efficient reporting and submission of data from hospitals.

8.2 Printed data

Of most immediate interest is that most surveyed hospitals were able to provide printed reports of utilisation. Approximately 75% of surveyed hospitals indicated a willingness to provide data. A further 12% indicated they would consider the proposal. Other hospitals require further information or an incentive of some description to participate.

The establishment of a project infrastructure which could receive and process printed information would initially seem the most practical way to implement the project. The overall objective, however, should be to progress towards electronic capture and processing over a short time frame. Given that 25% of hospitals have indicated that computer data are currently available, a 5 year time frame would seem achievable.

If a manual approach to data collation is contemplated, the IMS option should be revisited. They already have in place the process and staff to undertake this operation. In addition they are already in receipt of data from 25 of the hospitals surveyed, 14 of which were teaching hospitals. These hospitals represent 25% of total current Australian public hospital expenditure. No doubt there are other hospitals involved for which data have not been obtained. However, before such an arrangement could be initiated, certain undertakings would have to be obtained from IMS to satisfy the Commonwealth and other interested groups. These relate specifically to the integrity of information, compatibility of coding systems with those specified in this report (or as otherwise determined within a framework of consultation) and access to raw data and information regarding the methodology of statistical projections.

8.3 Electronic data

Electronic lodgment of data is more problematic. Importantly, a standard coding system is not in operation in most sites. Drug descriptions were similarly variable. These and other factors complicated manipulation of sample data. Only a few hospitals have electronic reports available and sample data demonstrated no consistent format across sites which would enable automation of collation and reporting. The development of standards for data and file formats will be fundamental to the successful operation of such a project.

The electronic program could be conducted concurrently with manual data entry if rapid data collection was required. The program would still take 5 years to achieve its electronic goal but more data from more hospitals would be available in a shorter time frame to assist with the understanding of overall utilisation patterns. The manual submission program would be downgraded as more hospitals submitted electronic data.

8.4 Data submission

The format in which the data are submitted will have a significant bearing on how the project is structured. If information is processed manually by keying data from printed reports, several data entry personnel will be required in addition to pharmacists and computer personnel. Although a standard framework for data input would be required at the project office, standardisation of submitted data formats across the subscriber base would not be critical. Data would be interpreted by data processors and keyed in accordance with descriptions obtained from a scrolling list in the database. This would enable more hospitals to be recruited initially to the program than those able to submit electronic data. The lag time in commencing operations would be shorter since establishing an acceptable standard code for use by all hospitals would not be required.

For collation and analysis, hospitals could be grouped into strata which have reasonably constant utilisation across a range of hospital types within and across States. Those groups would be coordinated to submit quarterly data in a staggered fashion. These would not necessarily correspond with fiscal quarters. For example, 6 groups of hospitals might be defined and each month 2 of these groups would submit data for the previous 3 months drug utilisation. This would smooth the influx of data, reduce the volume of processing to a manageable level and facilitate reporting. Each group of data would be processed over the ensuing month and be completed and reported back to subscribers before the next group of data is submitted. Each group would therefore submit data only once every 3 months, or 4 times over any 12 month period. All hospitals would have submitted a complete financial year's data within 3 months of the closure of each financial year and the aggregated report would be available to subscribers one month later. Publication of cumulative data should occur during the following month. Much of this could be performed on-site with appropriate computer hardware, peripherals and publishing software.

The first hospitals recruited to the provide data should be those which use the most drugs (eg. the teaching hospitals). These hospitals are most able to generate the required data. The project team would work with these hospitals to ensure submitted data are received in the preferred format and that problems with source data are reported back to sites for correction. Other hospitals would be recruited progressively with the aim of capturing 75% of public hospital utilisation over a 5 year time frame.

8.5 Standard drug code

As described above and fundamental to the success of the project, is the requirement for a standard drug code for each drug product available in Australia. This requirement should be addressed as a matter of urgency. Dialogue towards agreement on a standard drug code incorporating a minimum set of drug descriptors must be initiated and brought to a satisfactory conclusion. Stake holders include Standards Australia, pharmacy and medical groups, the pharmaceutical industry, pharmaceutical wholesalers, bar-code groups, the computer software industry, distributed network operators, Internet service providers, medical information providers, State/Commonwealth authorities, and others. The code should be hierarchical in nature and linked to a therapeutic classification system. Additional code extensions could be developed for specific applications.

The lack of standards for describing and reporting drug utilisation from public hospitals creates a problem when attempting to aggregate information from different sites. Even hospitals using the same software differ in the drug codes used or the way drug descriptions are entered. This is because codes and descriptions are created locally rather than by central software houses.

The major difficulty encountered in my study was matching sample drug data to a common (standard) drug description. An SHPA code was supplied by only one site and thus the only way to match drug names to the ATC code (and hence a DDD) was to create a match between the drug name supplied and the one specified by the ATC classification system. The different drug descriptions used by each site made mapping to ATC codes difficult and required prior synchronisation of descriptions for each group of data. Similar difficulties were encountered when trying to standardise dose forms, strengths and strength units to a level where calculations for DDDs could occur.

It could be argued that it would have taken less time to manually input descriptions and DDDs alongside the supplied definitions than to attempt to automate the process. However, as some sites supplied data with more than 8000 records, this was not practical. An alternative approach would have been to key the supplied information into a central repository using standard descriptions selected from a look-up table (this is the method used by IMS). Again, with the large number of records supplied by some sites this was not possible within the time frame of the project. In any event, the objective of the project was to investigate the feasibility of a process which obviated manual data entry.

Until agreement on either a unique drug code (to the level of generic name, form and strength) or a standard description (which would allow mapping to a standard code (eg. ATC) and standard drug descriptor in a central data base), automation of collation and reporting for hospitals will be difficult. Standard definitions for data and data file formats would circumvent this problem.

8.6 Development of standards

The disparate computer hardware and software platforms used around the country and the limitation of data management system architectures currently *in-situ* (eg. no available field for a standard drug code or the inability of some software systems to manipulate alpha numeric data indexes), would initially make it difficult to use a standard code throughout all current systems.

Similarly, software manufacturers are unlikely to make changes to their data structures to accommodate the drug usage reporting requirements of the Commonwealth of their own volition. Even

less likely is that hospital pharmacy departments will be prepared to re-configure catalogues and inventory systems to accommodate standard drug or other descriptions.

A more practical approach would be to establish a central database which would provide the repository and management site for an Australian standard drug code and drug descriptors. Links between the major classification systems could be established and maintained. These could be updated as new drugs or products become available and resultant changes distributed to the subscriber network on a regular basis.

Contributing sites could then adopt one of 2 approaches for supplying drug utilisation figures. Firstly, they could modify their existing record structures to incorporate the standard codes and or drug descriptions (which would be linked to the central data base) and then output the required data fields in a suitable file format for use by the central data base administrators. The second option would be for hospitals to create master tables in-house which would link each drug entity for the respective hospital with the standard code maintained in the central database. Some relatively simple in-house processing which matched this code to the drug utilisation figures could then be performed. The resulting output would be only the data elements required for the central database. This would be forwarded on floppy disc or other suitable media.

Several groups have tried to develop a standard drug code, including the SHPA, the Family Medical Research Unit (FMRU) of the University of New South Wales, and the AMH. The SHPA has developed a standard coding system to the level of the individual drug or chemical and have proposed an extended coding system down to the level of dose form and strength. Similarly, the FMRU has undertaken development work to extend the ATC code to drug form, strength, pack size and manufacturer information from its current core classification (ie: to chemical). Only the FMRU and PBS systems incorporate codes for drug, form, strength, pack size and manufacturer. The FMRU and SHPA systems impart meaning to their codes by using a hierarchical approach to code structure. The AMH has derived a hierarchical therapeutic drug classification system using a fully relational database.

The SHPA and FMRU systems make provision for future inclusion of additional drug entities, although the concepts underpinning this are fundamentally flawed. This is because the FMRU, SHPA and other systems provide for future expansion by leaving strategically placed 'gaps' in their numbering systems. When, as is inevitable, new drug products become available which exceed the 'gap' capacity, or which are required in parts of the system where there are no gaps, the integrity of the systems will be compromised by necessary, non-standard modifications to accommodate these additional products. None of the systems (except the Americal Hospital Formulary System (AHFS)) are integrated with a therapeutic classification system although the PBS has mapped its codes to the ATC system. This limits the use of the codes for other purposes, for example, linking drugs to computerised knowledge resources.

Development work which has mapped 90% of the SHPA codes to ATC codes has been completed. At the present time an ability to incorporate SHPA codes is within the capacity of most pharmacy computer systems available in Australia. However, the current form of the code does not provide the level of utilisation detail required. Of additional note is that over half of the hospitals operating computer systems do not use SHPA codes for reporting purposes. The SHPA may need to encour-

age non-users to adopt this standard and progressively implement the system into pharmacy operating software.

Initial adoption of the ATC code (or some Australian variant) as the standard for utilisation reporting would enable merging of the DUSC database with the proposed hospital database thereby creating a complete data set for Australia. Ultimately, the ATC variant should be linked to a broader therapeutic classification system (eg. the AMH) which could be then used for other purposes, for example computerised prescription writing packages for medical practitioners.

The AMH classification system addresses the above limitations, but is currently incomplete. The AMH derives drug 'codes' by integrating its lists of drug products into a therapeutic classification used for the organisation of drug information. This is accomplished using a relational database and hierarchical data structures. Tree numbers can be generated for drug groups, drugs, form, route, strength and other drug details. Alternatively, a numbering system integrated into a therapeutic classification system can be generated, accommodating multiple contextual classifications for drugs. Contexual classification allows a drug entity to appear in more than one place within the system. For example, aspirin could be classified as an analgesic, antiplatelet, and antiinflammatory agent without compromising the system structure. The AMH data structure will accommodate combination products, herbal, non-prescription and therapeutic devices, has capacity for unlimited future expansion (by virtue of its relational database), and allows incorporation and mapping of other coding systems to the AMH identifiers.

Responsibility for the maintenance of the codes would sensibly rest with the TGA. As new drug products are registered or approved for marketing, a new code would be assigned. The code would remain with the product for perpetuity. In the absence of the TGA assuming responsibility for maintenance, then the DUSC or the AMH may be interested in undertaking this role.

A rational approach to developing and maintaining the standard code and descriptors would be to arrange for relevant stake-holders to meet and discuss the various applications for such a code. The various organisations could continue to use their own individual codes for their specific purposes. Agreement on a standard code would enable mapping of organisational codes to the standard codes for reporting purposes. Providing the respective maps are maintained by the relevant organisation and the same codes used for reporting purposes, centralisation of data would not be difficult.

9. SUMMARY

The estimated 684 public hospitals comprise 64,706 beds and collectively spend almost half a billion dollars annually on drugs. Teaching hospitals account for the largest proportion of hospital beds and drug expenditure. Some aggregated data from State and Commonwealth data sources are currently available. Aggregated drug utilisation data are published for Queensland, South Australia and Victoria. Some data for individual drugs (eg. Section 100 and Controlled Substances) are also available from State/Territory Health Departments. Industry drug utilisation data sources include IMS Australia, VHA Trade and various individual pharmaceutical manufacturers and wholesalers.

Two hundred fifty two hospitals were surveyed representing 76% of all public hospitals and 164 returned surveys were eligible for analysis. These accounted for 65.5% of surveyed hospitals, 61% of available beds, and 72% of estimated drug expenditure.

Ninety two percent of respondents had computerised pharmacy dispensing or inventory systems. All requested purchased data elements were available from 54.3% of respondents. Similarly, 54.3% (different respondents from previous figure) were able to report requested drug issue data elements. Forty three percent were able to report both drug purchase and drug issue data. About half of hospitals surveyed describe drugs according to a unique code, although coding systems vary between hospitals. The most common code used was the SHPA code. Five hospitals could not report the required demographic data.

Printed reports were available from 78% of hospitals. Computer file reports (in access ASCII or other file types) for drug purchase or issue data were available from 15.2% and 17.1% of hospitals, respectively. Six hospitals were able to supply pilot data within the timetable of the project.

Six hospitals provided pilot data which were converted into a standard format for expressing drug utilisation statistics. The minimum data fields were: generic name; strength; dose form; number of units purchased/issued; corresponding cost of purchase/issue. There was no consistency in the record or field structures for the 6 sites submitting pilot data.

Utilisation data were converted to mass units and expressed as DDDs per 100 occupied bed days or per 100 occasions of patient service. Report formats developed were based on the ASM. The establishment of a facility to receive and process printed information initially is recommended The program should progress towards electronic capture and processing over a 5 year time frame. Quarterly reporting of purchase/issue data is recommended. Data separated into inpatient and non-inpatient samples would be preferred.

10. CONCLUSION

Routine collection of drug utilisation data from public hospitals is feasible (23,24). Most surveyed hospital pharmacy departments have computerised inventory and/or dispensing systems. Findings indicate significant potential for submission of printed and electronic files and for automation of analysis and reporting. The lack of standards for describing and reporting drug utilisation from hospital sites is problematic. The present difficulty could be resolved by a standard approach to coding drugs, and definitions for data and file formats. The establishment of a central site for management of an Australian standard drug code is therefore proposed. Groups with possible interest include the SHPA, DUSC, the TGA and the Australian Medicines Handbook. Links between the major classification systems could be updated as new drugs or products become available. Contributing sites could: (a) modify their existing record structures to incorporate the relevant standards for coding and file formats, or; (b) create master tables 'in-house' which link hospital drugs with the standard code. Data could be forwarded by floppy disc, streaming tape, modem or *e*Mail.

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CHAPTER 23

GENERAL DISCUSSION, SUMMARY AND CONCLUSION

To facilitate rational and cost-effective use of drugs in hospitals, it is necessary to have accurate information on patterns of prescribing and utilisation. From this foundation, qualitative assessments of drug use can be made. Where use is sub-optimal, corrective measures can be implemented and subsequent evaluation used to monitor their impact.

The type or magnitude of drug misuse identified at the RAH are not different from those described in the literature. This is because patients, diseases, drugs and factors which influence prescribing have a common basis. The findings described in this thesis demonstrate the value of a comprehensive DUE program for measuring and assessing drug utilisation for a major Australian teaching hospital. In addition, it explores the feasibility of collecting quantitative data from public hospitals in a broader context.

The successes claimed for the local program, based on measurements of savings, criteria re-evaluation, and patient outcomes, are self-evident. They show that an important objective for DUE is in assessing where drug use problems are occurring and where correctional actions should be targeted. They have also demonstrated the contribution of DUE to the quality use of medicines, by showing improvements in utilisation over time with selected agents. At the national level the findings demonstrate the type of drug utilisation information available around the country, its accessibility and potential application.

1. AN INITIAL COMMENTARY

After being involved with DUE for a number of years, one realises that to persist in such efforts requires tolerance, patience and a healthy dose of cynicism. This is because of the idiosyncrasies, peccadilloes, egos, vested interests, rhetoric and politics associated with the Drug Committee and other committees, administrators, clinicians, pharmacists and accountants.

Drug misuse at the RAH is not intentional despite the number of resources readily available to enhance rational prescribing. Rather, there exists a complex milieu of influences over prescribing and drug use. Some forces (eg. the pharmaceutical industry) are overt and operate to undermine the philosophy of rational and economic drug use by promoting particular drugs or product lines to junior medical staff using sophisticated marketing techniques over which the Drug Committee has limited influence. Other forces are more subtle, for example, the conservative culture of the hospital and some staff, which resists influence over all aspects of medical practice, including prescribing.

These factors do not render DUE ineffectual. Instead, they demonstrate the challenging milieu of personalities, politics, economics, bureaucracy, conceptual hurdles and process or information system limitations, facing the effective operation of DUE programs. These are real challenges to DUE and to DUE personnel and, as potential obstacles to a DUE program, they must be recognised and overcome. Some of my observations in this regard are described briefly below.

1.1 Committees

The classic and potential 'inaction' of Committees applies equally to Drug Committees as to committee structures in other industries. DUE personnel should develop strategies in association with the Drug Committee chairman and senior colleagues to ensure the effectiveness of the Committee:

- educate members about the principles and practice of DUE so that they become advocates for the program and promote it outside the Committee;
- ensure that the Committee (rather than individual members) is charged with making decisions;
- ensure that hospital administration is represented on the Committee so that Committee decisions have the support and therefore the authority of the hospital;
- differentiate between important issues and minutiae before meetings;
- recruit committee opinion leaders to assist in effecting change;
- ensure individual Committee members do not undermine the work of the Committee outside the Committee.

Criticism of prescribing practices may become a sensitive issue even within the confines of Committee deliberations. Outside the Committee, suggestions of drug misuse are even more poorly received. The DUE process must therefore handle findings of inappropriate drug use non-punitively and always with the objective of improving patient care. Senior clinicians should be encouraged to monitor the activities of junior staff, rather than blame them for irrational prescribing, particularly when junior staff are often acting under the instruction of registrars and consultant staff (1).

1.2 Administrators

Hospital administrators must be careful not to defer responsibility for difficult decisions or poor 'medical' performance to the Drug Committee or the Pharmacy. This is particularly important when the Committees make difficult decisions to restrict the availability of drugs. In some cases these decisions, although well founded on medical or scientific principles, appear to be made for financial reasons (because the drugs involved are often expensive) or may oppose the current political or emotive tide. It is important that administrators support the Committee in such decisions and consult the Committee before implementing policy which may otherwise undermine Committee decisions.

These circumstances severely undermine the credibility, authority and morale of the Committee. Accordingly, the collective motivation of the Committee to make difficult decisions in the future may be impaired, thereby reducing the effectiveness of the Committee.

1.3 Accountants

There is no doubt that fiscal imperatives are a primary influence over health care around the world. Never-the-less, drug policy should not be solely driven by cost considerations. Finance staff should assist in development of drug budgets and managing expenditure and be made aware of the clinical reality that global budgets are consumed by individuals and that individual clinical situations are not always consistent with fiscal targets. The influence of hospital accountants over clinical decision making should be limited. Moreover, the impact of imposed reductions in resource allocation should be clearly communicated to the finance department and those responsible for them.

1.4 Pharmacy

I believe pharmacists in general and DUE pharmacists in particular, worry themselves over quality drug use issues which most clinicians (except perhaps clinical pharmacologists, who no doubt share the same frustration), don't even think about. There is little point in one group administering policy restrictions only to find that these policies are overridden by personnel who may not be aware of the reasons for the restrictions. I have been a witness to several occasions when pharmacists have administered Drug Committee policy in good faith only to have a bemused prescriber seek a higher authority who overrides the pharmacist's action. As with the issue of Drug Committee authority, care should be exercised to ensure that the authority of the Pharmacy in administering drug policy is not undermined. The granting of exceptions to policy should be limited to certain personnel and made in consultation with DUE personnel, the Director of Pharmacy and/or the Chairman of the Drug Committee or their delegate. Pharmacists may feel less inclined to risk future possible 'embarrassment' if they do not understand or are excluded from discussions about legitimate clinical situations which may call for 'special' consideration.

1.5 Authority

In certain circumstances, where professional staff resist change and/or 'friendly' approaches to adjust behaviour, it may be necessary for the Drug Committee to enforce compliance with drug policy. Thus, it is important to ensure that *authority* for DUE programs is established so that the Committee and the DUE program have 'teeth' when required.

1.6 Misunderstanding

Another barrier observed at the RAH has been the misunderstanding surrounding the DUE process and its purpose. The terms quality assurance and audit have negative connotations which some equate with attempts to intrude on professional conduct or exact punitive measures. This is a difficult conception to dispel. The vancomycin review was an example from which many lessons were learned. From that time forward, clinicians were involved in criteria development and in most review processes. Clinics were advised of all impending reviews and of the criteria upon which assessments would be made.

1.7 Pecuniary responsibility

Budgetary responsibility is a 'double-edged sword'. On one side when a committee has budgetary responsibilities, its major concern will be with the balance sheet. This may result in the quality objective of DUE being lost in the struggle to remain within budget targets. Conversely, when committees have no drug budget responsibility, drug utilisation may receive only cursory consideration, because responsibility for costs is shifted elsewhere. The Drug Committee resisted (not always successfully) efforts for it to assume responsibility for drug expenditure rather than quality of utilisation.

1.8 Resources

Other more practical factors influencing the implementation of DUE programs include the resources available to undertake such projects. Questions of whether staff will be employed to establish the program or be required from within existing infrastructures, will profoundly impact on the nature and scope of undertakings. The DUE program was assisted by a part-time research assistant, medi-

cal and pharmacy students, clinical and other pharmacists.

The cost of the program was also a consideration. As described previously, the initial survival of the program was contingent upon generating savings which were equivalent to the DUE pharmacist's salary. As is evident from my results, the program was more than cost effective over the years. However, because of this financial imperative, early DUE efforts targeted expensive drugs to the detriment of activities focussing on cheaper drugs. Thus, where program funding is a concern, there should be a balance between activities which generate savings as well as those where savings are of a lesser magnitude but which are still important from a quality perspective.

1.9 Information systems

Limitations of information systems has meant that the RAH DUE program has been labour intensive. This may have had its advantages since manual systems reduce the magnitude of programs to less ambitious proportions. Conversely, the automation which has been achieved, largely by the use of personal computers, has had a positive influence on the range and scope of projects. Computerisation and the increasingly common ability to link data from different sources means that data matching which was impossible with manual methods is now achievable over quite short time frames with desktop computers.

2. CORRECTING UNNECESSARY DRUG USE

At the RAH the Drug Committee has pursued a number of strategies to promote rational and cost-effective prescribing. Methods used include a drug formulary, pharmacy newsletter, implementation of a computerised individual patient use drug distribution system, and clinical pharmacist and clinical pharmacologist activities, each of which has been combined with an active DUE program. Feedback of program results is used to educate and encourage rational drug use. This may involve approaches by Drug Committee members or other experts to individual prescribers or wider groups. Other methods of promotion of the program and its objectives include distribution of letters, relevant medical literature, guidelines and protocols, which exemplify problem practices and suggest more appropriate alternatives.

2.1 Administrative measures

Corrective actions, which have the most lasting impact, are those least preferred by prescribers. They include regulatory or administrative controls such as use of formulary restrictions, required consultations or limiting drug use to specialist clinics. These methods are effective because they have been administered by external groups (eg. Pharmacy) and are generally absolute in their application (ie. restrictions are satisfied or they are not). However, it is not practical, possible or even desirable to introduce such measures for all drugs available in the hospital.

2.2 Education

In general, educative strategies have been less effective than other strategies for bringing about changes in prescribing habits. This is because the success of these methods is dependant on doctors reading the information, and applying it at the time of prescribing. Local surveys have shown that clinicians do not always consult the formulary or other documents for therapeutic advice. This means that the availability of guidelines is not sufficient to ensure rational drug use (eg. treatment of *C. difficile* colitis). Even the use of protocol based treatment does not cover all eventualities (eg.

DOFMS). Strategies employed at the RAH include hospital newsletters, Drug Committee memoranda, the formulary or leaflets distributed with dispensed drugs. The hospital formulary contains a range of therapeutic information as well as providing a list of drugs available from the hospital pharmacy. It is available on each ward, in each outpatient clinic and is distributed to each doctor in the hospital. However, even this is insufficient to prevent inappropriate drug use (eg. see acyclovir and norfloxacin review results). Systematic screening, prospective or concurrent monitoring or administrative measures, may be the only solution in these situations.

2.3 Prospective monitoring

To date, prospective monitoring efforts at the RAH have generally been directed at drugs which are expensive and used intermittently (eg. r-tPA). In some instances (eg. muromonab OKT3; $5000 per treatment course), assessments of compliance with criteria are made by a pharmacist before drugs are issued. Other drugs (eg. octreotide) have required the approval of the Chairman of the Drug Committee (or delegate) before they can be dispensed.

For other drugs (eg. r-tPA), which must be available for emergency and after hours use, it is not practical for doctors to seek approval before use. Therefore, monitoring is performed as part of the restocking process. Replacement stock is only provided following completion of a 'monitoring form' by the prescriber or delegate. The importance of maintaining emergency stock in the cardiac treatment areas seems to provide sufficient motivation for staff to comply with these directives. This form must record the name of the senior doctor who authorised treatment and be signed by that doctor or senior registrar. The form must be forwarded to the pharmacy immediately following each treatment course. The information transcribed on the forms is reviewed for compliance with criteria and doctors are advised when divergence from criteria is noted. The 'monitoring form' also serves as an educational aid by including the RAH drug use criteria on the reverse side.

2.4 Concurrent monitoring

Formal efforts at DUE monitoring have been described in the preceding chapters. The review of drug charts and drug therapy by clinical pharmacists are other examples of concurrent review. The impact of these activities has been limited by the number of pharmacists at ward level (< 1 pharmacist per 120 beds), and subsequently by the time available for close scrutiny of drug therapy orders. Regardless of the number of pharmacists available, they still cannot be in all places at all times. Thus collectively, these efforts have been inadequate to ensure compliance with formulary or other recommendations for drug use and without mechanisms which systematically screen all prescriptions, identification of 'at-risk' patients or drugs cannot be accomplished.

Systematic concurrent screening can be only accomplished by computerised prescribing systems or by recruiting dispensing pharmacists to the task when prescriptions are received for processing. At the RAH, technological solutions for computerised prescribing are many years away. Recruitment of dispensing pharmacists is however being attempted. This process has dual objectives: (1) to provide dispensary pharmacists with opportunities for clinical liaison with prescribers for selected drugs and (2) to augment the hospital DUE program by identifying 'at-risk' patients and 'risky' drugs by concurrent monitoring of prescriptions.

An example was my establishment - in mid-1995, and after completion of data collection for this thesis - of a concurrent, broad based, antibiotic monitoring program. This program was intended to

curb the misuse of expensive broad spectrum antibiotics identified by the DUE program, and to impose responsibility for ensuring appropriate anti-infective use on infectious disease specialists and clinical microbiologists. This program encompasses selected expensive, broad spectrum antibiotics including imipenem, ciprofloxacin, ceftazidime, vancomycin and Timentin™. The program procedure requires prescribing doctors to seek approval for continuation of antibiotic treatment from an infectious disease specialist, within 48 hours of commencing treatment (Note: Certain clinics, for example the Haematology unit, were approved to use specific drugs (eg. Timentin™)). The approving specialist must then contact the pharmacy to confirm continuation of therapy and provide details for indication, dosage and duration of treatment, for pharmacoepidemiology purposes.

The program initially met with resistance by some sections of the hospital. These episodes were resolved by negotiation. Interim analysis has shown close correlation between increased utilisation of selected antibiotics (eg. vancomycin) and the incidence of infection with peculiar organisms (eg. MRSA). Although reductions in expenditure have not been demonstrated, analysis has shown that utilisation is appropriate, based on drug choice, dose and duration of therapy. Data for interventions, the differential cost between requested drugs and those actually approved, and an assessment of clinical outcomes (with or without interventions), are awaited.

Programs of this type do have some disadvantages. They are labour intensive and disruptive to Pharmacy work flow. They must also be implemented cautiously and in a constructive manner to prevent the pharmacy being seen as 'drug police'. Care has been taken to identify the impositions/restrictions as originating from the Drug Committee (rather than Pharmacy) and to ensure that non-approvals are made by medical peers (rather than pharmacists).

An intended benefit of the program is that it has offered dispensary pharmacists an opportunity to directly interact with doctors and offer information and rationale about alternative treatments (by reference to hospital and other guidelines). A corresponding difficulty however, has been a reluctance by all but a few pharmacists to 'challenge' prescribers about the use of particular drugs, because they do not feel confident in their own knowledge base. This is currently being addressed by in-service education programs.

Several years ago it would not have been possible to impose this type of program at the RAH. Many Drug Committee members would have opposed its implementation as being unnecessarily restrictive. Similarly, certain members of the Division of Microbiology would not have supported the program or been prepared to refuse approval in selected circumstances. Only more recently, with changes in Committee membership, microbiology staff changes and the establishment of a hospital Infectious Diseases Unit - combined with increasing prevalence of multiple- antibiotic resistant organisms and fiscal imperatives - has the political will and support from clinical and general administration for such a program been forthcoming.

2.5 Involvement of senior staff

The most successful outcomes of the DUE program have been those involving well circumscribed groups of clinicians and/or patients. Examples include methylprednisolone, calcium folinate, the use of topical thrombin powder and antibiotic prophylaxis in colorectal surgery. The latter review involved qualitative methods while problems with the former were identified by quantitative review.

In each case, drugs were used by a discrete group of prescribers as opposed to drugs used by most hospital clinics (eg. ceftriaxone). In each instance, discussion with the user groups achieved changes to Unit policy. The impact of these changes was immediately evident. In all cases, the use of the 'offending' agent was reduced significantly or eliminated.

These outcomes occurred as a result of presenting objective data about inappropriate or unnecessary use, rationale supporting this assessment and importantly, recommendations for alternative therapy supported by objective documentation. By offering opportunities for negotiation and user ownership for the ultimate decision, compromise was easily obtained, to the mutual benefit of user, the patient and the hospital.

2.6 Responsibility for junior staff

In contrast, we have found that most prescribing apart from specialised units and the theatres was performed by junior medical staff - interns, residents or junior registrars - with senior medical staff having variable input. A suggestion therefore is that junior medical staff should be specifically targeted for educational intervention. An alternative view (1) is that if we are to improve the prescribing of junior medical staff, it may be more effective to place responsibility for inappropriate or unnecessary prescribing of the junior staff at the feet of their senior colleagues. In this way, peer pressure by groups such as the Drug Committee can be applied.

Consultant staff are responsible for the treatment of patients under their care including supervising the prescribing of junior staff and at least being aware of what treatments are being ordered. If inappropriate prescribing (by junior staff) is occurring then it is either happening with knowledge (and therefore approval) of the consultant, or else the consultants do not know what their junior staff are doing. The former circumstance demonstrates either poor understanding of pharmacological principles, failure to maintain a current knowledge base or even ignorance on the part of the consultant. The latter is an indictment of the level of supervision and direction given to junior medical staff. Either way, the ultimate responsibility for prescribing must rest with the supervisor and cannot be easily delegated. The responsibility is continuous and is particularly important in the early, formative years of postgraduate medical training. If the supervisor is made aware of drug misuse, their responsibility should be to implement measures to correct it. To prevent misuse, senior staff should be encouraged to review prescribing of junior staff to complement the more formal objective DUE programs undertaken by the Drug Committee.

3. PROGRAM LIMITATIONS

Although the DUE program has met with general 'in-principle' acceptance, program benefits have been limited by a reticence of the broader hospital community to implement available recommendations. Historically, DUE activities and results were viewed with some suspicion and recommendations were slow to be implemented. By placing the onus for DUE activities with the Drug Committee, the impact of the program has been less than perhaps could have been achieved with more widespread support and assistance. This environment is now changing.

3.1 The changing economic environment

A review of current hospital practices and consideration of alternative approaches to medical service provision is being undertaken widely in every area of hospital activity. Resulting decisions, imposed

by fiscal constraints, are now outcome driven. The twin general objectives are equity of access and optimisation of patient care. Since therapeutics is an integral part of patient care, programs for ensuring quality drug use must become an integral part of this review process. Therefore, a knowledge of DUE objectives, methods and benefits is becoming increasingly important.

In the current economic climate, service managers are seeking advice from the Pharmacy Department for means by which drug expenditure might be reduced. As a result, quantitative pharmacy DUE activities, which had been operating as a pharmacy background activity since 1988, began to be applied more widely after mid-1993. Service managers are now reviewing their own drug utilisation and are seeking advice from the pharmacy to assist interpretation of usage patterns. Consequently, joint Pharmacy-Service quantitative DUE has become a routine activity in many clinical areas. Ensuing recommendations have been accepted and speedily implemented. Correctional strategies are generally structural in nature and effects are immediate. They require little monitoring and produce cumulative savings. Subsequent quantitative utilisation review is then used to monitor the resulting effect of implementation of new processes and systems.

Another mechanism to reduce drug utilisation has been to reduce ward and Pharmacy inventory by altering the system of drug distribution within the hospital. These changes were facilitated by the progressive implementation of a computerised Pharmacy dispensing and inventory system together with changes to purchasing and materials management systems. Other strategies have been the reduction in the supply of discharge drugs, reductions in drug wastage by ensuring timely return of unused drugs to pharmacy, recycling of drugs previously discarded, and using a patient's own drugs while in hospital.

Savings generated by these and other DUE activities have been used in association with the 'Priority Drug Funding Model' (2), to finance new drug therapy initiatives. This has enabled the hospital to offer specialist drugs to additional patients without increasing drug expenditure in real terms. This has been crucial to the recent functioning of the Drug Committee. The 'Priority Funding Model' is now seen as a positive example of quality assurance in practice and has become a model for other areas in the hospital.

3.2 DUE is not only about saving money

Despite previous definitions of DUE which cautioned against cost containment as the primary objective, it is precisely difficult economic conditions which have led managers to be receptive to DUE as a management tool at the RAH. Of concern however, is that if cost containment constitutes the primary motivation for DUE at the RAH, the goal of ensuring rational drug use may be forgotten. In this context, DUE may be perceived as aiming to limit the choice/use of drugs rather than as an exercise in quality assurance. Whether this perception has long term ramifications to the continuing acceptance of the program remains to be seen. In the interim and in spite of the fiscal imperative, instigation and continuation of the DUE program at the RAH has ensured that quality of drug use and improved patient care remain priorities for the Drug Committee and the Pharmacy.

The capacity of quantitative DUE strategies to reduce drug costs is finite since drugs are not available free of charge. If further reductions in expenditure are required, attention must turn to minimising unnecessary drug use. This can only be achieved by qualitative DUE. Thus, by necessity, the

current acceptance of quantitative activities will also ultimately progress to acceptance of qualitative initiatives.

4. SUMMARY

The objective of this thesis is to provide an assessment of drug usage evaluation (DUE) as a tool for promoting the quality use of medicines in a hospital setting. Inappropriate drug use contributes to adverse patient health outcomes and increased health costs. Some consequences include patient under- or over-treatment, drug toxicity, adverse drug reactions, antibiotic resistance and other iatrogenic disease. They result in preventable patient morbidity and mortality, costly remedial care, additional costs for diagnosis and management of drug induced illness and in unnecessary wastage of resources. Drug usage evaluation (DUE), by promoting rational and economical drug therapy, aims to improve such outcomes.

My research describes both quantitative and qualitative DUE. Quantitative DUE is most often concerned with structural aspects of drug use. This included a study into the feasibility of collecting individual drug utilisation data from public hospitals around Australia. My qualitative research involved concurrent and prospective reviews of drugs, drug management of particular disease states and the drug aspects of medical procedures, over 40 topics in all. These included antibiotics, antiemetics, anti-ulcer drugs, intravenous fluids, sustained release morphine, anaesthetic agents, cytotoxic drugs, laxatives, antiviral drugs and tissue plasminogen activator. Studies have ranged from simple descriptive activities to expansive reviews. Structure, process and outcome indicators have been explored.

DUE is a multidisciplinary activity with the key players being medical practitioners and pharmacists. It has an educational focus and provides a foundation for more specific drug or procedure directed quality assurance activities, for education programs and for other strategies directed at improving the quality of drug use. Audit criteria for the qualitative aspects were therefore developed in association with relevant experts before reviews were undertaken. This ensured that criteria were practical, relevant, reproducible and clinically valid. In most cases, collected data were also reviewed by a clinician before final assessments of appropriateness were made. Clinicians were also involved in the review process. This not only ensured that a clinical interpretation was applied to data but also maintained program credibility and overall clinician acceptance of the DUE results.

The DUE program at the Royal Adelaide Hospital (RAH) was implemented in October 1987 in response to increasing pressure from the Hospital's administration to contain drug expenditure. The program was coordinated by me and integrated into the existing pharmacy service, augmenting the established formulary and supply procedures.

The program operated under the authority of the RAH Drug Committee. It is cyclical and is comprised of 2 integrated components:

1. Quantitative review:
    - routine quantitative reviews of rate, cost and expenditure data;
    - determination of user groups and review of usage patterns.
2. Qualitative review:
    - descriptive reviews;

- criteria based reviews.

Projects have involved clinical pharmacists, pharmacy trainees, medical students and clinicians. The DUE program has also become a useful basis for teaching and development of basic research skills for graduate and undergraduate students.

The program has become fundamental to the function of the Drug Committee. It has also focussed the hospital administration, finance and prescribing community's attention on quality assurance of drug therapy. The development of the 'Drug Policy Consensus Statement' and subsequently, the 'Priority Drug Funding Model' exemplify this point.

Re-evaluation has demonstrated improvements in utilisation for a number of drugs following implementation of corrective strategies. These have included education programs, formulary restrictions, required consultations and prospective monitoring. Total savings in excess of $900,000 have been described. This has allowed subsequent funding of new therapy initiatives.

The RAH DUE program has also become a model for other Australian hospitals. At least 10 major hospitals have similar programs. The increased interest in DUE has also seen the SHPA and ASCEPT establish specialist committees to further education and research in this area[i].

4.1 Quantitative DUE

Quantitative DUE has been pivotal to the DUE program at the RAH. For example, review of information systems, streamlining purchasing, inventory and drug distribution practices, and undertaking negotiations for discounts for selected agents have resulted in significant economies in drug utilisation at the RAH. In total, per annum savings resulting from quantitative DUE activities have exceeded $775,000.

The current economic climate demands economy in all aspects of health care, including drugs. DUE provides a mechanism for identifying opportunities to enhance the economy of the drug use process. DUE is now well accepted as a management tool to this end at the RAH. Recording and analysis of quantitative drug utilisation data forms the cornerstone upon which the hospital DUE program was built. These data have assisted the pharmacy and the Drug Committee (and others) to monitor changes in patterns of drug use.

An understanding of information sources and systems has been important to the establishment and conduct of the RAH DUE program. This includes knowledge about which data sources are available as well as their limitations. Quantitative analysis has been used to describe hospital drug expenditure in annual and in longitudinal terms. This has shown that the hospital has contained drug expenditure in real terms over almost 2 decades. This conclusion applies whether drug use is measured in inflation adjusted dollars, or as drug costs per patient or per occupied bed day.

Drugs from six major therapeutic classes have consistently accounted for the majority (approximately 70%) of hospital drug expenditure. Of the 400 drugs and 2000 products used at the RAH, approximately 10 account for one third of total drug expenditure.

[i] I chaired the inaugural SHPA Committee and was a foundation member of the ASCEPT Clinical interest group.

Rate and cost trends for major therapeutic drug classes, drug groups within classes and individual drugs have been described. Figures have been derived from purchase, expenditure and issue data. Utilisation has been expressed as dollars, as percentage and dollar variance from budgets, as variance from statistical thresholds and as differences between years. Rapid identification of 'problem' utilisation patterns has been possible as has objective quantification of user groups.

A number of different report types have been used to describe the hospital utilisation profile. These reports emphasise different aspects of drug utilisation and assist in determining potential concerns in usage patterns. Reports describe major therapeutic groups, major classes within groups and subclasses within classes. Reports include month-to-date and year-to-date utilisation figures and offer comparisons with budget or with previous year figures.

4.2 Qualitative DUE

Many qualitative reviews have been described and different methods have been used to examine various elements of drug use. Most often, DUEs involved a comprehensive examination of many aspects of drug utilisation. Assessments of 'whether a drug was needed in the first place ?' through to measurements of clinical outcomes, were made. Some projects have been revisited to assess improvements in utilisation as a result of educational or other strategies.

The quality of drug use found by the studies was variable. For most drugs studied, appropriate use was noted in 50-75% of patients by one or more criteria assessed. Some drugs (eg. H_2 receptor antagonists) were generally found to be used for the right reasons. For other drugs (eg. antibiotics, r-tPA), the indication for drug use was questionable. A range of strategies have been employed to enhance drug use. Some common findings associated with drug misuse included:

- antibiotics used when there was no objective evidence of infection;
- excessive drug dosage or frequency of administration;
- inadequate dose or frequency of administration;
- prolonged duration of therapy;
- use of broad spectrum antibiotics when narrower spectrum and often less expensive antibiotics would have sufficed;
- unnecessary use of IV therapy.

Total savings offered by correction of drug misuse identified by qualitative DUE have been estimated to be in excess of $300,000. At the conclusion of my research, at least $150,000 of this had been realised. In most instances, poor understanding of general prescribing principles for antibiotics or other drugs was thought to be the main reason for inappropriate use.

4.3 Public hospital quantitative data collection feasibility study

This study arose from concern over the lack of centralised information on individual drug use from the public hospital system. The aim was to investigate the feasibility of establishing a comprehensive, central database for routine collection and reporting of individual drug usage data from public hospitals. The research was funded by a grant from the Commonwealth Pharmaceutical Benefits Scheme Education Program.

The objectives of the project were to:

1. review the extent of data available from public hospitals;

2. obtain and test pilot data;
3. provide recommendations for data formats;
4. prepare a cost analysis for the establishment of a centre to collect data.

The project was conducted in 3 phases including a survey of public hospitals. The study found that the range of Commonwealth, State and Industry drug utilisation data sources provide an encouraging starting point from which to gather public hospital utilisation data in a central source.

A survey of 252 public hospitals showed that over 75% of hospitals can provide utilisation data, mostly in the form of a printed report. Less than 20% of hospitals have ready access to electronic reports. An assessment of pilot data demonstrated that there is no consistency in record or field structures for electronic data. The lack of standards for describing and reporting drug utilisation from hospital sites is problematic. The present difficulties could be resolved by development of a standard drug classification and drug coding system, and definitions for data and file formats.

Recommendations for a minimum data set include:

- standard drug code;
- number of units issued or purchased;
- the cost of that issue or purchase;
- a description of the unit of issue.

The establishment of a central site for management of an Australian standard drug code was proposed.

5. BARRIERS

The major barriers associated with the DUE program at the RAH have been:

- misconceptions and suspicion by some staff about the goals and objectives of DUE (ie. to promote safe, rational and cost effective therapy rather than simply to restrict prescribing and cut costs);
- encouraging broad ownership of the DUE program by senior medical staff;
- having senior medical staff accept responsibility for prescribing of junior medical staff for patients under their clinics;
- resistance to change;
- getting medical staff to refer regularly to hospital or other guidelines for drug therapy;
- maintaining longevity of corrective actions;
- inability to introduce broad based prospective or concurrent monitoring because of resource constraints and the availability of computerised prescribing, and clinical decision support systems;
- measuring improvements in clinical outcomes attributable to DUE.

6. FUTURE OPPORTUNITIES

Concern over the lack of centralised information on individual drug use from the public hospital system has been described as a major focus of this thesis. The aim of the study described herein, was to investigate the feasibility of establishing a comprehensive, central database for routine collection and reporting of individual drug usage data from public hospitals. My findings and recommendations offer enormous opportunity for future development and research.

Future opportunities also exist for research into the application of outcome indicators in hospitals (and other settings) as measures of the quality of drug use and as an extension of DUE methodology. Similarly, research opportunities for pharmacists or other life science graduates exist in the related areas of cost-benefit, cost-utility and cost-effectiveness analysis and for the development of administrative research skills which contribute further to optimal drug utilisation.

Extension of institutional DUE methods into the community sphere is also worthwhile. The differences between hospital and community practice settings will however require modification of the methods described herein.

This latter area is where my energies are now being directed, following my appointment (in December 1995) as Editor of the Australian Medicines Handbook (AMH). This publication will be an independent, concise, comparative, and peer reviewed source of prescribing information. I hope that the AMH will improve quality use of medicines by providing an independent, up-to-date, practical drug information reference for medical practitioners, pharmacists, other health professionals and their students. Importantly, the AMH will serve as a teaching text and as a basis from which to develop optimal drug use criteria.

7. CONCLUDING REMARKS

Continuing evidence of poor prescribing illustrates the need for ongoing monitoring, intervention and education, and for DUE. There needs to be a broad recognition that quality drug use is important to patient care. There seems little point in investing time, effort and money in investigation and diagnosis when the treatment subsequently offered to patients is either unnecessary, irrational or even unsafe.

There needs to be support for DUE as a quality assurance process for drug therapy. Concurrent reviews of some or all aspects of prescribing by appropriately trained staff should be viewed as a constructive process which complements other aspects of patient management. To this end, any DUE program should have adequate plant and equipment, information systems and personnel resources. Importantly, the DUE program must have "teeth", so that key personnel have the ability and authority to initiate (or cause to be initiated) interventions when aberrant prescribing is observed.

Senior medical staff should be involved in the process. They should assist in the development of criteria and participate in intervention strategies aimed at the promotion of rational prescribing principles, particularly in areas and for staff under their direct supervision. They should take responsibility for the prescribing of their junior medical staff and again ensure that rational prescribing principles are observed and promoted.

Since it is unlikely, in a large teaching hospital, that all drugs or drug groups can be monitored simultaneously, it is necessary to instigate prospective targeted monitoring programs for "risky" drugs or "at risk" patients. Such monitoring can be facilitated by computerised individual, or unit-dose, drug distribution systems.

A number of personnel could undertake such programs including clinical pharmacologists, clinical pharmacists and dispensing pharmacists. Nursing staff, research assistants and students may also be valuable staff resources. Since clinical pharmacologists are few and far between in most institutions (and non-existent in others), it would seem reasonable to require pharmacists, in particular clinical

pharmacists, to be involved in the DUE process. Dispensing pharmacists should also play a role in detecting potential problems at the point of issue of drug therapy.

8. CONCLUSION

My thesis has shown that the RAH DUE program has contributed to quality use of medicines by:

- defining an acceptable quality of use for a broad range of drugs;
- making assessments about the quality of drug use;
- coordinating educational and other strategies to correct specific or general aspects of drug misuse;
- re-evaluating the use of drugs for which measures were instituted to improve utilisation;
- demonstrating general and specific improvements in utilisation by a number of measures (savings, re-evaluation, no adverse outcomes as a result of correctional strategies or interventions), and;
- demonstrating savings in excess of $1 million over the 6 years of the author's involvement with the program.

I therefore conclude that the use of DUE, for measuring and modifying drug use at the RAH, has been successful in implementation and cost effective in operation. In addition, I have described a practical model for routine collection of quantitative drug utilisation data from the Australian public hospital system.

9. BIBLIOGRAPHY

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APPENDIX 1

Royal Adelaide Hospital Formulary Classification System

4:00 ANTIHISTAMINES
4:04 H1 Antagonists
4:08 H2 Antagonists

8:00 ANTI-INFECTIVE AGENTS
8:08 Anthelmintics
8:12 Antibiotics
- 8:12:02 Aminoglycosides
- 8:12:04 Antifungal Agents
- 8:12:06 Cephalosporins
- 8:12:07 Miscellaneous beta-lactam antibiotics
- 8:12:08 Chloramphenicol
- 8:12:12 Erythromycins
- 8:12:16 Penicillins
- 8:12:24 Tetracyclines
- 8:12:28 Other Antibiotics

8:16 Antituberculars
8:20 Plasmodicides (Antimalarials)
8:22 Quinolones
8:24 Sulfonamides
8:26 Antileprotics (Sulfones)
8:32 Antitrichomonal/Anti-Anaerobic Agents
8:36 Urinary Germicides
8:44 Antiviral Agents

10:00 ANTINEOPLASTIC AND IMMUNO-SUPPRESSANT AGENTS
10:04 Alkylating Agents
10:08 Antineoplastic Antibiotics
10:12 Antimetabolites
10:16 Mitotic Inhibitors
10:20 Hormonal Agents
10:28 Other Antineoplastic Agents
10:32 Immunosuppressant Agents

12:00 AUTONOMIC DRUGS
12:04 Parasympathomimetic (Cholinergic) Agents
12:08 Parasympatholytic (Anticholinergic) Agents
12:12 Sympathomimetic (Adrenergic) Agents
12:16 Sympatholytic (Adrenergic Blocking) Agents
12:20 Skeletal Muscle Relaxants

14:00 BIOLOGICAL RESPONSE MODIFIERS
- 14:00:02 Interferons
- 14:00:04 Interleukins
- 14:00:06 Polyribonucleotides

20:00 BLOOD FORMATION AND COAGULATION
20:04 Anti-Anaemia Drugs
- 20:04:04 Iron Preparations

20:12 Coagulants and Anticoagulants
- 20:12:04 Anticoagulants
- 20:12:08 Antiheparin Agents
- 20:12:12 Antiplatelet Aggregating Agents
- 20:12:16 Haemostatics

20:40 Thrombolytic Agents

24:00 CARDIOVASCULAR DRUGS
24:04 Cardiac Drugs
24:06 Antilipaemic Agents
24:08 Hypotensive Agents
24:12 Vasodilating Agents (Peripheral)
24:16 Sclerosing Agents

28:00 CENTRAL NERVOUS SYSTEM DRUGS
28:08 Analgesics and Antipyretics
28:12 Anticonvulsants
28:14 General Anaesthetics
28:16 Psychotherapeutic Agents
- 28:16:04 Antidepressants
- 28:16:08 Tranquillisers
- 28:16:16 Other Psychotherapeutic Agents

28:20 C.N.S. Stimulants
28:24 Anxiolytics, Sedatives and Hypnotics
28:26 Antiparkinsonian Drugs

36:00 DIAGNOSTIC AGENTS
36:04 Adrenocortical Insufficiency
36:12 Blood Volume
36:18 Cardiac Function
36:38 Intestinal Absorption
36:40 Kidney Function
36:56 Myasthenia Gravis
36:61 Pancreatic Function
36:64 Phaeochromocytoma
36:66 Pituitary Function
36:67 Sweat Test
36:68 Tuberculosis
36:88 Test Reagents (blood/faecal/urine)
36:90 Radiopaque and Contrast Media
36:92 Miscellaneous Diagnostic Agents

40:00 ELECTROLYTE, NUTRITION AND FLUID BALANCE
40:04 Acidifying Agents
40:08 Alkalinising Agents
40:10 Ammonia Detoxicants
40:12 Electrolyte and Fluid Balance
40:14 Potassium Removing Agents
40:16 Trace Elements
40:20 Protein and Caloric Agents
40:24 Sugar Substitute
40:26 Dialysis Solutions
- 40:26:04 Peritoneal Dialysis Solutions
- 40:26:08 Haemodialysis Solutions

40:28 Diuretics

50:00 EAR, NOSE AND THROAT PREPARATIONS
50:04 Anti-Infectives
- 50:04:12 Miscellaneous Anti-Infectives

50:08 Anti-Infective and Anti-Inflammatory Agents
50:16 Local Anaesthetics
50:28 Mouthwashes
50:32 Vasoconstrictors and Decongestants
50:34 Wax Removing Agents
50:36 Other ENT Agents

52:00 EYE PREPARATIONS
- 52:04 Anti-Infectives
  - 52:04:04 Antibiotics
  - 52:04:05 Antibiotics with Anti-Inflammatory Agents
  - 52:04:06 Antivirals
  - 52:04:12 Miscellaneous Anti-Infectives
- 52:08 Anti-Inflammatory Agents
- 52:10 Carbonic Anhydrase Inhibitors
- 52:12 Contact Lens Solutions
- 52:14 Diagnostic Agents
- 52:16 Lubricants and Emollients
- 52:18 Local Anaesthetics
- 52:20 Miotics
- 52:24 Mydriatics
- 52:26 Solutions (irrigating, storage)
- 52:32 Vasoconstrictors
- 52:36 Other Agents

56:00 GASTRO-INTESTINAL DRUGS
- 56:04 Antacids and Adsorbents
- 56:08 Antidiarrhoea Agents
- 56:10 Antiflatulents
- 56:12 Cathartics and Laxatives
- 56:16 Digestants
- 56:20 Anti-Emetics
- 56:24 Anti-Ulcerants
- 56:32 Antispasmodics
- 56:40 Miscellaneous Gastro-Intestinal Drugs

60:00 ANTIRHEUMATIC AGENTS
- 60:04 Anti-inflammatory Agents
  - 60:04:04 Steroidal Anti-inflammatory Drugs
  - 60:04:08 Non-steroidal Antiinflammatory Drugs
  - 60:04:12 Slow Acting Anti-rheumatic Drugs
- 60:08 Anti-hyperuricaemic and Uricosuric Agents
  - 60:08:04 Anti-hyperuricaemic Agents
  - 60:08:08 Uricosuric Agents
  - 60:08:12 Miscellaneous

64:00 DETOXIFYING AGENTS AND ANTAGONISTS

68:00 HORMONES AND SYNTHETIC SUBSTITUTES
- 68:04 Adrenal Corticosteroids
- 68:06 Corticotrophic Agents
- 68:08 Anabolic Agents/Androgens
- 68:10 Gonadotrophin Inhibitor
- 68:12 Contraceptives (Oral)
- 68:14 Contraceptives (Spermicidal)
- 68:16 Oestrogens/Anti-Oestrogens
- 68:18 Progestogens
- 68:20 Antidiabetic Agents
  - 68:20:04 Hypoglycaemic Agents (Oral)
  - 68:20:08 Insulins
- 68:21 Glucagons
- 68:28 Pituitary and Hypothalamic Agents
- 68:36 Thyroid and Parathyroid

72:00 LOCAL ANAESTHETICS

76:00 OXYTOCICS

80:00 SERUMS AND VACCINES
- 80:04 Serums
- 80:12 Vaccines
- 80:16 Allergenic Extracts

84:00 SKIN AND MUCOUS MEMBRANE PREPARATIONS
- 84:04 Anti-Infective
  - 84:04:04 Antibiotics
  - 84:04:08 Antifungals
  - 84:04:10 Antiviral Agents
  - 84:04:12 Scabicides and Pediculicides
  - 84:04:16 Miscellaneous Topical Anti-Infectives
- 84:06 Anti-Inflammatory Agents
- 84:08 Antipruritics and Local Anaesthetics
- 84:24 Emollients and Protectants
  - 84:24:04 Basic Liniments
- 84:28 Keratolytic and Cleansing Agents
- 84:50 Pigmenting and Depigmenting Agents
  - 84:50:04 Pigmenting Agents
  - 84:50:08 Depigmenting Agents
- 84:80 Sunscreen Agents
- 84:88 Rectal Preparations
- 84:90 Vaginal Preparations
- 84:92 Irrigating Solutions
- 84:94 Miscellaneous Agents

86:00 RESPIRATORY AGENTS
- 86:04 Adrenal Corticosteroids
- 86:06 Antitussives
- 86:08 Bronchodilating Agents
- 86:14 Unclassified Respiratory Agents

88:00 VITAMIN PREPARATIONS
- 88:04 Vitamin A
- 88:08 Vitamin B Group
- 88:12 Vitamin C
- 88:18 Vitamin D
- 88:20 Vitamin E
- 88:24 Vitamin K Activity
- 88:28 Multivitamin Preparations
- 88:30 Multivitamin and Mineral Preparations

90:00 SPECIAL MEDIA

92:00 UNCLASSIFIED THERAPEUTIC AGENTS

APPENDIX 2

Royal Adelaide Hospital, Drug Committee

Drug Policy Consensus Statement

Royal Adelaide Hospital
North Terrace
Adelaide
South Australia, 5000

Pharmacy Department
Phone (08) 224 5549

ROYAL ADELAIDE HOSPITAL

DRUG COMMITTEE / ONCOLOGY COMMITTEE

ANTINEOPLASTIC DRUG WORKING PARTY

CONSENSUS STATEMENT

Preamble:

A joint Working Party of the Drug Committee and Oncology Committee of the Royal Adelaide Hospital (R.A.H.) was formed in March 1990 in response to difficulties experienced by both committees in relation to new antineoplastic drugs and cancer treatment initiatives at the R.A.H.. The Oncology Committee perceives a need for such treatments particularly in situations where they may be curative, prolong life or relieve symptoms. Clinical or safety advantages over existing therapies should also be considered. The Drug Committee found difficulty in fully assessing the clinical and economic implications of these often expensive treatments. In addition, because of the constraints imposed by an essentially fixed drug budget over the last 3 years and the expectation of similar funding arrangements in the future, the Drug Committee is concerned at the potential inability to fund some new treatments.

The R.A.H. / I.M.V.S. / University of Adelaide is the major centre in South Australia providing comprehensive services for the investigation, treatment and prevention of all forms of malignancy and will soon be augmented by the addition of the Hanson Centre for Cancer Research. It is certain that these issues will become critical as more of the new and expensive therapies presently on the horizon need to be made available to patients.

The Working Party with Dr. C. Juttner as Chairman defined Terms of Reference (Appendix 1). and met on 10 occasions between March 6th and June 21st, 1990.

The Working Party advocates continuation of protocol based management practice for all aspects of cancer treatment, including antineoplastic drugs. The Working Party recognises that the provision of cancer treatment is expensive on a per capita basis. However, it also consideres that current practices are generally appropriate and are provided to the highest professional standards and in the best interests of patients.

The Working Party believes that additional drug funding requests should follow the demonstration of optimal utilisation of current resources. This process is occurring but is limited by deficiencies in the detail of management information available from current systems and by a lack of human resources.

The Working Party firmly believes that these principles have application beyond the management of cancer. The Working Party accepts that there is a valid need to "ration" drugs, but is unanimous that this should be on the basis of professional standards rather than cost. The increasing range of new drugs, often biological in origin and often extremely expensive, needs to be accepted and mechanisms developed to facilitate the rational introduction of these drugs into the R.A.H. healthcare system. This includes developing effective mechanisms for achieving hospital funding variations.

The Principles together with recommended actions are stated below :

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ANTINEOPLASTIC DRUG WORKING PARTY

CONSENSUS STATEMENT

1. The provision of cancer services at the R.A.H. should be based on optimal professional standards. Decisions to offer a particular treatment should follow careful deliberation on clinical, professional, scientific and health economic considerations. Treatment choices should not be dominated by cost factors.

2. A consistent, professionally based, peer influenced (and when necessary administratively enforced) mechanism which ensures rational and cost-effective treatment decisions should be implemented throughout the RAH.

3. The Working Party believes that the use of antineoplastic drugs at the RAH is generally appropriate. There are probably some instances where treatments are offered inappropriately but the incidence cannot be quantified.

4. The Working Party recommends that protocols and treatment guidelines be established for ALL treatments. These guidelines should improve the standards of care and may provide a basis for future medical audits or Drug Utilisation Review (DUR).

   Protocols and treatment guidelines should explicitly describe:

   4.1 Treatment indications.
   4.2 Patient selection (inclusion and exclusion) criteria.
   4.3 Treatment objectives (ie. cure, prolongation of life, palliation etc.).
   4.4 First, second and subsequent treatment options.
   4.5 Precise treatment endpoints.
   4.6 Drug dosage and schedule.
   4.7 Anticipated annual patient numbers
   4.8 Safety and efficacy data
   4.9 Financial considerations including comparisons or cost differentials with other treatment options (ie. drug and non-drug)

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5. The use of investigational therapies (eg. new drugs, established drugs for new indications or in new protocols) should be encouraged. All new guidelines and/or protocols should be submitted to and approved by the RAH Human Ethics Committee or Drug Committee before treatment is initiated. Individual patient usage should be deferred until guidelines/protocols have been presented to the Drug Committee.

6. Present RAH drug funding arrangements will not sustain new drug technologies or research initiatives. Although some offsets will occur by the substitution of outdated therapies with newer treatments, future funding restrictions will inevitably result in some new drug/treatment initiatives being unavailable at the RAH. This may compromise the quality of patient care in advancing areas of medical practice and is incongruent with the RAH 'centre of excellence' philosophy.

7. Alternative funding models should be explored to sustain both research initiatives and established new treatments. Active and continued pursuit of additional funding avenues from international/federal/state granting bodies, the pharmaceutical industry and the S.A. Health Commission should be encouraged. The RAH could also allocate Units separate research/initiative budgets on a competitive basis.

8. The early implementation of Unit based budgeting should improve resource allocation in accordance with professional and clinical requirements. Supporting management information systems must be developed as a priority.

9. The Drug Committee's ongoing DUR program should be expanded. Present activities are limited by resource constraints and information system deficiencies. A computerised system linking activity, patient, diagnosis, therapy, cost and clinical information is urgently required to relate changes in drug consumption to patient workload and facilitate medical audit, DUR, the rational allocation of existing resources and the pursuit of funding for new treatments.

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10. The Board should ensure that effective, improved clinical and financial information systems are provided for patients and staff, with the primary objective of optimal utilisation of available funds rather than balancing the budget.

11. Resource allocation priorities for ALL treatments should be determined by multidisciplinary consultation and subsequent decisions clearly promulgated to all disciplines.

By:

- Dr. C. Juttner, Director, Division of Haematology, I.M.V.S.
- Dr. C.L.M. Olweny, Director, Medical Oncology and Chairman, Oncology Committee, R.A.H.
- Prof. F. Bochner, Department of Clinical and Experimental Pharmacology, University of Adelaide and Chairman, Drug Committee, R.A.H.
- Mr. G.M.H. Misan, Senior Pharmacist and Project Officer, Drug Committee, R.A.H.
- Mr. E. Dean Martin, Assistant Director, Pharmacy Services, R.A.H.
- Dr. R. Antic, Director, Thoracic Medicine, R.A.H.
- Mr. J.A.R. Williams, Head, Hepatobiliary Surgical Unit, R.A.H.
- Dr. Robert Webb, Staff Specialist, Anaesthesia and Intensive Care, R.A.H.
- Dr. E. Rozenbilds, Assistant Medical Director, R.A.H.,

for and on behalf of the Antineoplastic Drug Working Party, 21/6/90.

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Recommended Actions

A. *That the Oncology Committee establish mechanisms for review of protocols and guidelines governing cancer management at the RAH.*

B. *That information systems be developed which permit optimal utilisation of existing resources. These systems would link activity, patient, diagnosis, therapy, clinical, cost and other financial data in order to provide Units and Committees with accurate, timely, and up-to-date information to assist in the determination of resource distribution.*

C. *That Unit/Department based management be established and alternative, improved methods be explored to determine operating budgets.*

D. *That additional resources be provided for expanded application of valid instruments to measure the appropriateness of health care delivery. These may include drug utilisation review, cost-benefit, cost-effectiveness or cost-utility analysis or other methodologies.*

E. *That these techniques when established be used to determine priorities for health care delivery.*

F. *That the continued pursuit of alternative funding sources for new initiatives including treatments, be encouraged and R.A.H. 'initiative' budgeting be established.*

G. *That effective mechanisms for achieving hospital budget variations including variations to the drug budget, be established.*

****

ROYAL ADELAIDE HOSPITAL

DRUG COMMITTEE

Anti-Neoplastic Drug Working Party

TERMS OF REFERENCE

1. To establish formal, consultative liason between the RAH Oncology Committee and the RAH Drug Committee.

2. To promote the rational, cost-effective use of drugs in the management of neoplastic and other disease in the context of the constraints imposed by Drug Budget.

3. To evaluate the cost-benefit, cost-effectiveness and cost utility of the anti-neoplastic drugs in treatment of neoplastic and other diseases with view to establishing an equitable balance between funds allocated for anti-neoplastic drugs and drugs used for the treatment of other diseases.

4. To promote the development, application and regular review of 'Protocols' and treatment guidelines which describe:

   (i) selection criteria for patients eligible to receive anti-neoplastic drugs
   (ii) dosage regimens for anti-neoplastic drugs administered to the above patients.

5. To report activities of the Working party to the Drug Committee and Oncology Committee at regular intervals.

6. To establish mechanisms for obtaining drug budget variations as new treatments become available for the management of neoplastic and other diseases.

MEMBERSHIP

Membership will include representatives nominated by the Drug Committee and Oncology Committee. Drug Committee representatives: Professor F. Bochner, Mr. J.A.R. Williams, Dr. Ral Antic, Dr. Robert Webb, Mr. E.D. Martin and Mr. G. Misan. Oncology Committee representatives: Dr. C. Juttner, Dr. C. Olweny, Dr. Richenda Webb.

TENURE:

The 'lifetime' of the Working Party should not extend beyond June 30, 1990, unless otherwise determined by the Drug Committee.

APPENDIX 3

Sample DUE Data Collection Sheets

CEFTRIAXONE DUR - DATA COLLECTION SHEET

Patient Details :-

Surname: _____ Initial: _____
UR.No.: _____ Age: _____ Sex ____
Ward/Clinic: _____
Consultant: _____
Admission/O.P.D.appointment date ___/___/___

Drug Details :-

Was ceftriaxone dose altered during therapy | Y | N |

Initial dose | 1G | 2G | ___days Dose thereafter | 1G | 2G | ___days

Date Commenced ____/____/____ Date Ceased ____/____/____
Number of days _____ Number of doses _____

Concurrent antibiotics: amoxycillin ☐ gentamicin ☐
metronidazole ☐ other _____

Comments _____

Clinical Details :-

Indication for ceftriaxone: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

If 6,7 or 8, give details _____

Infection site(s): _____

Infection severity | SEVERE | MODERATE | MILD | UNDEFINED |

Signs/symptoms: | CXR | WCC inc. | Temp > 37.5 | Pulse > 100 |

Concurrent diseases: Pulmonary ☐ Hepatic ☐ Other _____
Renal ☐ Cardovasc ☐

Details: _____

Creat. clear. | 10-30 | 30-50 | >50 | Wt ____Kg Se Cr ____mmol/l

Penicillin / cephalsporin allergy: | Y | N | Steroid(s) | Y | N |

Organism(s) cultured: _____
Culture site(s): _____

Sensitive to: | PEN | AMP | AUG | GEN | CEP | | | |

Pharmacy review :-

	A	I
Indication	☐	☐
Drug choice	☐	☐
Dose	☐	☐
Frequency	☐	☐
Route	☐	☐
Duration	☐	☐

Intervention | Y | N |

Intervention type:

Consultant ☐ Intern ☐
Registrar ☐ Nurse ☐
RMO ☐ Casenotes ☐
Micro / Inf Dis. referral ☐
Alert note ☐1 ☐2
None ☐

Recommendation _____

Time taken _____ Signed _____ Date _____

Clinical Micro / Infectious Diseases Recommendation:-

Continue ceftriaxone ? | Y | N | Dose___ Frequ._____ Duration____

Recommended Treatment	Drug	Dose	Freq	Route	Duration

Advised | Cons | Reg | RMO | Other _____ | Document in notes | Y | N

Comments _____

Time taken _____ Signed _____ Date _____

Outcome Assessment:

Clinical | Cure | Improved | Failure | N/A

Micro | Cure | Persistence | Relapse | Superinf | Unknown | N/A

Adverse effects: | Y | N | Hepatic | Diarrhoea | Nausea | Vomiting | Thrush | Death | Other_____

Related to ceftriaxone : | Definite | Probable | Unlikely

Time taken _____ Signed _____ Date _____

Summary:-

Intervention outcome _____

Total days____ Total grams____ Inapprop days____ Inapprop grams____

	A	I	U
Indication			
Choice of			
Dosage			
Frequency			
Route			
Duration			

Total cost ceftriaxone = $_____

Cost of inapprop ceftriax = $_____

Cost of approp alternative = $_____

COST AVOIDANCE

COST INCURRENCE = $_____

CEFTRIAXONE INDICATION CODES & DOSAGE GUIDELINES

1. Gram-negative meningitis due to Enterobacteraciae or resistant strains of Haemophilus influenzae.
2. Infections due to organisms resistant to earlier generations of cephalosporins where aminoglycoside (eg. renal impairment) or amoxycillin (eg. penicillin hypersensitivity) administration is contra-indicated.
3. Severe Gram-negative infections known to respond poorly to amoxycillin/aminoglycoside combinations or earlier generations of cephalosporins (e.g bone/joint infections, brain or hepatic abscesses).
4. Anorectal, or pharyngeal gonorrhoea, and in gonococcal urethritis caused by penicillin resistant strains.
5. Severe community acquired or nosocomial pneumonia of undetermined aetiology. Combine with erythromycin if Legionella is suspected.
6. Prophylaxis 7.Other indication 8.Undefined

DOSAGE

Severe/life-threatening infections:	Moderately severe infections:	Gonorrhoea:
2G daily for 3 days followed by 1G daily for 4 - 7 days (1,2,3,4).	1G daily for 7 - 10 days (1,2).	250 mg I.M. administered as a single dose

NOTES

1. Ceftriaxone should be administered as a single daily dose.
2. Ceftriaxone may be administered by I.V. bolus over 3 minutes, as an I.V. mini-infusion over 30 minutes or by deep I.M. injection.
3. Dosage reduction will be dependent upon a satisfactory response to therapy as indicated by improvement in clinical state, fever reduction, culture results or reduction in leucocyte count.

PNEUMONIA REVIEW - DATA COLLECTION SHEET

Surname:_____ Initial:____
UR:_____ Age:_____ Sex:_____
Ward:_____
Consultant:_____

Admitted from:
Community ☐
Nursing home ☐
Other hosp. ☐
Admission date:_____

Provisional diagnosis: | Typical | Atypical | Aspiration | pneumonia

Likely etiology:_____

Relevant history/predisposing factors:
Recent hospital admission ☐ COAD ☐
Recent viral infection ☐ Alcoholism ☐
Other:_____
_____

Secondary indications for antibiotic therapy:_____

Antibiotic therapy from LMO: | Yes | No | Details:_____
_____
Duration:____days

Results obtained before antibiotic therapy started:

Sputum Gram stain ☐
CXR ☐
Other ☐
Details:_____
_____
_____

Antibiotics given in RAH before blood and sputum collected: | Yes | No | Hours before: | | N/R |

Infection severity: | Very severe | Severe | Moderate | Mild |

Clinical details:
Fever (T > 38) ☐
Hypoxia (Pa O2 < 8kPa) ☐
Hypotension (syst BP < 90) ☐
Oxygen (via mask/nasal specs) ☐
Assisted ventilation ☐
WCC:_____ Other:_____

Procedures performed: (eg. biopsy, bronchoscopy, drainage, aspiration)
_____
_____

Diagnosis confirmed: | Yes | No |

Details if No:_____
_____

Culture and sensitivity data: (select relevant results)

Source	Organism(s)	Sensitivities	Date

Other test results:

CXR: _____

Antigens: _____

Serology: _____

Other: _____

Consults:

		By:	Date:
Clinical micro/Infectious dis.		_____	_____
Thoracic med		_____	_____

Renal function: Weight= _____Kg Documented renal impairment : Yes | No

Se Cr = _____

Creatinine clearance = _____

Documented antibiotic sensitivities: _____

Antibiotic therapy:

drug	dose	freq.	route	date started	date ceased	durat.	therapy type +	reason changed or ceased *

\+ Therapy type: E = empiric P = proven pathogen

* Reason changed or ceased: 1. satisfactory response 4. altered diagnosis
2. poor response 3. adverse effects
3. C&S results 5. other (_____)

Therapeutic drug monitoring: (mark A or I)

Antibiotic	Done	Sampling times	Dose adjustments

Clinical outcome: Recovery | Death Other: _____

Micro outcome: Cure | Persistance | Relapse | Superinfection | N/A | U/D

Hospitalization days: _____

Summary: (A)ppropriate (I)nappropriate (N)ot Applicable

Antibiotic	Indication	Drug Choice	Dose	Freq	Durat	Route	TDM	OVERALL

Comments: _____

_____

_____

_____

(ref:dur-rec sht/2, pneu.doc)

AUDIT CRITERIA and DATA RECORD FORM FOR ACYCLOVIR D.U.R

Inpatient	Retrospective	Weight _____kg	Patient Details
Outpatient	Prospective	Creatinine Clearance _____ml/minute	

Page 1

INDICATION		PROCESS INDICATORS			
Diagnosis	Preconditions	Route	Dosage regimen	Duration (in days)	Admin. Time
1. THERAPY			DOSE (mg) TIMES / DAY		
1.1 Initial Genital Herpes in IC	1. moderate/severe symptoms [Y N UD] AND 2. treatment within 6/7 of onset of lesions [Y N UD] 3. Pregnancy criteria met [NA Y N]	O IV	200 [ ] 5x [ ] A I A I Renal criteria met [NA Y N UD]	7-10 [ ] A I	>1HR <1HR A I
A I	[A I UD]	A I	[A I UD]	A I	NA A I
1.2 Initial Herpes proctitis in IC	1. moderate/severe symptoms [Y N UD] AND 2. treatment within 6/7 of onset of lesions [Y N UD] 3. Pregnancy criteria met [NA Y N]	O IV	200 400 [ ] 5x [ ] A A I A I Renal criteria met [NA Y N UD]	7-10 [ ] A I	>1HR <1HR A I
A I	[A I UD]	A I	[A I UD]	A I	A I
1.3 Recurrent Genital Herpes OR Herpes Proctitis in IC	Previously documented: 1. severe/long lasting episode/recurrence [Y N UD] AND 2. treatment within 2/7 of onset of lesions [Y N UD] 3. Pregnancy criteria met [NA Y N]	O IV	400-1000 total [ ] 2-5x [ ] A I A I Renal criteria met [NA Y N UD]	5 [ ] A I	>1HR <1HR A I
A I	[A I UD]	A I	[A I UD]	A I	A I

Page 2	INDICATION		PROCESS INDICATORS			
Diagnosis	Preconditions	Route	Dosage regimen		Duration (in days)	Admin. Time
			DOSE (mg)	TIMES / DAY		
1.4 Opthalmic Herpes Simplex with Dendritic ulcers in IC	1. unsatisfactory response or compliance with topical ointment [Y N UD] 2. Pregnancy criteria met [NA Y N]	O IV	400 [A I]	5x [A I] Renal criteria met [NA Y N UD]	7 [A I]	>1HR <1HR [A I]
[A I]	[A I UD]	[A I]		[A I UD]	[A I]	[A I]
1.5 IC: H. Whitlow, Zosteriform H. Simplex, Eczema Herpeticum recurrences near major wounds/burns	1. Pregnancy criteria met [NA Y N UD]	O IV	200 [A I]	5x [A I] Renal criteria met [NA Y N UD]	5 [A I]	>1HR <1HR [A I]
[A I]	[A I UD]	[A I]		[A I UD]	[A I]	[A I]
1.6 Initial muco-cutaneous H. Simplex in IS	1. induction chemotherapy or high dose steroids [Y N UD] OR 2. exceptions in 7 or 8 [Y N UD] 3. Pregnancy criteria met [NA Y N]	IV O	5mg/kg [A I]	3x [A I] Renal criteria met [NA Y N UD]	5 [A I]	>1HR <1HR [A I]
[A I]	[A I UD]	[A I]		[A I UD]	[A I]	[A I]

Page 3	INDICATION		PROCESS INDICATORS				EXCEPTIONS
	Diagnosis	Preconditions	Route	Dosage regimen	Duration (in days)	Admin. Time	
1.7	Initial muco-cutaneous H. Simplex in IS	1. maintenance doses of immunosupressive drugs OR 2. AIDS/Lymphoproliferative disorder 3. Pregnancy criteria met	O / IV	200-400 mg A / I; 5x A / I; Renal criteria met NA / Y / N / UD	5 A / I	>1HR / <1HR A / I	A. unable to take oral acyclovir OR B. progres'n of lesion failing to respond to oral acyc.
1.8	Recurrent muco-cutaneous H. Simplex in IS		O / IV	200-400 mg A / I; 5x A / I; Renal criteria met NA / Y / N / UD	5 A / I	>1HR / <1HR A / I	A. OR B. as above
1.9	Herpes Simplex Encephalitis in IC/IS	1. treat as soon as diagnosis suspected 2. Pregnancy criteria met	IV / O	DOSE (mg): 10mg/kg A / I; TIMES / DAY: 3x A / I; Renal criteria met NA / Y / N / UD	>=10 A / I or until resolution	>1HR / <1HR A / I	

Page 4

INDICATION			PROCESS INDICATORS			
Diagnosis	Preconditions		Route	Dosage regimen	Duration (in days)	Admin. Time
				DOSE (mg) / TIMES / DAY		
1.10 Disseminated H. Simplex in IC/IS	1. Pregnancy criteria met	NA Y N	IV O	5mg/kg A I; 3x A I; Renal criteria met NA Y N UD	5-10 A I; or until resolution	>1HR <1HR A I
		A I UD	A I	A I UD	A I	A I
1.11 Varicella Zoster in IC/IS	1. treat as soon as diagnosis suspected	Y N UD	IV O	10mg/kg A I; 3x A I; Renal criteria met NA Y N UD	>=7 A I; or until resolution	>1HR <1HR A I
	2. Pregnancy criteria met	NA Y N				
		A I UD	A I	A I UD	A I	A I
1.12 Herpes Zoster in IC	1. severe lesions OR. age > 60 years	Y N UD	O IV	800 A I; 5x A I; Renal criteria met NA Y N UD	7 A I	>1HR <1HR A I
	AND 2. lesions <= 72 hours old	Y N UD				
	3. Pregnancy criteria met	NA Y N				
		A I UD	A I	A I UD	A I	A I

Page 5	INDICATION		PROCESS INDICATORS			
Diagnosis	Preconditions		Route	Dosage regimen	Duration (in days)	Admin. Time
				DOSE (mg) TIMES / DAY		
1.13 Zoster opthalmicus in IC	1. involvement of eye	Y N UD	O IV	600-800 5x	7-10	>1HR <1HR
OR	2. <= 72 hrs of onset of skin lesions	Y N UD		A I A I	A I	A I
	3. Pregnancy criteria met	NA Y N		Renal criteria met NA Y N UD		
A I		A I UD	A I	A I UD	A I	A I
1.14 Zoster opthalmicus in IC	1. severe eye involvement	Y N UD	IV O	5mg/kg 3x	5	>1HR <1HR
				A I A I	A I	A I
	2. Pregnancy criteria met	NA Y N		Renal criteria met NA Y N UD		
A I		A I UD	A I	A I UD	A I	A I
1.15 H. Zoster, Zoster Opthalmicus, Meningoencephalitis in IS	1. Pregnancy criteria met	NA Y N	IV O	10mg/kg 3x	5-10	>1HR <1HR
				A I A I	A I	A I
				Renal criteria met NA Y N UD	or until resolution	
A I		A I UD	A I	A I UD	A I	A I

Page 6	INDICATION		PROCESS INDICATORS			
Diagnosis	Preconditions		Route	Dosage regimen	Duration (in days)	Admin. Time
				DOSE (mg) TIMES / DAY		
1.16 Disseminated Herpes Zoster in IC or IS	1. Pregnancy criteria met	NA Y N	IV O	10mg/kg 3x	5-10	>1HR <1HR
				A I A I	A I	A I
				Renal criteria met NA Y N UD	or until resolution	
A I		A I UD	A I	A I UD	A I	A I
2. SUPRESSIVE THERAPY						
2.1 Suppression of recurrent Genital Herpes or Herpes Proctitis in IC	1. painful and frequent recurrences (>= 6/yr)	Y N UD	O IV	200mg 2-3 4-5		>1HR <1HR
				A I A A I	A I	A I
	2. Pregnancy criteria met	NA Y N		Renal criteria met NA Y N UD	recurr. rate reass'd yrly	
A I		A I UD	A I	A I UD	A I	A I
2.2 Suppression of recurrent mucocutaneous H. Simplex in IS	1. severe or frequent recurrences (eg monthly)	Y N UD	O IV	200mg 2-5		>1HR <1HR
				A I A I	A I	A I
	2. Pregnancy criteria met	NA Y N		Renal criteria met NA Y N UD	for duration of immunosuppression	
A I		A I UD	A I	A I UD	A I	A I

Page 7	INDICATION		PROCESS INDICATORS				EXCEPTIONS
Diagnosis	Preconditions		Route	Dosage regimen		Duration (in days)	Admin. Time	
				DOSE (mg)	TIMES / DAY			
3. PROPHYLAXIS								
3.1 Prophylaxis of mucocutaneous H. Simplex in IS	1. in Bone marrow transplant	Y N UD	O IV	200mg	3	28	>1HR <1HR	Unable to take oral acyclovir (see 3.2)
				A I	A I	A I	A I	
	2. Pregnancy criteria met	NA Y N		Renal criteria met	NA Y N UD	peritransplant period		
A I		A I UD	A I		A I UD	A I	A I	
3.2 Prophylaxis of mucocutaneous H. Simplex in IS	1. in Bone marrow transplant and unable to take oral acyclovir	Y N UD	IV O	125mg	2	28	>1HR <1HR	
				A I	A I	A I	A I	
	2. Pregnancy criteria met	NA Y N		Renal criteria met	NA Y N UD	peritransplant OR when able to take oral acyclovir		
A I		A I UD	A I		A I UD	A I	A I	
4. Other indication _____	1.	NA Y N UD					>1HR <1HR	
_____	2.	NA Y N UD		A I	A I	A I	A I	
_____	3. Pregnancy criteria met	NA Y N UD		Renal criteria met	NA Y N UD			
IS IC								
A I		A I UD	A I		A I UD	A I	A I	

D.U.R. CRITERIA FOR ACYCLOVIR (ACV)

NOTES:

1. The dosage of Acyclovir should be reduced in renal impairment:

   A. IV

Creatinine clearance (ML/min)	Standard Dose (%)	Dosing Interval (hr)
25-50	100	12
10-25	100	24
0-10	50	24 and after dialysis

   B. ORAL
   In patients with a creatinine clearance of less than 10 ML/min, reduce the total dose by 2/5.

2. Pregnancy
   Pregnant women without life threatening disease should not receive systemic Acyclovir. Acyclovir is not teratogenic or mutagenic in animals but no well controlled studies concerning its safety in pregnant women have been performed.

3. Lactation
   Acyclovir does pass into breast milk but as it is licensed for use in neonates it is of doubtful Clinical significance.

4. IV infusion of acyclovir should be given over a period of at least an hour to prevent renal tubular damage.

Abbreviations
ACV = Acyclovir
IC = immunocompetent
IS = immunosuppressed
d = day

PATIENT RESPONSE:

1. Infection resolved | Y | N | UD |

2. Side effects | Headache | Nausea | Vomiting | Diarrhoea | Rash | Phlebitis | Other _____ |

3. Consult | Virology | Microbiology | Infectious Diseases | Dermatology | None |

4. Advice heeded | Y | N |

Details _____

_____

_____

5. Total Grams Appropriate Inappropriate

IV _____

Oral _____

6. Additional comments _____

_____

_____

OVERALL CLASSIFICATION | APPROPRIATE | INAPPROPRIATE | UNDEFINED |

By Gary Misan, Kathryn Robinson, May 1990. Ref: acyc_1.doc.

APPENDIX 4

Sample RAH DUE Information Instruments

MEDICAL DIRECTORS MEMORANDUM

CEFTRIAXONE

TOO OFTEN, TOO MUCH and for TOO LONG

These are the findings of a recent, comprehensive Drug Committee review of the use of ceftriaxone at the Royal Adelaide Hospital. The review found widespead, "over-enthusiastic" use of ceftriaxone throughout the hospital.

TOO OFTEN
40% of patients prescribed ceftriaxone were considered suitable either for alternate antibiotic therapy or should not have received any antibiotic therapy. Many patients received ceftriaxone in divided doses when single daily doses have been shown adequate in many clinical studies, even in severe infection.

TOO MUCH
Ceftriaxone dosages higher than required were documented in 5% of courses. 25% of ceftriaxone doses should have been reduced at sometime during therapy. The value of ceftriaxone administered unnecessarily represented 55% of the total value of ceftriaxone used during the review period.

TOO LONG
Excessive duration of antibiotic therapy was documented in 27% of courses reviewed.

Overall, 85% of ceftriaxone prescriptions did not comply with one or more aspects of the R.A.H. guidelines

Irrational use of third generation cephalosporins amounts to poor prescribing. Unnecessary use contributes to increased risk of adverse effects, antibiotic resistance and superfluous expenditure.

Projected ceftriaxone expenditure for 1990/91 is $170,000, half of which may be unnecessary. A saving of at least $50,000 per annum is achievable with the co-operation of the R.A.H. medical staff.

The Drug Committee will embark on a comprehensive programme of education and monitoring of ceftriaxone use commencing April 8th, 1991. From this date :-

- Each ceftriaxone order will initiate a consultation by a member of the Drug Committee, Division of Clinical Microbiology, Infectious Diseases Unit or the R.A.H. Pharmacy Department.
- Orders will be assessed for compliance with hospital guidelines for indication, drug choice, dosage, route, frequency and anticipated duration of ceftriaxone administration.
- Recommendations for continuation of ceftriaxone treatment or for alterations to antibiotic therapy will be communicated to medical staff verbally or in writing by the assessors.
- Medical staff responsible for individual patients will be expected to implement the recommendations of the assessors.

R.A.H. guidelines for the use of ceftriaxone are published in the 1991/92 edition of the Formulary on page 230.

The Drug Committee looks forward to your co-operation.

Dr. Richenda Webb
Medical Director

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DRUGS & THERAPEUTICS Update

Issue No 1 March 1989

A ROYAL ADELAIDE HOSPITAL DRUG COMMITTEE AND PHARMACY DEPARTMENT COMMUNICATION

• A LETTER OF INTRODUCTION •

Welcome to the first issue of Drugs and Therapeutics Update. This publication replaces Current Topics in Drugs and Therapeutics as an information service from the Royal Adelaide Hospital Pharmacy Department and Drug Committee.

The aims of this bulletin are to inform RAH staff of Drug Committee policy and meeting decisions, the availability of new drugs and drug products from the RAH pharmacy and amendments to the RAH Formulary. Information concerning drug expenditure, drug utilisation review projects, therapeutic guidelines, helpful prescribing points and other drug related issues will also be included. Contributions and comments from readers are welcome.

The Editors

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• DRUG COMMITTEE NEWS •

The Drug Committee

Membership

The Drug Committee is comprised of 2 representatives each from the Divisions of Medicine, Surgery and Clinical Services, and one each from the IMVS, Division of Nursing and the Department of Clinical and Experimental Pharmacology (University of Adelaide). Ex officio members include the Medical Director or delegate, the Director, Pharmacy Services, representatives from the Finance Division and from Pharmacy Services and the Drug Committee Project Officer.

The Drug Committee reports through the Medical Committee to the Board of Management and through the Medical Director to the Executive. Memoranda arising out of the Drug Committee are issued through the Medical Director's Office.

Terms of Reference

- To serve in an advisory capacity on all matters pertaining to the safe use of drugs.
- To develop a formulary of drugs accepted for use in the hospital and provide for its constant revision.
- To establish or plan suitable educational programs for the hospital's professional staff on matters related to drug use.
- To initiate and/or direct drug use review programs and studies, and review the results of such activities.
- To review consequential costs and budgetary considerations as well as undertaking cost containment programs as required.
- To liaise with other hospital committees as appropriate.
- To ensure review and documentation of the hospital position in relation to accreditation standards.

Function

The role of the Drug Committee is to provide prescribers through the Formulary with a range of medications which according to the present state of medical knowledge, meets clinical needs and avoids duplication of therapeutic effect.

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• DRUG COMMITTEE NEWS •

Recent Drug Committee Decisions

Nicotinic Acid (Niacin)
250mg Sustained Release Tablets
- evaluation approval for Lipid Clinic only.
In doses of 1g or more per day, nicotinic acid decreases the synthesis of VLDL cholesterol, effectively lowering both the VLDL and LDL cholesterol concentration. Nicotinic acid also enhances lipoprotein uptake into peripheral tissues which results in a decrease in serum phospholipid concentrations and also an increase in HDL cholesterol concentrations. Sustained release nicotinic acid is claimed to be better tolerated than standard formulations which commonly produce dose-limiting facial flushing, dizziness and pruritus due to the vasodilator action of the drug.
Dosage: 250 - 500mg two or three times a day.
Hospital cost: $7.65 per 60.

Menthol 0.5%, Camphor 0.5% in Aqueous Cream
- approved for inclusion in Formulary.
Use of this cream should be reserved for the treatment of intractable pruritus unresponsive to other measures, for example the pruritus of renal failure. It should be used with caution in patients with extensive areas of broken or damaged skin.
Dosage: Apply sparingly 2 - 3 times each day, as necessary.
Hospital Cost: $3.45 per 200g.

Bronchostat Enteric Coated Tablets
- not approved.
Oral administration of Bronchostat tablets containing 10^{11} formalin killed *Haemophilus influenzae*) is claimed to prevent acute bronchitis due to *H. influenzae* in at-risk groups. The Committee believes that there is insufficient evidence in the scientific literature to support the efficacy of this agent at the present time.

Omega-3-Essential Fatty Acids 300mg Capsules
- to remain Individual Patient Use (RAH) approval.
The Committee has received advice from the Department of Clinical Chemistry, IMVS, that neither the clinical safety nor efficacy of fish oils have been proven in long term, controlled, clinical trials. Their use should be reserved for research purposes or situations where the potential risks are outweighed by the anticipated benefits.
The administration of omega-3-essential fatty acids should be reserved for patients with Type IV or Type V hyperlipidaemia who have suboptimal responses to clofibrate and in whom nicotinic acid is contraindicated.
Dosage: 1.8 - 3.6g per day administered in 3 or 4 divided doses.
Hospital Cost: $18.36 per 280.

• FORMULARY UPDATE •

New1989/90 Edition
The 1989/90 edition of the RAH Formulary is now available and has been distributed to all medical staff, wards and departments throughout the hospital. The content has been extensively revised and includes several new features.

Restricted Drugs List
The blue pages section contains a list of NON-FORMULARY drugs which are available on a limited basis from the RAH Pharmacy. These drugs are restricted for use by specified clinics or defined user groups or otherwise only after application to and approval by the RAH Drug Committee.

New Therapeutic Guidelines
The 1989/90 edition of the Formulary contains a number of new therapeutic guidelines to aid prescribers in the management of a variety of conditions. These include:
- Alcohol and drug dependency detoxification management guidelines.
- Anaphylactic and anaphylactoid reactions management guidelines.
- Cancer chemotherapy guidelines.
- Insulin, storage and expiry guidelines.
- Vancomycin, therapeutic guidelines.

New Products
The following products are now available from the RAH Pharmacy and included in the RAH Formulary:
- Acyclovir 400mg tablets.
- Beclomethasone dipropionate metered aerosol spray, 250 microgram/dose (BECLOFORTE).
- Cimetidine 800mg tablets.
- Piroxicam 20mg capsules.
- Ranitidine 150mg dispersible tablets.
- Ranitidine 300mg tablets.

Discontinued Products
The following products have been discontinued by the manufacturer and are no longer available from the RAH Pharmacy.
- COLOXYL with DANTHRON 50/50mg (see also p. 3).
- stilboestrol tablets 1,5,10mg

For further information regarding Formulary items contact Central Pharmacy (ext. 5545) or the Pharmacy Department, Drug Information Centre (ext. 5546).

• PHARMACY NEWS •

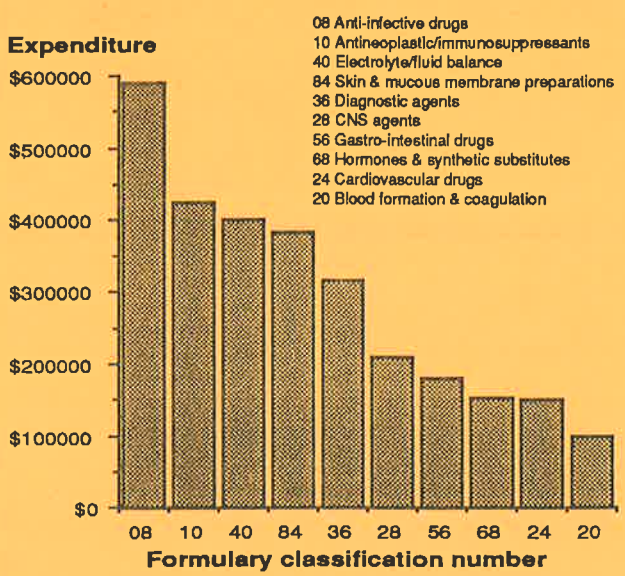
ATGAM - World Shortage
Lymphocyte Immune globulin (ATGAM, Upjohn) will be unavailable in Australia during 1989. However, limited supplies of antilymphocyte and anti-human thymocyte globulins (LYMPHOGLOBULINE, THYMOGLOBULINE, May & Baker) are available following IPU approval from the Commonwealth Department of Health, Canberra. Further information may be obtained from the Pharmacy Drug Information Centre (ext. 5546).

COLOXYL with DANTHRON
COLOXYL with DANTHRON tablets have been discontinued by the manufacturer. In keeping with hospital policy regarding the avoidance of combination preparations where possible, COLOXYL with SENNA is not available from the Pharmacy Department. Prescribers should order COLOXYL (50 or 120mg) and SENOKOT (tablets 7.5mg or granules) separately when both drugs are required. This allows more flexible manipulation of the dosages of the individual components than the combination preparation.

• FINANCE NEWS •

The Finance sub-committee and Drug Committee undertake regular detailed review of drug purchases and issues to assist in the assessment of prescribing trends, prediction of possible budget overruns, identification of areas of potential drug misuse and in planning of financial and administrative policy.

The "Top 10" Formulary drug categories for July 1 to December 31, 1988 are provided below.



• DRUG PROFILE •

CEFTRIAXONE (ROCEPHIN)

Antimicrobial activity
Ceftriaxone is a long-acting, broad spectrum, beta-lactamase-resistant, third-generation cephalosporin active against most strains of *Streptococci* and *Staphylococci* including *S. pneumoniae, S. pyogenes, S. aureus* and *S. epidermidis. S. faecalis* and MRSA are resistant. Susceptible Gram-negative organisms include *H. influenzae, E. coli, Neisseria, Klebsiella, Enterobacter, Citrobacter* and *Proteus sp.. Clostridia sp.*, including *C. welchii*, anaerobic *streptococci* and *Fusobacteria* are usually sensitive but *C. difficile* is resistant. Ceftriaxone is not recommended for the treatment of infections caused by *Pseudomonas aeruginosa, Listeria monocytogenes* or *Bacteroides sp.*

Pharmacokinetics
Ceftriaxone achieves high peak serum concentrations after both IM and IV administration which are many times (several hundred to a thousand fold) that which are required to inhibit the growth of susceptible micro-organisms. Ceftriaxone readily penetrates into the CSF.
Plasma protein binding ranging from 83 - 96% after usual dosages. Ceftriaxone is eliminated by both renal and biliary mechanisms. Dosage modification is usually not necessary except in patients with combined renal and hepatic function impairment.
The mean elimination half life of ceftriaxone ranges from 5.8 - 8.6 hours in healthy adults extending to 8.8 - 15.7 hours in patients with severe renal or liver disease.

Clinical Efficacy
Ceftriaxone has demonstrated efficacy in septicaemia, meningitis, severe genito-urinary tract infections, lower respiratory tract infections, bone, skin and soft tissue infections, antibiotic surgical prophylaxis, and sexually transmitted diseases.

Dosage and Administration
Ceftriaxone may be administered by IV bolus, IV mini-infusion (e.g. over 15 - 30 minutes) or by deep IM injection. The usual adult dosage is1-2g administered as a single daily dose, depending on the nature and severity of the infection.

Adverse Effects
Reported side effects include nausea, vomiting, diarrhoea, altered haematological indices, skin reactions, abnormal serum chemistry, phlebitis, and candida superinfection.

Hospital Cost
250mg - $5.13, 1g - $16.96, 2g - $33.92.

• THERAPEUTIC GUIDELINES •

Vancomycin

A drug usage review of vancomycin conducted 1987/1988 revealed that according to one or more study criteria, prescribing was inappropriate for over half of the study population. The study also indicated that potential cost savings within the RAH drug budget of $60,000 may be possible with more prudent prescribing of this agent. The following guidelines are provided to assist prescribers in the use of vancomycin.

Indications

Vancomycin should be reserved for the treatment of:

- culture proven infections caused by multiple antibiotic resistant organisms,
- infections caused by organisms sensitive to methicillin or cephalosporins in patients with a history of serious hypersensitivity reactions to these agents,
- infections in patients where there is a high suspicion that the causative organism may be resistant to multiple-antibiotics (e.g. a patient colonised with MRSA or who has had a previous MRSA infection).
- antibiotic-associated enterocolitis in patients unresponsive to first line agents (metronidazole/bacitracin).

or as a prophylactic agent in patients:

- colonised with or who have a history of infection with MRSA or other multiple antibiotic resistant organisms,
- undergoing the insertion of prosthetic implants in whom penicillins or cephalosporins are contraindicated.

NOTE: Vancomycin should not be used in an attempt to eradicate MRSA colonisation unless there is evidence of systemic infection.

Dosage and administration

Therapy and Prophylaxis:

1-2 g/day IV given in 2-4 divided doses. Dilute each 500mg in 100ml of Glucose 5% or Sodium chloride 0.9% and administer over not less than 1 hour.

Antibiotic associated colitis:

250mg orally administered four times daily.

Duration of treatment

Therapy

- culture proven invasive infections - 7-14 days.
- bacterial endocarditis - 4-6 weeks.
- empirical therapy - 96 hours unless culture and sensitivity results indicate the presence of MRSA or other multiple-antibiotic resistant organisms.
- antibiotic associated colitis - 7-10 days.

Prophylaxis

- 24 hours therapy only (≤ 2g vancomycin/24 hours).

Monitoring

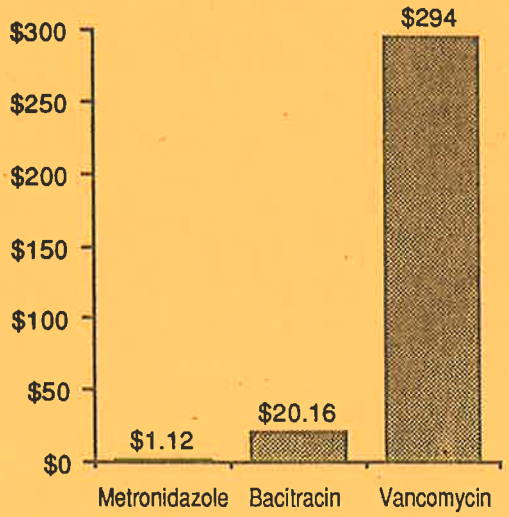
Peak and trough drug levels should be monitored at least twice weekly. Maintain peaks below 50mg/l and troughs below 12mg/l.

Hospital Cost

vancomycin 500mg inj. - $21.00,
vancomycin 250mg capsules - $10.50 each.

Antibiotic Associated Colitis - Cost of Treatment

The following graph illustrates the cost differential for 7 days treatment of antibiotic associated colitis using oral metronidazole, bacitracin or vancomycin. These drugs have similar clinical efficacy suggesting that cost should be a major factor in determining drug selection. The choices would seem obvious.



For further information refer RAH Formulary pages 232 - 233.

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DRUGS & THERAPEUTICS Update

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A ROYAL ADELAIDE HOSPITAL DRUG COMMITTEE AND PHARMACY DEPARTMENT COMMUNICATION

• DRUG COMMITTEE NEWS •

Revised Terms of Reference

The Terms of Reference of the Drug Committee were recently revised with particular reference to the Committee's responsibilty for the drug budget (see below). An option which provides for renomination upon the expiration of member tenure has also been included. The respective clauses now read:

- to ensure the cost-effective use of drugs within the budget allocation.
- TENURE - 2 years with option of renewal on renomination.

Drug Utililisation Review

- continued prescriber support needed

As a corollary to the S.A. Health Commission directive that the hospital limit patient activity for 1989/90 to the budget set by the Commission (Refer Administrator's Memorandum, 25/7/89), the Drug Committee has been instructed to limit drug expenditure to the budget allocation. In past years this has been achieved by administrative and procedural strategies, for example, limiting discharge and outpatient drug supplies. Other strategies including Formulary controls, close monitoring of the Pharmacy inventory, bulk-buying, and State Supply contract tenders, have also assisted in reducing drug expenditure.

A modern teaching hospital undertakes innovative activities including the introduction and evaluation of new drugs, treatment protocols or therapeutic initiatives. However, such innovation is severely curtailed by the current budget climate. Since there is little scope for additional savings through actions similar to those described previously, the Committee must explore alternative methods for containing drug expenditure. To this end the Committee through the process of Drug Utilisation Review (DUR), is carefully scrutinising the use of many drugs/drug groups to ensure that hospital use is in accordance with generally accepted medical, pharmacologic and therapeutic principles. The aims are thus two-fold:

- to promote rational and cost-effective drug use and thereby prevent unnecessary drug expenditure,
- to generate savings from within the budgetary allocation to fund new therapies or initiatives.

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Savings generated through this process are not diverted into the hospital's general ledger but are retained within the drug budget for the benefit of hospital patients. To date, the DUR programme has resulted in decreased expenditure for drugs such as vancomycin, cefoxitin, methylprednisolone, and ELASE. These savings have provided funds for new drug therapies/initiatives including interferon, octreotide, the acute pain service, tissue plasminogen activator and urokinase.

The Drug Committee seeks the continuing support of medical and allied staff in its objectives and for the DUR process.

METHYLPREDNISOLONE INJECTION 500mg

- Formulary restriction expanded to include treatment of multiple sclerosis.

Following advice received from the Department of Neurology, methylprednisolone has been approved for the treatment of multiple sclerosis. The main indications are acute relapses with moderate to severe disability, and in chronic cases associated with spasticity.

Dosage
500mg IV (over 30 minutes) daily for 5 days.

Hospital cost
$18.40/500mg

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MEGESTROL ACETATE 40mg TABLETS
- approved for inclusion in Formulary
Megestrol acetate is a synthetic progestagen used in the palliative management of recurrent, inoperable or metastatic breast or endometrial carcinoma. Megestrol acetate has a low incidence of adverse effects but should be used with caution in patients with a history of thromboembolic disease.

Dosage
40mg administered 4 times each day.

Hospital Cost
$57.20 per 100

MUPIROCIN 2% OINTMENT
- Formulary restricted, for use by Dermatology Department only
Mupirocin (Pseudomonic acid A) is a naturally occurring antibiotic produced by Pseudomonas fluoroscens. In vitro, mupirocin demonstrates excellent activity against staphylococci (including MRSA) and most Streptococci (excluding Group D streptococci). Mupirocin has less activity against other Gram positive organisms. Most Gram negative bacteria and anaerobes are not sensitive to mupirocin. Mupirocin shows little potential for skin sensitisation and no cross-resistance with commonly used antibiotics.

Dosage
To be applied sparingly to the affected area three times daily for up to 10 days.

Hospital Cost
$4.50 per 15g

GLIPIZIDE 5mg TABLETS
- approved for inclusion in the Formulary
Glipizide is an oral hypoglycaemic and "second generation" sulphonylurea which may be particularly useful in older patients as hypoglycaemia is reported to occur less frequently than with other sulphonylurea agents. (See also P4.)

Dosage
2.5mg to 40mg daily, with food.

Hospital cost
$9.47/100

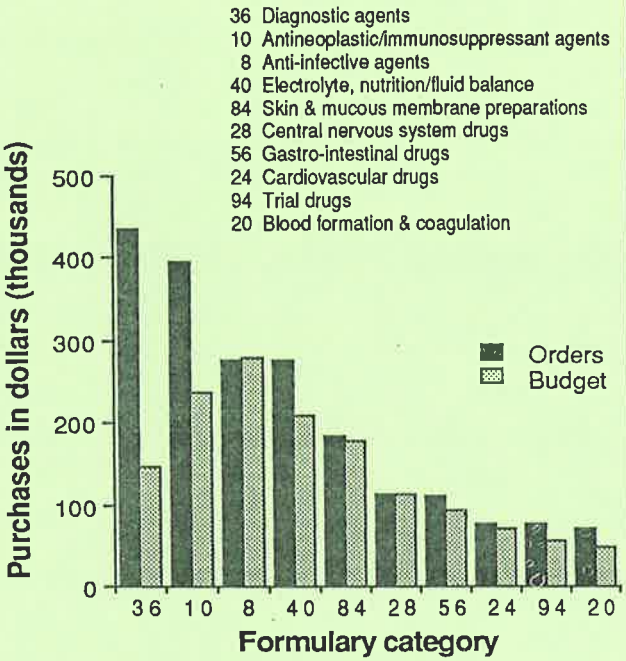
CHLORPROPAMIDE 250mg TABLETS
- deleted from Formulary
This follows discussions with the Endocrine Unit and concern over the long duration and adverse effect profile of this drug compared with other oral sulphonylurea drugs.

• FINANCE NEWS •

- where does all the money go ?
The Finance sub-Committee and Drug Committee undertake regular detailed reviews of pharmacy drug purchases and issues to assist in the assessment of prescribing trends, prediction of possible budget overruns, identification of areas of drug misuse and in planning of financial and administrative policy.

The "Top 10" purchase categories for the first quarter of 1989/90 are illustrated below and compared with notional budget figures for the same period. Unfavourable budget variances were exhibited for all categories except Anti-infective agents. This is partly due to increased inventory activity associated with the recent relocation of the Pharmacy Department and bulk purchases of some products in anticipation of significant price increases.

Top 10 drug purchase categories 1989/90



• FORMULARY UPDATE •

Additions

glipizide	5mg tablets

Deletions

chlorpropamide	250mg tablets
hydroxyephedrine normethadone tab (TICARDA)	10mg 7.5mg
hydroxyephedrine normethadone	20mg / ml 10mg / ml

oral drops (10ml) (TICARDA ORAL DROPS)

• DRUG UTILISATION REVIEW RESULTS •

CEFTRIAXONE
- too much, too often

Ceftriaxone was considered for inclusion in the R.A.H. Formulary in September 1988 as a replacement for cefotaxime because the spectrum of activity, documented efficacy, potential for single daily dosage and cheaper unit cost suggested patient care benefits and potential savings. These savings have not been realised and expenditure on ceftriaxone increased by 17% during 1988/89 compared with an overall increase in expenditure for other antibiotics of 10%.

A review of ceftriaxone usage at the R.A.H. was performed in June/July 1989 to determine:

(i) ceftriaxone user groups,
(ii) the dosage and frequency of administration,
(iii) indications for use.

The review was conducted over 6 weeks, on randomly selected patients in surgical, medical, intensive care and specialty clinics. Ceftriaxone courses were classified as empirical (organism unknown), for therapy (organism known), for prophylaxis, or as undefined when it was not possible to establish the reason for drug use (Table 1).

Table 1. Treatment type and clinic distribution.

TREATMENT TYPE	CLINIC DISTRIBUTION					TOTAL (%)
	Med	Surg	Spec	Orthopaed	ICU	
Empirical	1	7	5	1	2	16 (43.2)
Therapy	1	6	3	1	7	18 (48.6)
Prophylaxis	-	-	1	-	-	1 (2.7)
Undefined	1	-	1	-	-	2 (5.4)
TOTAL	3	13	11	1	9	37 (100)

Thirty seven ceftriaxone courses were reviewed. Approximately two-thirds of prescribed doses were for the 1g strength with specialty wards using the 2g strength more often than other areas. Sixty five percent of courses were for daily ceftriaxone doses of 2g or more with 43% of patients administered the 1g strength receiving a daily dose of 2g (i.e. 1g b.d.).

Inappropriate ceftriaxone therapy accounted for at least 10% of surveyed drug use with an additional, significant proportion of empirical use of ceftriaxone in surgical and specialty units being for spurious indications.

Interpretation of cost centre data in the light of these findings indicates that the proportion of high versus low daily doses of ceftriaxone is higher than that seen previously with cefotaxime. This means that prescribers are using 2g doses of ceftriaxone more often and/or for longer than is necessary. The recommended dosage of ceftriaxone for moderately severe infections is 1g/day given for a total of 7 - 10 days depending on patient response. For more serious, life-threatening infections, the recommended dosage is 2g daily for 3 days, reducing to 1g daily thereafter for a total of 7 - 10 days.

The rational use of ceftriaxone will delay the inevitable emergence of resistant organisms and extend the useful life of this drug at the R.A.H. In addition, the potential cost savings resulting from a reduction in unnecessary use will have a positive effect on the hospital drug budget. Guidelines which describe recommended indications and dosage schedules for ceftriaxone are provided below. Heads of Units are requested to ensure that these guidelines are followed by all levels of Medical staff.

CEFTRIAXONE GUIDELINES

Indications

Ceftriaxone and other third generation cephalosporins should be reserved for the treatment of:

(i) Gram-negative meningitis due to Enterobacteraciae or resistant strains of Haemophilus influenzae.
(ii) infections due to organisms resistant to earlier generations of cephalosporins where aminoglycosides (eg. renal impairment) or amoxycillin (eg. penicillin hypersensitivity) administration is contra-indicated.
(iii) anorectal, or pharyngeal gonorrhoea, and in gonococcal urethritis caused by penicillinase producing organisms.

Dosage *(1)*

Severe, life-threatening infections:
2g daily for 3 days, followed by a further:
1g daily for 4 - 7 days (2,3).
Moderately severe infections:
1g daily for 7 - 10 days.
Gonorrhoea:
250 mg I.M. administered as a single dose.

Notes

1. Ceftriaxone should be administered as a single daily dose.
2. Ceftriaxone may be administered by I.V. bolus over 3 minutes, as an I.V. mini-infusion over 30 minutes or by deep I.M. injection.
3. Dosage reduction will be dependant upon a satisfactory response to therapy as indicated by improvement in clinical state, fever reduction, culture results or reduction in leucocyte count.
4. The Division of Clinical Microbiology should be consulted when in doubt about indication or dosage schedule.

• DRUG PROFILE •

GLIPIZIDE

Introduction

Glipizide is an oral blood glucose lowering agent and "second generation" sulphonylurea. Its primary action is to stimulate insulin secretion from beta cells of pancreatic islet cell tissue.

Pharmacokinetics

Following oral administration peak plasma concentrations are reached at 1-2 hours and then rapidly decline (half-life of elimination is 3-4 hours) so that plasma levels are nearly undetectable at 24 hours. The drug is approximately 95% bound to plasma proteins. Glipizide is primarily metabolized in the liver and largely excreted as inactive metabolites in the urine.

Glipizide has a rapid onset of action with insulin release occurring within 30 minutes of administration. Despite the short plasma half life of 3-4 hours the hypoglycaemic effect persists for up to 24 hours allowing for once daily administration.

Indications

Glipizide is used to control hyperglycaemia in patients with non-insulin-dependent diabetes mellitus (NIDDM: Type II) after an adequate trial of dietary therapy. Glipizide may be a better choice in the older patient (greater than 60 years) because hypoglycaemia is reported to occur less frequently than with other sulphonylurea agents.

Adverse Effects

Hypoglycaemia may occur especially in the presence of significant hepatic or renal insufficiency, and care should be taken in the very elderly patient. Prescribers should read the approved product prescribing information for details of other adverse effects.

Drug Interactions

It has been suggested that Glipizide is highly protein bound and therefore less easily displaced from protein binding sites, so that drug interactions are potentially less likely. However there is currently no clinical evidence to support this concept. Potential drugs that enhance or impair the action of Glipizide can be found in the prescribing information.

Dosage and Administration

The drug should be taken 30 minutes before meals. The initial dosage is 2.5mg to 5mg given prior to breakfast. The maximum recommended once daily dose is 15mg and the maximum recommended total daily dosage is 30-40 mg.

by Dr. A. P. Roberts, Endocrine Unit, R.A.H.
References available on request.

• PRESCRIBING POINTS •

Insulins - Guidelines for change from animal to human insulin

CSL-Novo Pty Ltd and Nordisk/Wellcome have advised that porcine insulins will not be available after December 1, 1989. All patients receiving these insulins will need to be transferred to the appropriate human preparation. Bovine insulins will continue to be marketed for the forseeable future.

Transfer from porcine insulins to the generically equivalent human insulins can usually be made DOSE-FOR-DOSE; some patients may require small dosage reductions.

The appropriate conversions are shown below:

Actrapid MC .....Actrapid HM
Monotard MC .....Monotard HM
Protaphane MC .....Protophane HM
Actraphane MC .....Actraphane HM
Velosulin Porcine .....Velosulin Human
Insulatard Porcine .....Insulatard Human
Initard Porcine .....Initard Human
Mixtard Porcine .....Mixtard Human

For patients on Rapitard or Semilente the appropriate conversions are:

Rapitard MC .....Actraphane HM
Semilente MC .....Actraphane HM

If the daily dose of Rapitard MC or Semilente MC is greater than 0.6 units per kg of body weight an initial dosage reduction of 10-15% should be made. In addition, it is recommended that dosages are divided into 2 or more daily injections.

Patients currently stabilised on porcine products should be transferred to the human product as soon as practicable. All newly diagnosed insulin dependent diabetics should commence therapy with the human preparations. Human insulins are available as pharmaceutical benefits under the P.B.S. (5 x 10ml, 2 repeats).

For further information contact the Diabetes Centre (Ext. 5111/6265) or the Pharmacy Drug Information Centre (Ext. 5546).

❄ *Season's Greetings from the Drug Committee* ❄
and the Pharmacy Department

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APPENDIX 5

Public Hospital Feasibility Study Survey Form and Information Sheet

S.H.P.A. Public Hospital Drug Utilisation Data Collection Feasibility Study
Hospital Survey Form

Section 1: Drug Purchase Data

Question: Can you provide the following data for individual drugs ***purchased*** by your institution ?	Yes	No	Not sure
A. drug code (eg SHPA, ATC, AHFS, PBS) *Note: Drug code does not mean hospital or wholesaler catalogue number*	❑	❑	❑
B. generic drug name	❑	❑	❑
C. drug strength	❑	❑	❑
D. dose form	❑	❑	❑
E. **pack** size	❑	❑	❑
F. purchase price for **pack**	❑	❑	❑
G. **unit** purchase price *(eg for 1 capsule or 1 ampoule)*	❑	❑	❑
H. total number of **packs** purchased for a given period	❑	❑	❑
I. total number of **units** purchased for a given period	❑	❑	❑
J. separation or estimate of above drug utilisation figures for:			
• inpatients	❑	❑	❑
• outpatients	❑	❑	❑
• other patient types *(eg Casualty, Home Health Care, same day)* (Please specify: _____)	❑	❑	❑

Section 2: Drug Issue Data

Question: Can you provide the following data for drugs ***issued*** to individuals, wards and departments from your Pharmacy ?	Yes	No	Not sure
A. drug code (eg SHPA, ATC, AHFS, PBS) *Note: Drug code does not mean hospital or wholesaler catalogue number*	❑	❑	❑
B. generic drug name	❑	❑	❑
C. drug strength	❑	❑	❑
D. dose form	❑	❑	❑
E. pack size	❑	❑	❑
F. purchase price for **pack**	❑	❑	❑
G. **unit** purchase price *(eg for 1 capsule or 1 ampoule)*	❑	❑	❑
H. total number of **packs** issued for a given period	❑	❑	❑
I. total number of **units** issued for a given period	❑	❑	❑
J. separation of above data elements data for:			
• inpatients	❑	❑	❑
• outpatients	❑	❑	❑
• other patient types *(eg Casualty, Home Health Care, same day)* (Please specify: _____)	❑	❑	❑

Section 3: Data Format

Question: For drug purchase and / or issue data which of the following data formats would be available to a central data base ?	Yes	No	Not sure
A. Printed report	❑	❑	❑
B. **Fixed** field length, delimited, ASCII text file on floppy disk	❑	❑	❑
C. **Variable** field length record in ASCII format delimited by comma or other character	❑	❑	❑
D. Other file type (Please specify: _____)	❑	❑	❑
E. For **computer files**, the following information will be required to assist the Project Team in importing data into an electronic spreadsheet or database. Please indicate if you can provide the following information about the computer file :			
• the total record length *(for fixed length records)* or the delimiter character *(eg comma, for variable length ASCII records or other record types)*	❑	❑	❑
• the field structure or data dictionary *(ie what data fields make up each record)*	❑	❑	❑
• the field length and field offset *(ie how many characters long is each field in the record and where in the overall string does each field start and finish)*	❑	❑	❑
F. Does your department currently have available a report containing the above elements or one from which the data elements could be extracted *(ie by the Project Team, extraneous data elements would be discarded)*	❑	❑	❑
G. If you answered yes to question E. above, would you be willing to provide some data to the Project Team by mid-September to enable feasibility testing for the study.	❑	❑	❑

Section 4: Hospital Demographic Data

Question: Can you provide each of the following demographic data elements for your institution for each year quarter of a given financial year ?	Yes	No	Not sure
A. Number of beds	❑	❑	❑
B. Average % occupancy	❑	❑	❑
C. Number of occupied bed days	❑	❑	❑
D. Number of inpatient separations	❑	❑	❑
E. Number of hospital outpatient attendances	❑	❑	❑
F. Number of Casualty attendances	❑	❑	❑
G. Number of same day patients (excluding outpatients)	❑	❑	❑

Section 5: Project Participation

Question: Based on the information provided and the project's long term objectives..	Yes	No	Not sure
A. Would your department be **able** to supply quarterly drug utilisation data to a central database ?	❑	❑	❑
B. Would your department be **willing** to supply quarterly drug utilisation data to a central database ?	❑	❑	❑

To:	**Gary Misan** Project Director S.H.P.A. Public Hospital Drug Utilisation Data Collection Feasibility Study	**Phone:** **Fax:**	
From:		**Phone:** **Fax:**	
Re:	Drug Utilisation Feasibility Study Survey		
Date:			
Number of pages: (including cover page)	**3**		

Hospital Survey Form *continued...*

Section 6: Contribution to existing data bases

Question: Does your hospital / department currently contribute data to centralised databases maintained by the following organisations ?	**Yes**	**No**	**Not sure**
A. Your State Health Department .	❑	❑	❑
B. The Australian Institute of Health.	❑	❑	❑
C. The I.M.S. Australia, Australian Hospital Index database.	❑	❑	

Section 7: Your computer system

Question: Please describe the Name and Version of your pharmacy computer system(s) ?

A. purchase / inventory system .

B. dispensing system:

Section 8: Additional comments

THE SOCIETY OF HOSPITAL PHARMACISTS OF AUSTRALIA

A.C.N. 004 553 806

PATRON: His Excellency. The Governor of Victoria

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South Melbourne VIC 3205
Phone: (+61) 03 6906733 Fax: (+61) 03 6967634

S.H.P.A. Public Hospital Drug Utilisation Data Collection Feasibility Study

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Project Director

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PROJECT INFORMATION

PREAMBLE

At the present time, centralised utilisation data for individual drugs used within the public hospital system is not available in Australia. This is in contrast to data currently available for drugs obtained through the PBS[1], RPBS[2] and Guild prescriptions[3]. As a result there is a considerable gap in data and understanding of National and State drug utilisation patterns. This project will determine whether this deficiency can be remedied.

AIM and SCOPE OF PROJECT

The objective of the project is to investigate the **feasibility** of establishing a comprehensive, central database for routine collection and reporting of drug usage data from public hospitals. We envisage that if this database was established, hospitals would submit quarterly drug usage data in electronic format to a central processing office. Data would be collated, analysed and published in a contributor anonymous format similar to that used for the Australian Statistics of Medicines. Data would be available for *bone-fide* research and other purposes.

INTERESTED GROUPS and USE OF INFORMATION

All State Health Departments and a range of relevant State and National organisations have been circulated information about the project. A number of applications for such information have been proposed:

- Information would fill the gap in our current knowledge of National and State community drug utilisation patterns.
- Information would be useful in characterising usage patterns for particular drugs or drug groups around the country.
- Data could be stratified to describe drug utilisation patterns for different hospital types within and between States.
- Utilisation data could be combined with activity, demographic data (eg casemix) or epidemiological data (eg admission rates, antibiotic resistance) to characterise drug utilisation patterns for public health purposes (eg correlation between antibiotic use and antibiotic resistance patterns).

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1 The Commonwealth Pharmaceutical Benefits Scheme
2 The Commonwealth Repatriation Pharmaceutical Benefits Scheme
3 Pharmacy Guild Private Prescription sample.

- Information would be of interest to institutional Drug and Therapeutics Committees to assist in establishing comparisons between their agency and State or National trend data.
- State and Commonwealth authorities, could use data to target educational activities and achieve QUM4 and other policy objectives.
- Data could be combined with PBS and private prescription data to compare overall Australian drug utilisation patterns with those of other countries.
- Information would provide baseline data from which to initiate more detailed intra- or interstate drug utilisation review and drug usage evaluation activities.
- Data would also assist in measuring the effect of education programs or policy changes.

METHOD

The project involves 3 phases of data collection. The first is an attempt to characterise the extent of data currently available. This includes drugs funded under the Section 100 provisions of the PBS scheme. This data is needed to establish the denominator for the second sampling phase of the project. The required data includes aggregated drug expenditure figures for each hospital within the respective States, separated according to hospital type and / or region. Corresponding activity data (occasions of service for inpatients, outpatients and other patient types, number of occupied bed days etc.) are required. Aggregated data sources held centrally by State and Commonwealth Health Departments will provide most of this data.

The second phase requires establishing which hospitals (or regional authorities) could and would participate if such a project were established in the longer term. This information will be derived by surveying hospitals around the country. This data will be collated and compared with data from the first phase to establish how representative the sample of potential participants would be in making projections for the respective States.

The third phase involves obtaining data from a small number of hospitals in each State for a limited range of drugs (eg antibiotics) in order to attempt some data analysis, modelling and reporting. This will assist in determining whether electronic data from different computer systems can be integrated, and the possible problems inherent in this process.

The required data elements should be readily available from most computerised hospital pharmacy dispensing or purchasing systems. They include generic name, strength, dose form, purchase or issue quantity, unit purchase price and drug codes[5]. Patient prescription data is not required. Drug issue data is preferred. Utilisation separated into inpatient and outpatient samples is of most interest. In the absence of issue data, purchase data will be examined for useability. Data should be available on electronic media (ie floppy disk or via modem) and in ASCII format. All data received will be encrypted and reported in a format that will not identify contributors. Appropriate acknowledgment of data sources will be provided in the final report. Relevant data in the final form will be available to participating centres. Potential data contributors for Phase 3 of the project will be contacted following receipt and collation of Phase 2 survey data.

Survey forms are being distributed with this information sheet. Please take a few moments to complete the form and return by post or fax to the Project office on or before September 15, 1995. All enquiries should be referred to Gary Misan, Project Director at the Adelaide Project Office.

Gary MH Misan
Project Director, August 19, 1995

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4 A Policy on the Quality Use of Medicines, Commonwealth Department of Health Housing and Community Services, August 1992.

5 Drug coding systems used by the various hospitals will ultimately need to be mapped to ATC or other uniform coding system.

APPENDIX 6

Author biography

Biographical Details -

Gary MH Misan B Pharm

I obtained my Bachelor of Pharmacy degree from the South Australian Institute of Technology in 1979 and undertook training as a graduate pharmacist at the Flinders Medical Centre in South Australia. In 1980-82 I worked at the Gippsland Base Hospital in Sale, Victoria developing interests in radiopharmacy and clinical pharmacy. I joined the staff of the Royal Adelaide Hospital as a base grade pharmacist in 1982. In 1986 I was appointed a Senior Clinical Pharmacist (Professorial Medical Unit) and in 1987 as Project Pharmacist Drug Committee where I developed my interest in drug usage evaluation, antibiotic use and computing. In 1991 I obtained the position of Senior Specialist Clinical Pharmacist (Infectious Diseases Unit) where I maintained active clinical and research interests in HIV / AIDS and in the clinical use of antibiotics. I assumed the position of Director, Pharmacy Drug Distribution Services in 1994.

I have appointments as Affiliate Clinical Lecturer with the University of South Australia and the University of Adelaide and I am an accredited Clinical Tutor with the SHPA.

Until November 1995, I was Chairman of the SHPA COSP in Drug Usage Evaluation and Project Director for a Commonwealth funded study into the feasibility of collecting quantitative drug utilisation data from Australian public hospitals, which is reported in this thesis. I am currently a member of the Drug Utilisation Review Clinical Interest Group of ASCEPT and the Antimicrobial Special Interest Group of the Australian Society of Microbiology. In December 1995, I commenced an appointment as Executive Editor of the Australian Medicines Handbook.

I commenced study towards a PhD in Drug Usage Evaluation with the Faculty of Medicine University of Adelaide in 1988.

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