A prognostic model for priority public dental care

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Abbreviations

A & E	Accident and Emergency
ARCPOH	Australian Research Centre for Population Oral Health
ANOVA	Analysis of variance
AUC	Area under the Curve
CATI	Computer Assisted Telephone Interview
CDHP	Commonwealth Dental Health Program
cf	compared with
CI	Confidence interval
CDS	Community Dental Service
DMFT	Decayed, missing, filled teeth
EDS	Emergency Dental Service
IT	Information Technology
Min	Minimum
Max	Maximum
MIS	Management Information System

ns	not significant
n	sample size
NSW	New South Wales
P	P-value
PV+	Positive Predictive Value
PV-	Negative predictive value
PAL	Primary Approach Letter
QALYS	Quality Adjusted Life Years
Ref	Reference category for odds ratio
ROC	Receiver Operator Characteristic
ROP	Relief of Pain
RNI	Relative Needs Index
SA	South Australia
SA Dental Service	South Australian Dental Service
SD	Standard deviation
Se	Sensitivity
Sp	Specificity
SRF	Supported Residential Facility

Abstract

Excess demand over the service capacity of public dental services has resulted in ad hoc rationing of access to services. As a result a significant proportion of public dental service patients receive only same-day or priority dental care. However, many such appointments are of low urgency, an outcome which is facilitated by lack of a standardised method to determine access for those seeking priority dental care.

Aim: This thesis aimed to develop, validate and trial the implementation of a prognostic model for urgent dental care.

Methods: This was a multi-phased research study. The first phase, the Parent study, collected psychosocial data on people seeking emergency dental care in SA and NSW and dentists' assessment of urgency. Two sequential prognostic models for urgency of dental care were developed as preliminary research. As further development of the models was to occur only in SA, the sequential prognostic models were examined separately in SA and NSW. The next phase involved testing the validity of the models on patients accessing urgent dental care at two new SA sites over an eight month period in 2004. This led to the development of a single model, the Composite model, and testing of its accuracy. The Composite model was then tested in a 28-week intervention trial in four SA Dental Service clinics in 2006. Both quantitative outcomes and qualitative outcomes were assessed.

Results: The Parent study included 839 people seeking urgent dental care. Two sequential logistic regression models were developed to predict dentists assessed urgency of < 48 hours vs 2+ days, and 2-7 days vs 8+ days. The models used responses to 11 psychosocial questions to predict with acceptable accuracy dentist assessed urgency. Small differences in the regression coefficients of predictor variables of urgency were evident in the models specified for SA and NSW separately. Model testing showed acceptable accuracy against clinically determined urgency of dental care when examined on a new set of 294patients from two clinics in SA and showed greater accuracy in assessing urgency than the traditional SA method of receptionist assessment.

However, a single Composite model was preferred over the two separate models**.** The Composite model performed with higher sensitivity and specificity than reception staff and had higher reported AUC values indicating better fit of the model.

The implementation trial involved 728 people pre- and 1013 people post-implementation making contact with one of four SA Dental Service clinics. People reporting they had received treatment fell after implementation of the Composite model (74.8 *cf* 65.6%). Of those who received care, a lower percentage received care from the SA Dental Service (70.2% *cf* 67.9%) and subsidised private treatment (22.2% *cf* 17.4%) and more from private dentists (7.6% *cf* 14.7%). Post-implementation, a lower proportion of people receiving treatment from the SA Dental Service reported experiencing pain at first contact. Within the SA Dental Service, a decrease in the percentage of staff time spent on urgent dental care occurred (60.2% *cf* 39.8%) with a matched increase in time spent time spent on general, preventive dental care.

Focus group discussions showed that staff liked the transparency, support and equity the prognostic model provided. Staff remained concerned about those denied urgent dental care, but concern was ameliorated by the possibility in exceptional circumstances to over-ride the prognostic model.

Conclusions: Further development of a prognostic model for urgent dental care led to a single composite model with acceptable accuracy in the clinical setting. The single prognostic model was more accurate in predicting dentist assessed urgency and was also found to be more transparent, consistent and equitable than relying on receptionist judgement. Implementation of the prognostic model rationed urgent dental care. The allocation of SA Dental Service staff time and resources moved away from urgent and towards general preventive care.

Declaration

This thesis contains no material that has been accepted for the award of any other degree or diploma in any university. To the best of the candidate's knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis. The initial development of the Relative Needs Index (The Parent study), which has been described in this thesis, frames the rationale and provides an initial foundation for this thesis. The Parent Study was undertaken by a number of researchers in a contract research project and parts have been published, of which this candidate was a co-author. I give my consent to the thesis being made available for photocopying and loan if accepted for the award of the degree.

Signed: …….

Date: …….

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1 Introduction

This thesis reports on the validity and effects of a prognostic model developed for the purpose of prioritising between eligible persons seeking dental care in publicly- funded dental clinics in South Australia. As demand for both 'emergency' and general dental care continued to increase in the years after 1997 without commensurate increases to funding or changes to the delivery of those services, the development of more systematic and transparent criteria for decisions on access to public dental services gained momentum within state and territory public dental services in Australia[1].

Demand management has increasingly become a focus of public dental services as demand for these services increases and the system's capacity to service such demand remains constrained. Indeed, a vicious cycle in public dental care has been in operation in South Australia, whereby the system as it functions forces people into particular recidivistic care seeking behaviours deleterious to their oral health [2]. The behaviours include accessing 'emergency' dental treatment only and by-passing long waiting lists for preventive public dental care.

The prognostic model evaluated in this thesis had its inception in a research project entitled the Relative Needs Index (RNI) study[3, 4]. This RNI Study generated two regression models (the RNI models) using a set of independent variables that were the best predictors of the relative urgency for access to 'emergency' dental treatment (urgency determined as < 48 hours vs > 48 hours, then a subsequent further division of those >48 hours into 2-7 days or 8+ days). The predictive capacity of the models was subsequently statistically assessed[5]. This stage of the development of the RNI study is referred to as the Parent Study in this thesis. These models and their associated questions were used as the foundation for the development of a single prognostic model. This single model was built on a parsimonious set of urgency-setting questions that could be administered over the telephone. The single model which was subsequently used in this research is referred to throughout this body of work as the 'Composite model'.

There are two phases to the original research reported in this thesis. The first phase of the research involved testing the capacity of the RNI models on a fresh set of patients requesting care. Information used for this phase was patients' telephone responses to the RNI models' questions, reception staff assessment of patients' urgency and attending

dentists' assessment of each patient's urgency of treatment need. The attending dentists' assessment of urgency constituted the 'gold standard' against which the models' performance was tested. The purpose of this component of the research was to determine whether the RNI models could validly be used to prioritise patients and whether they possessed the prognostic accuracy as hypothesised in the RNI Parent Study [6]. The testing of the validity of the RNI models led to the development of a new single model to predict urgency of treatment need, the Composite model. The second phase of the research involved evaluating the self- reported oral health, receipt of treatment and system performance outcomes arising from implementing the Composite model in a real time setting. This was an intervention trial with a pre- and post- intervention design implemented at four clinic sites.

All patients calling the four clinics during the study period were contacted by the SA Dental Service by telephone and asked to complete a computer-assisted telephone interview (CATI) which captured, both pre- and post-intervention, basic information about satisfaction with the SA Dental Service prioritisation process, oral health, use of dental services and socio-demographic characteristics. This was to explore the potential effects of implementation of the new prognostic system and to understand the impacts on oral health, receipt of treatment and system performance. All persons contacted by the CATI interviewers were asked for their consent to being sent a more comprehensive questionnaire, which captured more detailed information on oral health impacts, dental goals, and satisfaction with service and beliefs about urgency-setting. The management information system (MIS) used by the SA Dental Service in all of its community clinics generated service provision data for consenting participants receiving care with the SA Dental Service and data on staff hours dedicated to different types of care provided.

Focus groups were conducted both pre- and post- intervention with reception staff from the participating clinics to build a qualitative analysis of staff perceptions and experiences of the prognostic model for urgent treatment.

1.1 Demand exceeds supply for adult dental care

Public dental services across Australia are facing shortages in supply and difficulties in retention of employees. Compounding this labour force problem is the increased public demand for dental services. Both these factors have led to the public dental sector's

inability to fully service current demand for dental care services[7, 8]. Subsequently, interest and investment in research on new and more appropriate ways of managing demand are becoming increasingly attractive to public dental service providers and ways to manage demand more equitably are of increasing interest to oral health policy makers[9, 10].

The SA Dental Service provides care to adults using means-tested eligibility criteria. Community dental clinics serve the eligible population and special services are provided for groups with special needs or considered to be particularly vulnerable (those with disabilities or Indigenous). The management system traditionally used by the SA Dental Service for patients requesting dental care has been to divide them into two groups: those persons reporting pain and some loss of oral function requesting urgent access to an 'emergency 'appointment, usually on the day the person called the clinic or a day or two thereafter; and, those seeking a check-up or routine dental care who are placed on a waiting list for appointment. 'Emergency' services have been provided on a first-in, first-served basis to those self-reporting such a need. Some prioritization has been implemented through recognition of special vulnerable groups, but little progress has been made in assessment of individual needs. General dental treatment, check-ups and routine maintenance care have been provided to patients using a waiting list system. Patients elect to put their name on a list and wait for their name to reach the top of the list. The waiting time associated with these lists depends upon factors which remain out of the control of the person wanting care. Waiting times under this system for general dental care are long, and depending on clinics, could range from 1-5 years. 'Emergency' care has become the bulk of care provided. Provision of care has become skewed towards meeting self- reported 'emergency' dental needs. This has reduced the system's ability to provide adequate general dental treatment to eligible patients because the bulk of resources are consumed in the provision of emergency care at the expense of providing general dental care[11].

Management of waiting lists has become more attractive and policy makers are seeking novel and effective methods for timely and more needs-based allocation of access to oral health care for those who are eligible for public dental health services[12]. There is a need to reorient existing services to provide more general dental care. This is coupled with a perception amongst service providers and the eligible community that many who get 'emergency' or higher urgency dental care allocated to them are not actually of high urgency.

There is increasing pressure on public dental services to provide access to dental care which is evidence-based. Together with the ongoing question of how best to balance the reality of resource scarcity with timeliness of care, this has led to an interest in the development of a priority-setting or prognostic model.

Screening or priority setting tools are being increasingly used in public dental programs for identifying people at high-risk of developing caries, mainly in children using school dental programs. This interest has developed in an era where prevalence of caries at population level has decreased significantly over the decades since the mid- 1960s and these tools aim to identify those most at risk of future disease development and to provide identified persons with appropriate preventive treatment. However, tools like these have not been developed with the objective of determining relative urgency *between* persons presenting with symptoms and/or an acute dental problem[13, 14]. Such a model is more a priority-setting or prognostic tool than a screening tool, as screening tools by definition deal with asymptomatic conditions[15]. A prognostic model has never been tried in the Australian dental setting. To introduce such a priority-setting model into a public health programme to determine access for individuals would not be ethical without testing whether such a model can deliver the outcomes it proposes [16].

1.2 Emergency dental care requires rationing

The primary research purpose was to develop and test the capacity of a prognostic model for urgent dental treatment. If the model proved to be sufficiently accurate in predicting urgency of need for 'emergency' care then a second research purpose was to investigate the impacts on oral health, receipt of treatment and system performance of the implementation of a new prognostic model in a number of public dental clinics. The model needed to be proven to be stable and transferable in both location and time in its capacity to predict urgency for care. To demonstrate this, standard primary measures of determining accuracy, sensitivity and specificity, have been utilised in this research [15, 17].

Generally, urgency-setting in the SA Dental Service follows some basic preliminary steps. Guidelines for administrative management of dental 'emergencies' exist, but vary between settings and have not been implemented consistently across staff or clinics or over time; ad hoc urgency-setting of persons seeking access to dental care, by receptionists, appeared the norm [15, 17, 18]. After meeting basic eligibility criteria for access

to publicly funded dental care, patient quotas for emergency care are filled each morning using patients' self- reported need and receptionist judgment, until all available booking times for such treatment are filled. Patients calling thereafter and finding no appointments available are advised to call back the following morning if they still have their dental problem [19]. An appointment for treatment is again re-negotiated depending upon the receptionist judgment and availability of appointments. Such a negotiated position is heavily dependent upon social interaction and negotiation skills between patients seeking emergency care and the receptivity of the gatekeeper, the receptionist, to people's demands. This interaction between those involved is influenced both by the way in which the demand is made by the person seeking care and the interpretation by the gatekeeper of the request for care. Potentially, this cycle of request, access or deferral and denial, can be repeated many times. This approach of the SA Dental Service to booking appointments is ad hoc, and varies between receptionists, clinics and over time as a result of potentially biased interactions between the person seeking access to 'emergency' dental treatment and the 'gatekeeper' of that care.

1.3 A priority-setting system can be fair and equitable

Long, and increasing, waiting times for general dental treatment in South Australian (SA) public dental clinics, coupled with a perception by dental staff that patients were unfairly using the system in order to receive 'emergency' care, led to the desire for an equitable way to identify those patients with higher clinical need for urgent care relative to others. If a more equitable way of identifying those patients with urgency need included identifying those whose needs were not urgent and denying them care, then resources could be transferred to the provision of general dental care. Such a system would be better able to provide more timely and efficient general dental care to those who needed it most than the current system was affording.

The term 'emergency' in the context of public dental health is an ill-defined, ambiguous one. The meaning embodied in the use of the term 'a dental emergency' appears to differ between policy makers, dental professionals, dental administrators, and the general

public. The traditional or normative definition of the term 'emergency' in the SA Dental Service and, in the context of dental need, includes people reporting dental trauma, haemorrhage and facial swelling and other life threatening oral health conditions. It has also tended to include those persons calling for relief of *dentally-related pain.* However, no definitive common nomenclature exists for use in the prioritisation or triage of patients seeking access to such urgency care. Contemporary Australian research suggests only a small percentage, less than one percent, of persons seeking emergency dental care report life threatening infections, swelling, trauma and the like [6, 12].

Currently, waiting lists for general dental care are based on the chronological queuing of patients, meaning that both urgent and general dental care is offered on a 'first come, first served' basis. Dental care is strictly allocated to patients in the order in which they enter the queuing system. Over time there have been increasing concerns about whether this was a fair approach to allocating access to public dental care. Additionally, the delivery of 'emergency' care at the expense of the provision of general dental care was also of concern.

One way of managing the problems associated with allocating dental care to patients on the basis of a chronological system is to ration the care on the basis of a person's overall experience of oral diseases and disorders. This way, patients can be given an urgency rating depending on their reported symptoms and the reported impact of their oral disorder. Systems that *do* prioritise patients with the greatest need are deemed to be equitable since they give those who are in greater need higher priority. This priority-setting among patients was hypothesised to better facilitate access to adult dental care in South Australia. However, this assumption of better or more equitable access for those in need afforded by such a model needs to be tested.

Explicit rationing is not a new concept, but how it is both introduced and delivered within any population makes it a potentially contentious pathway of demand management. In recent years in SA, the public dental service has seen the introduction of various methods of demand management in an attempt to better manage both provision and demand for public dental care. Past examples include the system-wide introduction and subsequent increases in patient co-payments. At a local level, receptionists have attempted to prioritise using criteria informally obtained from colleagues in an attempt to introduce some level of uniformity within as an informal method of demand management.

1.4 Aims of this research

The aim of this research was to develop and then test the implementation of a prognostic model to prioritise access to emergency dental care.

This research aimed to provide evidence for the validity and to determine the consequences of the introduction of a prognostic model.

This research examined:

1. The initial development of two sequential prognostic models for urgent dental care in the Parent Study
2. The stability and predictive accuracy of the those models when specified on data stratified by the two participating Australian states
3. The stability and predictive accuracy of the prognostic models on a new test set of patients
4. The development of a single 'Composite' model on a new set of patients in SA
5. The predictive accuracy of the 'Composite' model and comparison with that of reception staff
6. The impact of implementation of the 'Composite' model on self- reported oral health problems, receipt of treatment and system performance.

This thesis addressed two research hypotheses:

1) That the prognostic model will perform adequately on a new 'test set 'of patients. Its' adequacy would be determined by its stability and assessment of its predictive accuracy, sensitivity and specificity values.

2) That the implementation of the prognostic model in public dental clinics will lead to more appropriate system performance as measured by a change in the proportion of staff hours dedicated to the provision of both emergency and general dental care. This shift in the proportion of type of care provided is hypothesised to be evidence of the reorientation

of the public dental service system towards the provision of more comprehensive, preventively-oriented general dental care. In real terms this will mean reduced numbers and proportion of emergency patients booked during the course of the research.

1.5 Structure of the thesis

This thesis is structured around research that evaluates whether a prognostic model can predict with *acceptable accuracy* those patients requiring more urgent access to emergency care and the consequences of the implementation of the prognostic model in SA Dental Service public dental clinics.

Chapter 1 provides an introduction to the research problem to be addressed and the background to the initial development of the prognostic model.

Chapter 2 is a literature review around issues of problems in public dental services in Australia, triage and rationing, urgency-setting methods, dental indicators for urgency setting, acceptability and use of such urgency-setting models and the methods of development and validation available.

Chapter 3 provides background into the development of the initial RNI models and their predictions of accuracy.

Chapter 4 explores the performance of the models when applied solely to South Australian data.

Chapter 5 reports on performance of the RNI models on a new test set of patients and further development of a single 'Composite' prognostic model. Results show the predictive accuracy of both the RNI models and the new Composite prognostic model.

Chapter 6 reports the aims, methods and results from the implementation trial in SA Dental Service public dental clinic settings.

Chapter 7 reports on qualitative findings from focus groups with staff involved in the implementation trial.

Chapter 8 is a discussion of the research findings and strengths, limitations and implications of the research.

2 Literature review

Over the last few years, urgency-setting in public dental services has received more attention across the states of Australia and generated debate amongst stakeholders in the delivery of public dental services about the best way to approach and manage the gap between public demand for and any given services' capacity to supply dental services [10].

The literature on urgency-setting as it relates to public dental services is scant. Hence, inferences on urgency-setting *per se* must be made from theory and approaches to urgency-setting and their experiences in the general and specialist medical literature.

2.1 Public dental services in Australia

2.1.1 National perspective on public dental services

State and territory governments provide public dental services from their own health budgets and each is responsible for the structure and delivery of these public dental services. Consequently eligibility, delivery and types of care provided can potentially vary between the states and territories.

The South Australian Dental Service (SA Dental Service) is responsible for the provision of emergency and general dental services to financially disadvantaged sectors of the South Australian population; some 440,000 South Australian adults are eligible to use the service although only around 60% of those eligible make a dental visit in any one year. Nearly 2/3rds of the eligible population made their last visit to a private practice[1]. The eligible population is by no means a homogenous group and consists, for example, of the unemployed, under-employed, sole parents, aged pensioners, students and any others who fit the eligibility criteria by way of means testing. Dental services are provided through the Adelaide Dental Hospital and the 38 adult community dental service clinics throughout South Australia. Clinics are located mainly within community health centres and some hospitals[20].

The SA Dental Service defines its operating principles in its Mission Statement. The Mission Statement's primary principle defining the delivery of dental services is one of social justice; that fairness and equity and equivalent rights and services are an

entitlement of all eligible persons [20-22]. Additionally, the SA Dental Service Mission Statement includes a commitment to providing timely dental treatment and provision of services that are ideally oriented toward early intervention and the prevention of oral disease, and recognises that as a provider of public health care, it has a responsibility to provide dental care to eligible persons and to provide access to urgent care in a manner consistent with its principles [22, 23]. Such strategic directions relating to social justice, fairness and disease prevention in the delivery of public health services are consistent with recent State government policy for all health services which promotes the strengthening and reorientation of resources towards prevention, early intervention and primary care[1, 21]. Specifically, the SA Dental Service Mission Statement indicates that it should aim to provide most of its dental care for eligible adults in the form of general dental treatment (including preventive treatments).

The SA Dental Service has established waiting lists for general dental care. However, the service does recognise that patients can experience dentally-related problems that may require priority care and for whom it would be unreasonable to wait on a dental waiting list. The SA Dental Service mission statement shows endorsement of a preventive approach whilst simultaneously acknowledging that it resources those services which provide access to those in the greatest clinical need[22, 24].

The SA Dental Service aims to manage demand and provide services using 'appropriate and consistent processes' for identification of dental emergencies and situations that require urgent treatment. The provision of emergency and urgent treatment for a person's presenting chief complaint is to be provided within established timeframes, and, for those patients identified who do not have urgent treatment needs, they are to be given the opportunity to place their name on the waiting list for general dental care [22]. However, what is considered to be 'appropriate and consistent' is not defined. Such non-specific, subjective definitions are open to interpretation and leave the SA Dental Service with variation of what is considered appropriate and consistent across public dental clinics and over time. As such, such service delivery is not grounded in universal rights [22, 23].

Policy changes to service delivery and demand management strategies by SA Dental Service implemented from the late 1990s onwards have been an attempt to manage patient demand within the constraints of limited budgets, whilst simultaneously maintaining the integrity of its stated principles of service delivery. Such approaches to

demand management, alone or in various combinations, have followed traditional health rationing schema; delay access to services and treatment, dilution of services provided and deflection of demand to providers outside the SA Dental Service as described by Spencer in 2001[11]. In the past, the SA Dental Service has employed various combinations of these strategies and has included, for example, changes to criteria for eligibility to access services and the introduction of patient co-payments.

2.1.2 Pressure on public dental clinics

Despite the preventable nature of much dental disease, public dental clinics are currently under pressure to meet increasing demands for emergency dental care[10]. Increased demand for emergency dental care is having a deleterious impact on the way in which dental clinics are currently able to manage requests for general dental care (non-emergencies). Emergency dental treatment frequently takes priority, so sudden influxes of people defined as 'emergency' patients can delay the provision of general dental care because pulling people from the general waiting list for dental care is dependent on the time remaining available in clinics after satisfying the demand for emergency care. Clinics became increasingly focused on providing emergency care and waiting lists for general dental care continued to grow in the lead up to this research.

Waiting times in SA Dental Service clinics have fluctuated between 49 months in 2002 to 27 months in 2005. In 2004, 74% of patients who accessed public dental clinics in SA received only emergency care [24, 25].

At the time of this research, demand for 'emergency' and general dental services outweighed the SA Dental Service's capacity to supply services and demand was being rationed by reception staff; they were the gatekeepers to public dental care. The main barriers to the receipt of timely general dental care in South Australia was the length of the waiting list and the lack of dental staff in clinics to provide service at full capacity [26, 27]. In 2005, public reports emerged that the wait for public dental treatment had "fallen by 22 months since mid-2002, from 49 months to 27 months, representing…a drop of 45%. Over the same period the number of people on the public dental waiting list had fallen by 43,000 people - from 102,000 to 59,000 representing a drop of 42%"[27-30]. Therefore the reduction in wait time was predominantly a result of reduced numbers seeking such care. This could simply be the outcome of deflection of eligible adults into private dental care.

Despite reports of falling waiting lists in certain regional areas of SA (which had mostly been due to periodic injections of additional governmental funding), on the whole, waiting lists remain longer than what is thought to be publicly acceptable. Approximately 40% of the adult population in South Australia (some 440,000 people) and their adult dependents are eligible for public funded dental care. Some 33% of those who are eligible use public dental services, with the majority of courses of care being emergency dental care. Those who attend for emergency care may do so because of actual or perceived difficulty in obtaining general dental care in a reasonable time. For instance, in 2004, approximately 74% of all visits made to South Australian Community Dental Service (CDS) clinics by dentate cardholders were for 'emergency' care. As most services provided are emergency treatments, this results in fewer people being seen from the waiting list for general dental care and waiting time lengthening. [19, 28-30]. This in turn encourages more people to present for 'emergency' care or to be deflected into private dental care.

The SA Dental Service's main long-term aim and objective is to reorient the system so that more general dental care can be provided in order to generate better oral health outcomes for its' clients. This needs to be done within the limitations of existing budgets and without denying patients access to necessary emergency care [1, 23, 25, 31]. Essentially the challenge is to alter the mix of resource use by changing, at the margins or even more profoundly, the way in which the public dental system operates for adults. Whether it is possible to clear the wait list by merely implementing a reorientation of the delivery system without an injection of funds is unlikely, but not known at this point. However, for systems operating under constrained conditions, where the budget is static, the question is, 'What resources should be re-allocated to improve the benefit to the population sub-group being served?' The need is to maximise oral health outcomes with resources unchanged. This concept of maximising the benefit from the use of available resources is central to the development of an economic approach to priority-setting within the context of demand management [32-36].

The delay in the provision of general dental care is compounded by labour force shortages in the public dental service whereby reductions in the number of dentists willing to practise in public dental clinics has resulted in fewer clinic hours of treatment provided and, hence, further delays to a person's access to general dental care [7]. Such labour force driven pressure has resulted in reduced access to public dental clinics for general dental

care [26, 28]. Achieving more timely access to public dental services is clearly an issue that needs to be addressed.

Long waiting lists and waiting times for general dental care and the increasing focus on emergency dental care indicated that public dental services were struggling to meet the needs of the community. Consequently those relying on public dental services were placed at risk of poor oral health outcomes. As summarised by Luzzi , '[the] way eligible adults use public dental services and the way the delivery system is managed is in the hands of the providers"[2]. Poorer oral health outcomes measured by untreated decay rates, tooth loss, edentulism and periodontal disease for people eligible for public dental services is not about reduced motivation in this social strata for achieving good oral health, but about an inability to receive timely access to general dental services[1].

In summary, the pertinent issues for adults using public dental services in South Australia were 1) reduced access to timely dental services despite being eligible to receive public funded dental care due to an increase in demand for emergency dental care and 2) a limited scope of treatment received as part of emergency treatment provided, especially the increased receipt of extractions and the lack of focus on maintenance of teeth and prevention of oral disease [1].

2.1.3 Oral health, access and dental service utilisation in Australia

Contemporary Australian dental health literature consistently suggests that it is a lack of timely and comprehensive access to dental services that generates oral health inequalities in Australia [2, 28, 37, 38]. Australian research and epidemiological surveys have repeatedly shown that oral health inequality between persons of cardholder and non-cardholder status in Australia relates not to differences in oral health indicator scores like composite measures of decay, missing and filled teeth (DMF score), which show no statistical differences between the two groups, but to access to care and difference in treatments received (or lack thereof) [27, 37-40]. The apparent difference in oral health status between persons eligible for public dental care (cardholders) and persons ineligible to receive public dental care (non-cardholders) lies in the differential between the two groups in their ability in accessing timely comprehensive dental care[2, 28, 29, 38, 41]. Likewise, Australia's

Dental Generations: the National Survey of Adult oral Health 2004-06 report (NSAOH) showed that disadvantaged adults had the same overall DMF as non- disadvantaged adults and it is lack of access to dental services which generates inequalities in oral health status as evidenced by higher decayed and missing teeth scores and lower counts of filled teeth[29].

Research conducted in South Australia by Luzzi in 2005 showed that persons eligible for public dental care report similar planned oral health behaviours as persons using private dental care, but differ in their capacity to translate the desire for dental services into a dental visit [2].

This body of Australian research shows systemic issues exist in the public dental services regarding reduced capacity to provide timely access to general dental care. It is lack of access to more comprehensive and preventively-oriented services that hinders better oral health outcomes for those eligible for public dental care in South Australia and Australia-wide. This body of research around timeliness of care also reinforces the motives and supports the principles behind the re-orientation of public dental services toward providing more general dental care [1, 41]. In summary, under-funding of state dental services reduces the capacity of these services to provide timely and comprehensive general dental care to eligible persons in need of care and strategies are required to differentiate between people seeking care to determine the urgency of their need and to determine relative need between eligible persons requesting access to care. Such strategies are required to improve the equity of access to dental care.

2.1.4 Emergency dental services

Research from a study in NSW and SA public dental clinics reviewing dental care seeking behaviour, found that less than 1% of persons accessing 'emergency' care had an emergency using the normative definition of dental trauma, haemorrhage, facial swelling and other life threatening oral conditions[6]. The vast majority of persons seeking 'emergency' dental care do so for relief of dentally-related pain[2, 6, 12].

Anecdotal evidence from dental staff in multiple clinics in South Australia, New South Wales and Victoria suggests that once a patient is in the dental chair and the attending dentist is assessing the presenting problem, whatever treatment required, the majority of

dentists will attend to the dental need irrespective of its urgency[18, 42]. This is contrary to clinical protocols which require no priority of treatment if, upon presentation to the clinic, the person does not present with a condition which is classified as a true 'emergency'. Refusal by clinical staff to limit treatment for the presenting problem only is justified by staff on the basis of wastage of clinical facilities, staff time and equity issues. This has made 'getting a foot in the door' by means of garnering an emergency appointment the way in which patients access most dental treatment. Research into the Victorian public dental services by Cameron (2002) credits the long wait periods for dental care for encouraging those "...patients awaiting general care to bypass the waiting list process by exaggerating the urgency of their needs in order to obtain immediate access to treatment"[28] and reports of patients adopting such an approach have been echoed by dental and reception staff working in other Australian dental services[12, 28, 43].

Reliance on public provision of emergency dental care and the limited availability of and access to general dental care has served to reinforce the very pattern of dental care that has led to inequalities in access [38,29]. Longitudinal research by Luzzi into utilisation of public dental services in South Australia by adults eligible for such care showed that emergency visiting behaviours of long-term users of public dental services were due to impediments in the system and not due to preferences by public patients for relief of pain visiting only [2]. Such a pattern of service delivery will have negative repercussions on the long-term oral health of South Australians if clinics continue to operate under these conditions. Spencer and Harford 2006 suggest that "…[more] frequent, preventive-oriented treatment sets the groundwork for higher rates of preventive care and lower rates of extraction"[26]. Low socio-economic status, which has the effect of reducing access to dental services by limiting a person's capacity to purchase private dental care along with non-availability of general dental care (because of long waiting lists), appears to underlie much of the demand for emergency dental care in South Australia [27, 38, 39, 44]

2.1.5 Gatekeepers to public dental care

Historically, delivery of 'emergency' public dental services has been made on the basis of chronological order of requests and the criteria used to determine access to care are not well defined beyond the general criterion of the life threatening conditions of trauma, haemorrhage and facial swelling as discussed in Section 2.1.4 [23].

Dentists are often cited as being the gatekeepers to dental care, but the fact remains that it is the receptionist in the public dental services in Australia who act as the first or primary gatekeeper. The dentists sit behind the gate waiting [45, 46]. Patients' self- reported need for care, the receptionist's subjective judgment and subsequent interpretation of such self-reports have controlled access to public dental services and whether persons presenting or calling first for urgency care are allocated an 'emergency' dental appointment[12, 18].

Local research by Kahan on receptionist decision-making in the Victorian public dental service found that the more compliant and socially acceptable the person's manner was in their request for access to care, the more likely the receptionist was to feel empathy for a person. The more empathy any given receptionist felt towards a person seeking care, the more likely that person was to receive an appointment for care in an urgent care time slot [43].

Kahan found that reception staff categorised potential patients into those who were perceived as 'demanding, hypochondriacs, liars or otherwise undeserving' of access to scarce public dental care and those who were compliant, polite and behaving in generally socially acceptable ways[43, 47]. Compliant, acceptable patients were therefore perceived to be deserving of access to scarce resources; they received empathic concern from the receptionist and subsequently received an appointment for treatment. Such attitudes by reception staff are essentially the by-product of a system which rations access to care in an ad-hoc way and reflects stresses inherent in such rationing within the system.

Over the years in public dental clinics in SA, patients have been discouraged from presenting to the clinic in-person, as no guarantee to be seen is given. Persons have instead been encouraged to make a telephone call to their local community dental clinic to be triaged over the telephone. However, no single model for triage has been followed in the past, and reception staff, usually chair-side dental assistants with a working knowledge of dental symptoms, have been left to make dental appointments at their discretion[48]. Reception staff are not openly acknowledged as the primary gatekeepers to access to public dental care, but triage decisions on severity and need for treatment are made by reception staff every day as they are in other community health care settings [49, 50].

Increased demand for non-emergency services in emergency health care settings is a characteristic of the categorisation process institutions have for determining the type and amount of emergency treatment which can be received by any one person [51]. Questions of deservedness for care in public dental services can be seen as not a reflection of patient characteristics, but as a reflection of an overloaded system, with inability or inefficiencies in the servicing of demand[2, 43]. This phenomenon of receptionists' subjective interpretation of claims for emergency care becomes particularly acute in service settings operating under budget constraints[52]. In light of this knowledge, services that adjust their priority-setting systems or their approach to priority-setting in acute care settings have the potential to reduce demand for resources and therefore are better situated to promote the provision of more appropriate, comprehensive care [32, 33, 35, 51, 53, 54].

In 2002, NSW Health introduced a computer assisted urgency triage system using call centres for access to their public dental services. The Priority Oral Health Project (POHP) was devised by means of an expert committee and used a decision tree approach to triage. The evaluation of POHP, although limited due to inadequate design of the intervention which restricted the statistical power of analysis, did show that triage using decision making protocols was feasible in the context of the Australian public dental system and that the use of such protocols aided management of dental waiting times. It also supported the hypothesis that if stakeholders are not consulted in the process of devising the intervention, or have limited 'ownership' of the process, then success in implementation of such decision making tools may be limited. Priority-setting using self-reported symptoms in other areas of health care, such as surgery and psychiatry, have long been an accepted strategy [55, 56]. When first introduced in NSW, however, the POHP was contentious among clinical staff due to its use of a non-clinical ranking system for access to general dental care. The POHP evaluation showed that using socio-demographic and economic characteristics as proxy indicators for relative urgency when all else is considered equal was appropriate when oral health status was used as an outcome measure [21]. Those reporting relative social disadvantage had significantly higher oral health needs.

2.2 Rationing is essential for equity

The demand for public dental services has outweighed the system's capacity to supply them. The provision of public dental services, like any public health service, has at its core two very divergent philosophical concerns. Inherently, the health of the individual and the health of the wider community compete in the context of resource scarcity and an equitable distribution of care. Demand management in the provision of emergency dental services aims to reduce pressure on these services without compromising patient care so as to reallocate resources to more comprehensive, preventively-oriented general dental care. These are potentially conflicting ideals and make for tense arrangements in the current context of the delivery of dental public health [33, 57-60]. Acting in opposition are the gains to be made to the individual versus the social interest in the common good and somehow this tension must be resolved at the level of service provision [61]. This resolution is expressed in the concept of demand management, which is the process of decreasing or shifting the mix of demand for different types of care.

2.2.1 Rationing and demand management

The literature on demand management and health resource allocation outlines a variety of strategies that can be used to manage public demand for those treatments provided by a health service[62]. Strategies reported include denial of services to patients, selection of patients to receive care, deflection of patients away from the service, deterrence of patients in accessing the service or treatments, delay of such treatment or access, dilution of the health services provided and termination of treatment [11, 35, 36, 63-65]. All of the mechanisms encompass an element of withholding care to some degree by limiting patient eligibility or restricting the types of services that will be provided. They are used individually or collectively and represent the main strategies used in demand management in the health care sector [35, 63, 66]. In public health care systems, ability to pay is largely removed as a mechanism of demand management. Co-payments can and do exist as a demand management tool within the public sector. However, there has been a reluctance to apply these aggressively among means-tested low income adults. Therefore, other mechanisms of demand management naturally come to the fore[59].

Rationing is an explicit way to determine who is allowed to benefit from access to treatment [67]. Rationing is a "complex interaction of multiple decisions, taken at various levels" in a service where money (resources) is limited. Rationing is fundamental to running any efficient public health care system [57, 58, 68, 69]. One of the fundamental components in rationing health care is setting priorities to measure or weigh the costs and benefits of doing one thing vis-à-vis another. Rationing can address determinants of access to health services and subsequent cost-to-benefit ratios and can be held to mean *systematic* differentiation of health resource distribution amongst individuals, as in the case of 'urgency-or priority-setting'. Priority setting allocates resources through "the process by which criteria are applied to selectively discriminate among patients who are eligible for resources that had been previously allocated"[70]. This use of selected criteria to discriminate between need is referred to as *explicit rationing*.[59, 68] Rationing is sometimes *not* made in a systematic way that measures one need against another. Rationing using capacity to pay or pricing mechanisms to make decisions about who receives access to care is *implicit rationing.* Both are a form of triage[68, 71]. Triage derives from the French word *trier* meaning to cull or pick and from latin '*tria*', meaning three[72]. Triage is the process of sorting patients according to the nature and urgency of their presenting medical condition (demand management) and the assignment of treatment priorities to that individual. Essentially it is a medical term for rationing of acute medical services to persons presenting with an acute need. This process of assessment and urgency-setting clearly has ethical implications, as treatment is intentionally withheld from some people.

Management of scarce resources involves the economic and political forces operating any health care system[73]. The primary debate around rationing centres on the philosophical and moral tensions [64, 74-77]. Reasoning about justice in health care seems to play only a small part in clinical decision making about resource allocation [57, 71, 73, 78]. Faced with the reality of rationing, the issues are: who should ration and how rule-bound and explicit should it be? Rationing debates are complex, involving many competing interests [79-81]. Fairness or equity are often the core determinants in the public debate about decision making about rationing policies. Efficiency concerns are left to the administrators of the public services [58, 67, 82, 83]. As rationing is a process of *how* resources are allocated or appointed in provision of health services, this necessitates an understanding of the decision making processes involved in the task of rationing and who ultimately gains

access to care [79, 80, 84]. Theories of justice and equity can help make sense of the competing interests involved in such decision making [85-88].

2.2.2 Philosophical arguments for urgency of principles

Appointing systems do little to alleviate the imbalance of supply and demand. Resources do not permit all patients to be seen on the same day. Whatever the underlying motivation that leads a service to implement explicit rationing, agreement in the literature exists that any process or approach to it must be systematic and transparent, rational and evidence-based and neither capricious nor ill-defined in its outcomes[35, 89-91]. Priority-setting may be shown in the longer term to be insufficient in addressing waiting list times, but priority-setting becomes necessary if the objective of achieving equity of access amongst persons seeking care and timeliness of access to such care are to be met[66]. Decisions about how need, access, fairness and equality are defined and ultimately who gets access to treatment become important once an organisation has decided to implement some form of priority-setting. The literature covers competing positions and principles for determining costs and benefits that each divergent perspective offers [58, 67, 80, 85, 91-93]. Each perspective comes with a set of interests and values. Philosophy and ethics offer a way to navigate through these values [63, 91]. The question has been asked in the literature, 'What sorts of preferences constitute the right sort of preferences for priority-setting?[80]. It can be argued that the main task to concern ourselves with when looking to ration health care is the issue of *who* should benefit? How is need defined?

To help define need, there are several influential theories of justice e.g., utilitarian, Rawlsian, libertarian and communitarian, all of which deal with issues of equity of distribution and potential gains to be made from such distribution principles. The most constructive theory to use for an understanding of a priority-setting system is Rawls' *maximin principle* of 'justice as fairness' which theorises 'equity of opportunity' as a fundamental to achieving justice[92, 94]. Rawls' principle posits that all primary social goods, namely liberty and opportunity, income and wealth are the basis of self-respect and are to be distributed equally unless an unequal distribution of any or all of these goods is to the advantage of the least favoured[94]. Despite the fact that Rawls principle does not include health as a primary good, it is plausible to conceptualise and extend his definition of equity of 'opportunity and wealth' to include 'access to health care and

health'. This positioning of equity, equal *access* to health care with those in need receiving urgent access to care, and not the experience of *achieving* equal health status, supports the development principles of prioritising dental care.

Equity relates to the idea of the just distribution of goods and services and efficiency relates to the provision of services and goods in a way that maximises the good that is achieved by provision of those goods and services. Three equity principles are defined in the literature that are useful to the discussion on urgency-setting and access to care:

1. Health delivered according to need [74, 75]
2. Equal access to health care: financial and time [32, 34]
3. Equal health or opportunity for health [74]

Equity, as it pertains to the health domain, can be conceptualised as having two main tenets; 1) equity of *access* to care and 2) equity of *need* for care which can then be further formulated in two distinct types: *horizontal equity,* whereby persons in equal need will be treated the same and *vertical equity* whereby persons with greater need should be treated more favorably than those with less[95-97].

A prognostic model for urgent dental care meets the definitions of both horizontal and vertical equity; the fairness of how things are done to whom [74]. By no longer using 'subjectively defined' needs such as the judgement of receptionists but rather an objective measure, the implementation of a prognostic model is an attempt to deliver to the eligible population justice in the manner in which dental care is distributed.

Results from research into public dental waiting-list management in Victoria showed that waiting lists have been managed unfairly in terms of clinical equity (ie: using chronological queuing and not prioritising using indicators of clinical need) but have been managed fairly in terms of social equity [73]. Equity issues such as these are compounded by the variation of triage practices and patient access applied within the SA Dental Service.

Substantial, but unknown, quantities of people are denied access to public dental care in South Australia and the task becomes how to determine for whom care is necessary versus for whom care is 'merely' beneficial.

Daniels suggests four ways to fairly and justly ration resources in an effort to ensure equity amongst persons seeking care [95], criteria that are supported by Sheldon and Maynard[83]. Rationing must be done on the basis of the following conditions being met:

- Publicity. That the decisions and the rationale for deciding who receives access to care must be accessible.
- Relevance. That the grounds for such decisions must be ones that fair-minded people can agree are relevant.
- Appeals. That there must be mechanisms in place to enables challenges and resolve limit-setting decisions.
- Regulation. That there must be some form of regulation in place to ensure that the other conditions are met.

Research on public opinion regarding timely access to health care, indicates that the public supports providing urgent access to those who have the greatest need and there is general support for mechanisms which allow patients with greater need to be allocated greater urgency[98].

2.2.3 Gaming

The term 'gaming' was coined to cover the behaviour and intentions of patients and/or their care providers, who attempt to 'play' the health system with exaggerated or fictitious severity of self-reported symptoms[99]. This is done in an attempt to receive preferential access to treatment and hence to circumvent severe restrictions to 'consumer sovereignty' which exist to ensure some equity in the distribution of health goods [71,].

Inherent to the concept of gaming is the presence of competing interests by those seeking care for themselves (or on behalf of another) and those of the 'system' or gatekeepers who are attempting to ration in some form or another, the care that is desired. Pressure is applied by patients or their care providers to be provided with a service which is at odds with the need of the system to systematically ration access to health services [68].

One of the critiques of using explicit criteria for determining access to dental care is that the criteria become a target for 'system gaming'. However, such criteria, whether explicit or implicit, can be subject to manipulation by any given individual, be it a professional or a health consumer. The gaming of wait lists by health professionals on behalf of

individuals is a result of increased competition (between all agents and stakeholders in the health system) due to limited resources, be they fiscal or labour force driven. Gaming hinders a service's ability to allocate care to the sickest patients [124]. The hypothesis is that competition for scarce resources (access to health services) in turn directs behaviour and gaming is encouraged. Such gaming of the system in turn forces the need for explicit definitions for access to care[100].

The level of negotiation between health care provider and patient is one of the fundamental differences between public and private models of care. Weber describes the intent behind gaming as a rational and goal-oriented act in the presence of a fundamental lack of relationship between patient and care provider[101]. Waiting list criteria in other areas of medicine have been developed to try and minimise gaming, but primarily to manage the means which *physicians* use to manipulate the system to their patients' advantage, rather than to manage the various strategies used by individual patients themselves [100, 102]. In the context of Australian public dental care, gaming of the system by patients is understood by senior level administrators to be driven by both psycho-social need and physical oral symptoms, and has been raised as a concern of systems using a priority-setting approach. One of the proposed outcomes of systematic approaches to 'demand management' is the education of patients (and providers) to use health services 'astutely' by educating the patient to seek care at the right place and at the right time[60]. However, there is the perception that the client will become skilled at identifying the possible cues to garner an appointment or a higher urgency appointment and persons who employ such approaches are perceived to be engaging in deviant behaviour[43]. Additionally, administrators worry about staff engaging in similar behaviour to benefit favoured clients.

2.3 Methods for determining urgency

Over the years various scoring systems in medicine have been developed with the aim to determine which individuals should be prioritised to receive the most urgent access to care [65, 103-111]. None of these however have ever been tried in determining access to dental care. Indeed, one of the criteria of rationing access to care is that well developed clinical indicators exist to determine urgency or need [111]. Beyond trauma, swelling and

haemorrhage, the clinical criteria for urgency of access to care for patients with dentally-related pain have not been well developed or tested. Neither has a consensus been reached as to what is an appropriate wait for any given condition [112]. Many areas in emergency medicine use triage nurses, but not so in dentistry where (as discussed in 2.1.5), reception staff are given the daily task of triaging patients, often using criteria which are neither standardised nor tested [105, 113-115].

2.3.1 Types of scoring systems for urgency-setting

Scoring systems that have been developed for medical wait lists rely on various methods to determine urgency and are an attempt to determine which individuals are the most appropriate recipients of treatment[65]. Various methods of calculating a person's urgency for access to treatment have been developed and the literature documents three main approaches a clinical prediction rule can embody:

a) a Bayesian type approach [116];

b) a protocol approach and [117, 118]

c) a binary algorithm approach and

d) various hybrid combinations of these methods [46, 76] .

A Bayesian-based approach is commonly referred to as a decision-tree and is a structured approach to performing a quasi-clinical assessment by triage staff. The decision-tree methodology uses structured prompts to guide decision paths made in response to data input in answer to previous questions. This approach allows the user (usually reception or triage staff) to view the questions before selection and to move freely between assessing different symptoms and allows them to determine the needs of the patient by reviewing the whole response profile [116].

The protocol approach employs a rigid pathway for patient assessment and does not allow for user flexibility. Once a pathway is selected, the pathway determines the way through. The pathway is chosen early on and questions previously asked may be hidden, preventing the user seeing the whole picture of the patient. The answer to each protocol question determines the pathway which, unlike the Bayesian approach, cannot be re-negotiated [117, 118].

The binary algorithm approach is similar to the protocol approach, but the responses are forced formats to specific questions, yes or no or a, b, c, or d response types. The user is allowed no discretion in selecting response categories and the respondent has no discretion in answering questions. All questions in the series must have an associated answer recorded which can lead to a long consultation time[55, 119].

2.3.2 The usefulness of prognostic logic

Altman and Royston refer to models which are used in medicine to guide patient access to treatment or classify disease probabilities of individuals as 'prognostic models'[120].

Many disciplines utilise prognostic modelling, although the terminology used is inconsistent, sometimes referring to these models as diagnostic tests, screening tests or prediction models, but all are linked to statistical concepts of probability theory, regression and discriminant analysis[121-123]. For the sake of consistency, the nomenclature of 'prognostic model' of Altman and Royston has been adopted for use throughout this thesis. The primary aim of any prognostic model is to improve on human judgement by means of computer modelling, allowing for standardisation and objectivity in the analysis of presented data across populations and clinical settings [16, 124, 125]. Essentially, the primary principles involved in the development of such models must be concerned with providing decision-making precisely, accurately and parsimoniously[126]. Prognostic models are utilised in health services to discriminate between those patients who are more or less likely to experience worse health outcomes. The literature suggests that prognostic models are most useful and relevant when devised by experts for use by non-experts and when the key component to the model is *not* diagnostic but prognostic in its nature; is the patient at increased risk of poorer health outcomes, more suffering or other complications if they are denied treatment?[16, 120]

One of the criteria for the ethical use of prognostic models for health care is the ability for them to consistently be shown to perform accurately over time. In order to achieve this standard, prognostic models must be developed in the absence of bias. This means that the method used to select the most predictive variables must be done in a scientifically rigorous manner and must be sensitive enough to overcome possible ethnic, cultural, and

gender differences [104, 123, 127-129]. A New England Journal of Medicine editorial suggests four clinical purposes for prognostic modelling [130]:

1) to screen for pre-clinical diseases in asymptomatic persons,

2) the diagnosis of clinical disease in patients with symptoms of uncertain cause,

3) risk stratification in patients with clinical disease, and

4) guidance in the selection of therapeutic agents in patients with known disease.

The purpose of the prognostic model in this research covers elements of both 2) and 3).

There are many reasons why managers of health services may be interested in developing prognostic models to drive the administrative systems for prioritising health care, but by far the most traditional (and prevalent) reasoning behind such an approach is providing equity in access to services between persons seeking health care within a context of competing demands for care. Secondly, health systems generally operate under the constraints of limited resources, therefore making the cutting of the 'health care pie' in the most just manner, and in a manner which is defensible and evidence based, prudent.

Prognostic models are useful to administrators as they provide a means by which the criteria of access to dental care and the process of urgency-setting can be standardised. For the care seeking community, prognostic models can provide a level of equity and fairness in the system which may not be present otherwise.

Following is a list by Adams of eight suggested key factors in the successful development and implementation of a prognostic model as a prioritising system[89].This list is relevant to this thesis as it reflects the development and implementation phases.

Table 2.1 Key implementation factors for urgency scoring systems

Source: (Adams 1999, p31) [89]

2.3.3 Information technology and scoring systems

Information technology plays a fundamental role in the ability of a health service to provide standardised and equitable access to care. Some information management systems operate using decision-tree models, to guide the response direction of decision-making about urgency for persons seeking treatment and allow backtracking through responses. Such an open, 'unlocked' system potentially allows for user guided or user- and patient-guided alterations to allow patients to move up higher in urgency. 'Locked' systems operate using immutable algorithm-based models and do not allow for dynamic decision-making. Where such algorithm-based scoring systems are used, decision support software becomes imperative to utilise as calculating scores and generating appointments from complex mathematical models cannot be done manually[106, 131].

When access to health services is based upon chronological queuing, potentially patients wait for care with undefined minimum and/or maximum wait times for receipt of that care. When such queuing is replaced with standardised electronic booking systems with questions that are used to elicit severity of the health condition and maximum wait times for access to care are defined, patients achieve some justice in their access to services. Such a service becomes a needs-based service and patient autonomy is better facilitated through the use of such information to plan for all aspects of their care. This potentially

allows for a reduction in inequalities in access that can arise from regional or local differences by allowing persons with similar urgency to wait comparable times for an appointment. This is achieved by linking computer databases and electronic waiting lists from all connected health services to achieve a 'pooled' waiting list, enabling patients with similar needs to move to the front of queue at the same rate [12, 89].

2.3.3.1 Rationing by scoring systems

Ironically, it is the very element of 'effectiveness' of computer implemented scoring systems that is held up as its weakness or limitation. Explicitness of urgency-setting criteria removes any implicit and socially-based judgements made in assessing a person's need for care. Computers calculate the scores associated with 'patient' responses and probability theory is then used to sort the score and facilitate the allocation of an 'appropriate' appointment. Such logic, the systems rationing tool, remains unimaginative and removes the intuitive or the subjective, the particularly social element of the interaction [132].

Waiting lists (the mechanism of rationing) which are based on urgency-scoring have been likened to a fair and consistent central nervous system of the health system. The literature suggests several key principles be applied in the theoretical development of an urgency-scoring demand management tool [46, 90]. These fundamental principles are:

- transparency;
- explicitness;
- rationality; and
- objectiveness.

Transparency relates to the intention of implementation and application of the urgency-scoring tool used to determine access to care and the process should be explicit in its objectives. It should be clinically rational in that it meets clinical and community standards of need, based on quantitative, not qualitative reasoning and processes, and the tool should be objective in patient urgency-setting in that it assures individuals' access to care based upon standards of access and equity on a population level. Urgency-setting should involve a pooled wait list and be based upon scientific foundations. Political or economic influences should be openly acknowledged and should be managed in such a

way that still ensures access and equity [77, 88]. Selection of criteria used for urgency scoring can be made by utilising various methodologies and can vary in the weight given to the criteria chosen (see Section 2.2.2). Urgency-scoring criteria can be selected by a process of agreement by committee, from consensus-driven or populist approaches in panel discussions with or without public or government directives, or through selection by means of statistical and computer modelling [119, 121, 133-135]. Criteria for urgency and how they are selected can vary depending upon the explicit objectives for implementing urgency scoring [65-67]. Objectives must be pre-specified and criteria weighted in order of relative importance to reflect their associated value to maintain transparency and equity.

2.3.3.2 Objectives for using prognostic models

Research suggests that it is possible for non-emergency patients to be identified and safely triaged using scoring systems without an increase in adverse events [68, 69]. However, the literature also stresses that due care must be taken with such an approach and that any urgency-setting system should be proved to be a valid tool before it is used in a programmatic manner[136] "Usefulness is determined by how well a model works in practice, not by how many zeroes there are in the associated *P*-values" [71 p.454].

Urgency-scoring provides an objective away to manage issues of access of a given health service and associated waiting lists for care. Below is a summary of the rationale and objectives found in the literature for the implementation of priority-scoring. Access to care embodies the notion of vertical equity and waiting list management embodies concept of horizontal equity, both of which are important considerations in the justness of a urgency setting system (as described in Section 2.2.2).

A*ccess (vertical equity)*

1. To give equity of access [137]
2. To give certainty and timeliness of access [138]
3. To give transparency and consistency of access to services[138]
4. To give a more effective method of managing access to services [139]

Waiting List Management (horizontal equity)

1. To make the management of waiting lists transparent [140]
2. To make the process of prioritisation more transparent and structured [89]
3. To give fair and efficient management of waiting list [141]

4. To assist in the management of waiting lists [142]

2.3.3.3 The relationship between prognostic models and waiting lists

The usefulness of prognostic models lies in the ability of the models to be applied so that *predictable* numbers of patients are allocated appointments. It is this inherent logic which allows health services to be well-planned with regard to quantifiable need and contributes to stability within the system. This accounting for population health need allows waiting lists, in theory, to be better managed. System level interventions like prognostic models which include such aides as telephone decision support to assist with triage can potentially reduce clinical workloads and hence enable systems to be restructured and reoriented in the manner in which services are accessed and delivered [36].

Waiting lists that are both centrally administered and are managed daily at the clinic level are generally 'opaque'. Such opacity is due to the fact that the criteria for access to and moving through the system may be neither systematically defined, nor accounted for. Such lists can be vulnerable to potential manipulation by individual stakeholders, including the gatekeepers. Such opacity invariably leads to poor management of waiting lists and potentially adds to the inequity of the system [138, 143-146]. (See Section 2.2.3 on Gaming).

Complex scoring systems using prognostic models have been developed in an attempt to extinguish the approaches used by both patients and providers to garner access to care in systems where demand exceeds capacity to supply. The aim is to maintain and deliver equity when distributing scarce resources amongst those eligible for such care. The literature shows that scoring systems can be administered in a variety of ways and by a variety of personnel and for a variety of reasons, but inherently, all have rationing and prioritising as the primary objective. These services, staffed largely by registered nurses in emergency hospital settings, often serve a gatekeeper function, limiting access to emergency healthcare services and delivered by way of telephone triage, with call centre staff recommending appropriate levels of care supplemented by advice on self-care and information about provider availability [49, 103, 110, 147, 148]. Thus, potential yet indirect benefits such as improvement in access and availability of services (especially after-hours) have made telephone triage a rational and popular administrative initiative [50, 113, 149, 150].

2.3.4 Oral health, self-reported and clinical need

Central to informing receptionist decision-making is patients' self-reported perception of their oral health status, a measure which has been shown to be a more important predictor of use of dental care than normative or clinical measures of oral health status[151, 152]. However, patients vary in how they present their symptoms when seeking access to care. Tickel, Craven and Blinkhorn reported that it is both the psycho-social nature and physical symptoms of a dentally-related problem which provides the impetus to seek care. Patient reports of the signs and symptoms associated with any given dental condition can be vague and undifferentiated between clients, such that presentation of a clinical problem can be interpreted differently. This variation between the reporting of problems, not the problems themselves, provide the rationale for standardising assessment procedures for access to care[153]. Tickel, Craven and Blinkhorn also reported that the psychosocial and physical symptoms of a dentally-related problem provide impetus to seek care [153]. Reception staff have traditionally used the disclosure of such information to determine a patient's urgency of need for care and in doing so are operating using a social rather than medical model of care and are acting essentially as triage nurses (see Section 2.1.5). How a person's relative need for care is then translated into receipt of care depends on the criteria used to determine such decisions. Such decisions may be influenced by values from the health care organisation or society at large or a composite of both.

2.3.5 Dental pain

Dental pain is one of the main drivers for persons seeking access to both public and privately delivered dental care [41, 154]. Assessing urgency on the basis of pain, however, is very difficult due to the subjectiveness of the pain experience. A person's experience of pain and pain assessment are complex and influenced by many psychological, socio-cultural, and biological factors [155]. Assessing dental pain between individuals involves creating understandable hierarchical criteria. Additionally, a measure of how rational a long or short wait for treatment may be is not well defined in the dental literature.

Persons seeking relief from dentally-related pain have traditionally been classified in the SA Dental Service nomenclature as a dental 'emergency'. An investigation into pain relief

within the acute setting by the Royal College of Surgeons and Anaesthetists concluded that failure to relieve pain in the acute care setting is both morally and ethically unacceptable[156]. The recommendation from that report was that all patients have a right to pain relief. If we are to take this premise into the public dental setting, then we face a dilemma. If the majority of persons seeking care are experiencing pain or discomfort, yet only limited resources are available to immediately manage such demand, by denying access to care, is a duty of care being breached or does management of pain become an ethical dilemma only once the person is a patient under the care of a professional?

The majority of patients seeking emergency care in Australian public dental settings do so for relief of pain and the majority of 'emergency' care provided is for relief of pain [2, 27, 37, 157]. What is less understood is if this care-seeking behaviour and provision of care pattern is related to the debilitating nature of oro-facial pain or is it simply an outcome of historical policy? What the literature, however, does suggest is that any attempt to manage care seeking behaviour in public dental services and the prioritising of such patients (to attempt to reorient public dental services away from emergency care) must be able to assess the experience of pain somehow and respond to such an assessment in order to provide a service that is acceptable to the public[158].

2.3.6 Satisfaction with distribution of dental services is poorly understood

Little is known about public views on the organisation and distribution of public dental care. A considerable body of knowledge exists about receipt of care and satisfaction with care and treatments received. Measures of patient satisfaction are widely used to understand the broad areas of satisfaction with dental care so as to enable better management and delivery of health services. Davies and Ware proposed multiple dimensions of satisfaction that may be influenced by the 'preventive orientation' or lack thereof of, in any given dental service. The dimensions suggested are technical qualities, interpersonal aspects, accessibility/convenience, financial aspect, and inadequate management of dental pain, general satisfaction, and organisation of practice, specific features of treatment, efficacy/outcomes and continuity[159]. Measures such as these proposed by Davies and Ware are however only relevant to those who receive care. They relate to satisfaction around issues of services and resource availability. Patient

satisfaction with the process and distribution of access to health care is a different measure of satisfaction. How care is denied and clients' perspective of fairness and equity in such a process will greatly influence satisfaction with a prioritising process. This is a little researched area of dental service provision, for clients serviced in both the public and private sector. Different age cohorts accessing dental services have different needs and expectations of service provision that reflect attitudes on access to care. It could be expected that satisfaction with services will differ depending on the meeting of different needs. A predictor for satisfaction for one group may not necessarily be the same for another group with differing needs[160]. Past experience may also shape patient satisfaction with current services. Anecdotal evidence suggests that patients' previous experience with the public dental service is a predictor for future satisfaction with the service and with the triage process [161].

2.4 Methods to evaluate a prognostic model

2.4.1 Acceptability to patients

When reviewing literature on patient satisfaction with prognostic models it is clear that patients' appreciate an opportunity to express their health concerns in their own words in contrast to a rigid set of Yes/No answers to health questions without recourse to an alternative pathway [95, 98, 162]. Research shows that recognition and consideration of each patient's individual context when assessing and making recommendations about where and when to receive care is important to the health care seeker. Prudent use of open and closed questions to elicit information about presenting complaints is suggested in the literature and appears to offer a more socially acceptable way of identifying swiftly and accurately patients' needs whilst simultaneously giving them opportunity to feel heard[98, 163]. Incorporation of such a method of assessing patient need appears a pragmatic approach to the development of good prognostic models.

Research into public preferences for priority-setting shows that community support is greatest for urgency-setting tools which give greatest weight to philosophical principles of equity of access in relation to an individual's need for treatment [95, 96, 158, 164, 165]. Methods that utilise the maximisation of an individual's capacity to benefit do not rate favourably with the public if fundamentals of equity and need are compromised in the calculation for access to care[80].

2.4.2 Acceptability to staff

Research shows that nurses perceive a lack of autonomy in decision making when forced to use a single, rigid triage protocol[166]. United States research shows staff satisfaction with nurse triage systems is high when using algorithm and decision-tree approaches, both of which allow some flexibility for the gate-keeper to use experience to determine some outcomes for clients. However, the research also shows that nurses prefer the guideline-based approach in preference to algorithms [150]. For example, Farrand et al., found considerable resistance to formalising nurses' decision making in the Emergency Medical Services (EMS) system in Montreal [117]. They identified that professional judgement tends to override those decision-support tools which do not allow for the flexible processing of information provided spontaneously by callers, a finding supported in Western Australia by Larsen and confirmed in a simulation study of nurse utilisation and compliance with protocols for telephone advice [167]. However, Wachter et al. (1999) found considerable variation in protocol selection between nurses when presented with the same cases and poor interpreter reliability in final end-point advice [118].

A review of triaging by Overton-Brown et al., showed that nurses may over triage, meaning they give patients a higher clinical urgency than necessary, and they hence concluded that triage responsibilities should be given to more experienced nurses[168]. Research into public dental services suggests that despite experience in triage, experience with triage duties may alter receptionist relationships with patients to the point of over identification with patients known to the triage staff and may result in inequitable allocation of appointments[18, 42]. Such issues highlight training, practice, and audit as issues in maintaining equity in triaging by such 'subjective' means. It has been argued that The Manchester Triage System with the use of decision-tree style flow charts is too conservative and inflexible for the experienced, expert practitioner as it neither allows them to use their judgement or intuition[169]. It is these very characteristics, which according to Benner's model of skills acquisition, separate the novice from the expert at triage[170], findings which have been repeated consistently throughout the literature[171]. Some research has identified that professional judgement tends to override decision support tools which are constructed without flexible processing of information provided spontaneously by the callers. Nurses report that the choice of a single protocol for each call to be unnatural for professionals who could spontaneously integrate, in parallel, multiple aspects of a problem [166, 172].

Some research suggests that decision-making tools in some instances do not appear to result in automatic standardisation of decision-making or triage. Watcher et al. concluded that nurses did not reliably choose the same protocol in a given case and did not reach the same triage endpoint even when they followed the same protocol [118]. A majority of the nurses involved in triage by means of decision making by protocol described feeling confined by the protocols, believing that a protocol approach forced them to focus on largely irrelevant information to the situation at hand and a large proportion admitted to deviating at least once from the protocols during the triage consultation[118, 167]. Gatekeeper satisfaction with the use of any decision aid in triaging access to health care remains critical, as dissatisfaction with tools used will generate greater impetus to deviate from protocols and without gatekeeper cooperation efforts will most likely be defeated [173]. Without such gatekeeper cooperation, including development of protocols without the support and input of staff involved in the triage process, the principles of equity and fairness in access to services may be compromised and the desired outcome of better management of the system's capacity to provide services will generally be undermined [36, 173].

2.4.3 Clinical staff

The literature suggests that the main area of discomfort for health professionals about the use of decision making tools to triage care and access, is the threat of 'de-professionalization' as a result of implementing prognostic model algorithms. There is a belief that such models lack clinical credibility and are unable to provide accurate, generalizable and effective interpretations about individual patient need. There is the perceived danger that such models will undermine professional norms and that regulations imposed by administration constitute a threat to professional freedom[114, 174]. These concerns are reported mainly by clinical staff who are encouraged by management to use decision aides like prognostic models at the bedside. Suspicion about decision tools appears to be greatest in specialties where the use of such tools and aides are novel and not widespread [131]. It is interesting that clinicians reject *explicit* triaging of individuals and their denial of access to treatment which is defined as such by the use of reproducible and validated statistical models with gold standard criteria, but do not report having ethical objections to *implicit* triaging which is triage based on an individual's financial ability to pay for treatment or based on receptionist judgement and appointment

availability using chronological queuing[175]. This is in contrast to findings presented earlier about community perceptions of principles of explicit and implicit rationing in public health services.

2.5 Optimal methods for prognostic models

2.5.1 Model development and model validation

Validation of a prognostic model requires establishing that the model works satisfactorily for patients *other than* those patients whose data was used to derive the model. Validation also involves the comparison of observed and predicted event rates for groups of patients (calibration) and those measures which distinguish between patients who experience the event of interest and those who do not (discrimination) [120]. Wyatt and Altman define four main criteria which provide validity for any prognostic model [16].

Criteria 1. Clinical credibility

Clinical credibility of the model is established when all clinically relevant data are tested for inclusion in a model, when the predictions derived make clinical sense and the model is applied in the correct manner including adhering to the models clinical assumptions i.e. exclusion of acute dental emergencies. This criterion is sometimes referred to as face validity. Face validity for a prognostic model is met when clinicians believe that the criteria used capture all the important factors used in making judgements on urgency.

Criteria 2. Evidence of accuracy

The prognostic model must show evidence of accuracy of its predictions to at least the same level as the previous method of determining accuracy. The model should have a low false positive and negative rate and its error rate should be tested on a *new* set of patients for whom reliability of determining the presence or absence of an event of interest has been determined by clinical judgement but who *were not* used in the model derivation. Prediction models derived from regression techniques that quantify validity using the same data used to create the algorithm notoriously produce under- or over- estimations of predictive accuracy and can lead to unstable predictions, particularly when the sample size from which the regression estimates were derived was small. This potentially results

in an over fit or under fit of the models [176, 177]. The technique is known as data splitting and is used to minimise this optimism of under or over fitting the model. Splitting acts to shrink the regression coefficients or estimates to generate more realistic or 'true' values. It is used as an alternative to bootstrapping the data, which can be costly, time consuming and resource intensive. The data splitting technique uses half the data to generate the regression model and the other half of the data to test the coefficients fit and to estimate shrinkage factors [120, 178, 179].

Criteria 3. Evidence of transferability

The prognostic model must show evidence of transferability (sometimes referred to in the literature as generality or generalizability), whereby the test must be reproducible across time and place. The model must be shown to be transferrable to new sites and be derived and validated prospectively using a well-defined protocol. It must not be the result of a retrospective trawling of a patient database to look for associations between available and potential variables. This criterion is sometimes referred to as external validity. External validity is considered to be of greater importance than internal validity mostly when the prediction model of interest needs to be applied in another setting. This is due to the fact that the incidence of the outcome of interest is not accounted for in the model. Hence, one can only determine if a model has been over- fit or under-fit when the model is subjected to an external validation.

Criteria 4. Evidence of clinical effectiveness

Clinical effectiveness of any given model is established by means of a well-designed clinical trial whereby clinical practices and patient outcomes are measured. This is the ultimate form of external validation of a prognostic model, when the model can be shown to perform across time and place (see Section 2.5.2). However, additional considerations around clinical practice and patient level outcomes are evaluated by testing the model on self-reported oral health, receipt of treatment and system performance data that have not been used in the development of the prognostic model; further ensuring the model is reproducible and transferable. This approach to the systematic validation of prognostic models provides a comprehensive process for validation [120, 123, 180].

It is intended that the study results will be pragmatically applied. Assessment of adequate performance of the model will require interpretation of the results using clinical judgement within a context dependent framework. Pre-specification of what is considered adequate performance may need to be considered. In light of such consideration, recalibration of the parameters may be required if new information emerges which is deemed clinically significant [120]. If adequate performance of the prognostic model is achieved then implementation in other clinics can be considered appropriate. Monitoring of the performance of the prognostic model over time is recommended as changes in case-mix and context can affect the performance of the prognostic model.

Measuring the effectiveness of any intervention should include parameters of retention of dental clinic staff, public health outcomes and client and staff satisfaction and not just clinical outcomes. Looking at how expectations in one or some or all of these areas are met can help to ascertain the overall value of a new urgency need system.

2.5.2 Validation measures

There are various ways to classify, quantify and describe the relative value of any prognostic model. The most common in the literature are classification probabilities, predictive values, diagnostic likelihood ratios and ROC [123]. These assess a model's ability to prognosticate; that is to predict urgency of treatment required. Classification probabilities of sensitivity and specificity can be used to describe the accuracy of a model in identifying urgent patients, i.e., the true positive rate or positive predictive value (PV+), and non-urgent patients, i.e., the true negative rate or negative predictive value (PV-). Methods of test validation that account for prevalence and misclassification have been developed utilising receiver operator characteristic (ROC) analysis and the Area Under the Curve (AUC) statistic derived from ROC analysis [3, 181].

2.5.3 Diagnostic test indicators of the models

When testing a prognostic model, it is important to determine the size of the deterioration in performance, i.e.; the size of the change in sensitivity and specificity in the test phase compared to the original model development. However, what level of deterioration is

considered to be too much has not been agreed upon in the literature which makes interpretation of results uncertain [89, 99, 120, 182].

2.5.3.1 Test accuracy

Quantifying test accuracy commonly involves the use of measures of sensitivity, specificity and predictive values.

Sensitivity (Se)

A sensitive test would identify most of the patients who are urgent, and perhaps a few who are not. Mathematically, it represents that proportion of patients with dentist-determined urgent need who are "true positives" – that is, who are predicted to be in urgent need of dental care by the model.

Specificity (Sp)

A specific test identifies most of the patients who are not urgent, and maybe a few who are not. It represents that proportion of patients without dentist-determined need who are "true negatives" – that is, who are predicted not to be in urgent need of dental care by the model.

Values of sensitivity and specificity are determined for a binary classification of urgency. However, if urgency is assessed on a continuum then a series of arbitrary "cut-points" can be specified to create a binary classification, permitting optimal thresholds to be identified.

2.5.3.2 Diagnostic Accuracy

Determining the predictive capacity of a test to assess urgent need for dental care among patients with positive results and indicate less urgent need for dental care in patients with negative results requires evaluating the relative errors of the test. Each test comes with different costs and consequences which can be measured at both the individual level and health services system level. Predictive values form the third main criterion for evaluating model performance.

Positive and negative predictive values

The predictive value of a positive test is the probability that the patient with a positive test result *is* urgent (PV+) whilst the predictive value of a negative test is the probability that the patient with a negative test result *is not* urgent (PV-).

Accuracy of patients' self-reported symptoms may undermine the Se/Sp of the test [96].The prevalence of an urgent event also affects the PV+ and PV- values. If urgency is of low prevalence and the test being used to assess urgency of need for dental care in individuals is only moderately sensitive or specific, as will most likely be the case, then false-positives may overwhelm the positive test results. If the cut-off that has been selected as the threshold for an urgent need for dental care is relaxed, then a test will become more sensitive and less specific (fewer false negatives, more false positives, so better at ruling out urgency of need for dental care). If the cut-off that has been selected is tightened, the test will become less sensitive and more specific (more false negatives, fewer false positives, so better at ruling in urgency of need for dental care). This trade-off between sensitivity and specificity exists for virtually all tests, and manipulating the cut-off level can usually only improve one parameter at the expense of the other.

A simple way of looking at the relationships between a test's result and the gold standard (dentist urgency assessment) is shown in Table 2.2 . A test is considered to be either positive or negative and the clinician's assessment of urgency as either 'urgent' or 'not urgent'. The relationships between the test result and dentist urgency assessment are summarised using the sensitivity, specificity, PV+ and PV-. There are four possible interpretations of test results; two of which are correct, true positive and true negative, and two wrong, false positive and false negative. The test has given the correct answer when it is positive when a patient is urgent (true +ve) or negative when a patient is not urgent (true -ve). On the other hand, the test has been misleading if it is positive when a patient is not urgent (false +ve) and negative when a patient is urgent (false -ve). The positive and negative predictive values and the accuracy of a test are all influenced by the prevalence (frequency) of a disease in the population studied, with this effect most significant at the extremes. When urgent need is very low (5%), a positive test result is more likely to be a false positive than a true positive, thus lowering the PV+ of the test.

Table 2.2 Relationship between diagnostic test result & clinician urgency

		Clinician urgency (clinical assessment of urgency)		
		urgent +ve	**not urgent -ve**	Total
Test result (based on predictor variables)	**urgent +ve**	a (true +ve)	b (false +ve)	a + b
	not urgent -ve	c (false -ve)	d (true -ve)	c + d
	Total	a + c	b + d	N

Sensitivity=a/(a+c), Specificity=d/(d+b), PV+=a/(a+b), PV-=d/(c+d), a+b+c+d=N

2.5.4 Existing questions that might be useful in prioritising need

A prognostic model based on an algorithm which calculates a composite score for persons requesting care is derived from self-reported answers to closed ended questions and results in a prediction of urgency. It is intended that a booking for treatment would be subsequently made based on the relative urgency score (in reference to the scores associated wait time for treatment) calculated from the prognostic model.

There is increasing interest in the development of psychosocial measures of oral health and oral quality of life. Slade (1997) edited the proceedings of a conference on such measures, eleven in total[183]. While some of the available psychosocial measures have been examined in terms of this association with oral condition this has frequently not been the case.

One measure, Locker's Subjective Oral Health Status Indicators (SOHSI), which consists of a battery of eight subjective indicators, has been tested in Canada and the UK for its association with dental status [184]. Locker and Jokovic reported on the ability of subjective indicators to identify community-dwelling older adults who need dental treatment. Although there were significant associations between the subjective indicators and clinical measures, values for sensitivity, positive predictive values and positive likelihood ratios were low[185]. However, the measures did identify a sub-group of individuals whose

clinical conditions impacted on daily life and who would benefit the most from dental treatment. In this respect, Locker and Jokovic suggested that the subjective measures can be interpreted as indicators of need that complement conventional clinical measures of need for dental care [185].

Tickle, Craven and Blinkhorn tested the performance of SOHSI in the UK. They examined the association between the subjective indicators and dentate status, satisfaction and assessment of oral health. SOHSI was found to be reliable and to have satisfactory construct and concurrent validity. Correlations between self-reported number of teeth and the subjective indicators confirmed the strength of the theoretical model underpinning SOHSI and provide further evidence of its content validity [153]. These two studies give some indication of the possible utility of subjective indicators as tools for assessing relative need or urgency for emergency dental care. Locker and Jokovic (1996) clearly described the potential to identify sub-groups in greater need for dental care[185]. However, SOHSI has been used among older adults and there has been no examination of associations with either professionally assessed need, clinical judgments on urgency for emergency dental care, or the actual patterns of service used or types of care subsequently provided in clinical settings.

It is the prospect of the usefulness of models developed from subjective indicators, tempered by the lack of evidence among adults in general and on the relationship with clinicians' judgments and the process of dental care delivery that provides the rationale for this research.

3 Development of the Relative Needs Index; the Parent Study

3.1 Introduction

In 1998, public dental services across Australia were experiencing strong demand for emergency dental care and eligible persons seeking general dental care were placed on waiting lists of up to four years[1]. The abolition of federal level funding for dental health services meant that the capacity of public dental services to meet demand for dental care by eligible adults fell. Subsequently waiting lists for general dental care grew as the dental services concentrated on meeting demand for 'emergency' dental treatment. These factors stimulated the concept of the development of a tool to determine relative need between persons requesting access to public dental treatment. The development of a prognostic model to classify urgency for treatment, both emergency and general dental treatment, was undertaken and two sequential models were developed to predict the treatment urgency of patients seeking emergency dental care. The models were built using dentists assessment of urgency categories which represented a person's maximum wait time for treatment; needing care <48 hours, needing care 2-7 days and those that could wait 8 or more days.

3.2 Aim

The aim of the Relative Needs Index (RNI) Study was to predict urgency for access to dental treatment. The development process of the RNI is not a component of the original research for this dissertation. However, details of the study are included as preliminary research to this thesis and because this thesis includes analysis of the data derived from this 'Parent' study.

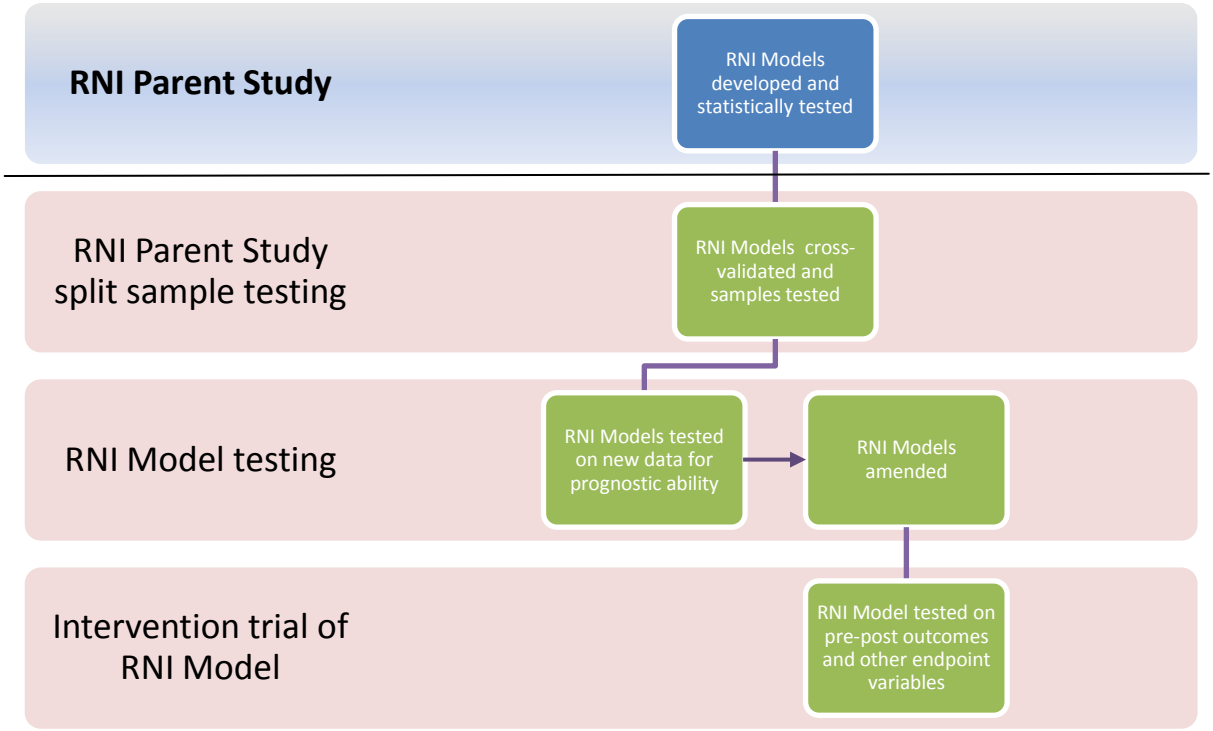


Figure 1. Study phases and their associated characteristics

The author contributed significantly to the design, data collection, development, management of and the analysis for the RNI Parent Study and conducted all the subsequent development and testing of the prognostic model for the purpose of this thesis.

3.3 Methods

3.3.1 Parent study design and participants

The RNI Parent study had a prospective study design. Subjects were a random sample of eligible adults who were dentate (defined as having six or more natural teeth,) 18 years or older and holding a current government concession card who presented to, or telephoned, one of nine public dental clinics in South Australia and NSW, for same day 'emergency' dental care. This population was essentially a non-specific treatment seeking population. Participants were recruited to the study using simple random selection by means of a computer-generated randomised list of the words 'In' and 'Out'. Potentially eligible patients contacting the clinic for 'emergency' dental care were randomly selected working down the list of people seeking treatment, with 'In' denoting inclusion into the study on a

daily basis. The probability of being selected 'In' was determined by the expected number of eligible people seeking care each day and the desire to minimise the workload to five new participants each day from each clinic. The required sample size was calculated using the simple random sample variance formula assuming a prevalence rate among eligible adults for public dental care of having at least 6+ natural teeth of 20% (p=0.2) and a Relative Standard Error (RSE) of the proportion of 0.1 (10%). To account for the clustered design effects of the sampling (DEFT) within public dental clinics, the sample size was increased by a factor of 1.5

$$n = \frac{(1 - p)}{p \times RSE^{2}(p)} \times DEFT$$

Figure 2. **Equation used to calculate sample size**

This final sample size of 600 was then doubled as two states were involved (SA and NSW) resulting in a total sample frame of 1200.

3.3.2 Data collection and measures

Adults participating in the study completed a structured questionnaire consisting of some 120 potential subjective oral health status indicator items which was administered by reception staff. Responses were pre-coded closed categories. Participants were asked about their subjective oral health status and dental visiting behaviour, presence of any symptoms related to various oral diseases and disorders, medication use, sugar consumption and consumption patterns, psychosocial impact of various oral diseases and disorders, dental anxiety, and socio-demographic characteristics.

Upon completion of the questionnaire, participants underwent a clinical assessment by a dentist. An assessing dentist provided a clinical judgement, 'dentists urgency assessment' (DUA) for patients dental care on an ordinal scale represented by the categories <48 hours, 2–7 days, 8–13 days and 14+ days. The assessing dentists based their judgement of urgency on their own clinical experience. For example, their judgement could have been based on what they considered to be high dental-medical urgency (e.g. to avoid hospitalisation, infection, tooth loss) or symptoms (e.g. pain). Assessing dentists were not trained and standardised in the way they assigned urgency categories to patients. This

was considered to be an appropriate 'real-world' method of measuring urgency as dentists tend to differ on treatment decisions[153] and using such a subjective measure was thought to reflect the way dentists currently think in terms of their treatment philosophies and approach to providing dental care. At the time of assessing patient urgency, the assessing dentists were unaware of the participants' responses to the structured interview. Both the questionnaire and the clinical assessment were administered prior to patients being clinically examined and treated.

There were two dependent variables used in this analysis and both used the decision on 'urgency' made by the assessing dentist, the dentists' urgency assessment (DUA). The first dependent variable used urgency = <48 hours vs. 2+ days (Model 1) and the second dependent variable used urgency = 2–7 days vs. 8+ days (Model 2).

3.3.2.1 Explanatory variables

Explanatory variables were developed from the dental literature to reflect potential predictors of 'urgency'. Subjective indicators were taken from Locker's battery of eight Subjective Oral Health Status Indicators (SOHSI) [184]. Items within four of the eight SOHSI, namely 'Oral and facial pain symptoms' (10 items), 'Other oral symptoms' (10 items), 'Activities of daily living impact scale' (6 items) and 'Worry/Concern impact scale' (2 items) were used, and an additional block of other symptoms were included which were generated out of discussion with staff at participating clinics (13 items). All items were pre - coded as either present or absent, except for the Activities of daily living impact scale and Worry/Concern impact scale which were recorded using a Likert type response of 'All the time', 'Very often', 'Fairly often', 'Sometimes' or 'Never'. A reference period of 'within the last week' was used. Dental anxiety, measured using Corah's Dental Anxiety Scale (DAS) was also included as previous research had shown that dental anxiety was associated with more severe presentation of symptoms because of dental care avoidance[186, 187] (See Appendix A). Socio-demographic characteristics of the patient (e.g., patient's age, sex, country of birth, Indigenous status and language mainly spoken at home, dental visiting behaviour (e.g., usual reason for visiting the dentist, time since last visit, site of last visit, frequency of dental visiting), medication consumption, type of pain and pain frequency were also collected.

It should be noted that presentations such as dental trauma, haemorrhage and facial swelling were not included in the development of the models. These 'acute' emergencies required a separate battery of questions that identify and stream such people into emergency care straight away. These questions should cover haemorrhage, trauma and facial swelling and be stringent enough to not miss patients with these particular presentations.

3.3.3 Analysis

Participant characteristics and distributions of dentist assessment of urgency and their predictors were examined and described using univariate statistics. Bivariate associations of urgency and their predictors were then examined. Significant associations between self-reported oral health indicators and psychosocial impacts and the DUA for emergency dental care were examined by means of binary logistic regression analysis. Prediction of the urgency of emergency dental care was based on the assessment of two models. Model 1: urgency = <48 hours vs. 2+ days, Model 2: urgency = 2–7 days vs. 8+ days only among those with a dentist urgency assessment of 2+ days. Hence, these were sequential priority-setting models. Multivariable analysis was undertaken with backward stepwise binary logistic regression of those variables found to be significant at the bivariate level. A stepwise modelling technique was adopted because firstly, there were a large number of hypothesised predictive variables and secondly, a backward stepwise approach was considered to be more advisable for the sake of parsimony in regard to the intended telephone screening application of the models[4].

3.3.4 Predictive test indicators

3.3.4.1 Hypothetical distribution of test results

The position of the cut-off point between 'negative' and 'positive' test results determined the test's sensitivity and specificity. The cut-off point is the value above which a test is interpreted as 'urgent'. If the cut–off is modified, sensitivity will be enhanced at the expense of specificity or vice versa. Cut-off values are selected such that the desired sensitivity and specificity are achieved. Selecting a cut-off point, say A=0.5, in the middle

of the overlapping range balances the number of false positives and false negatives (See Figure 3).

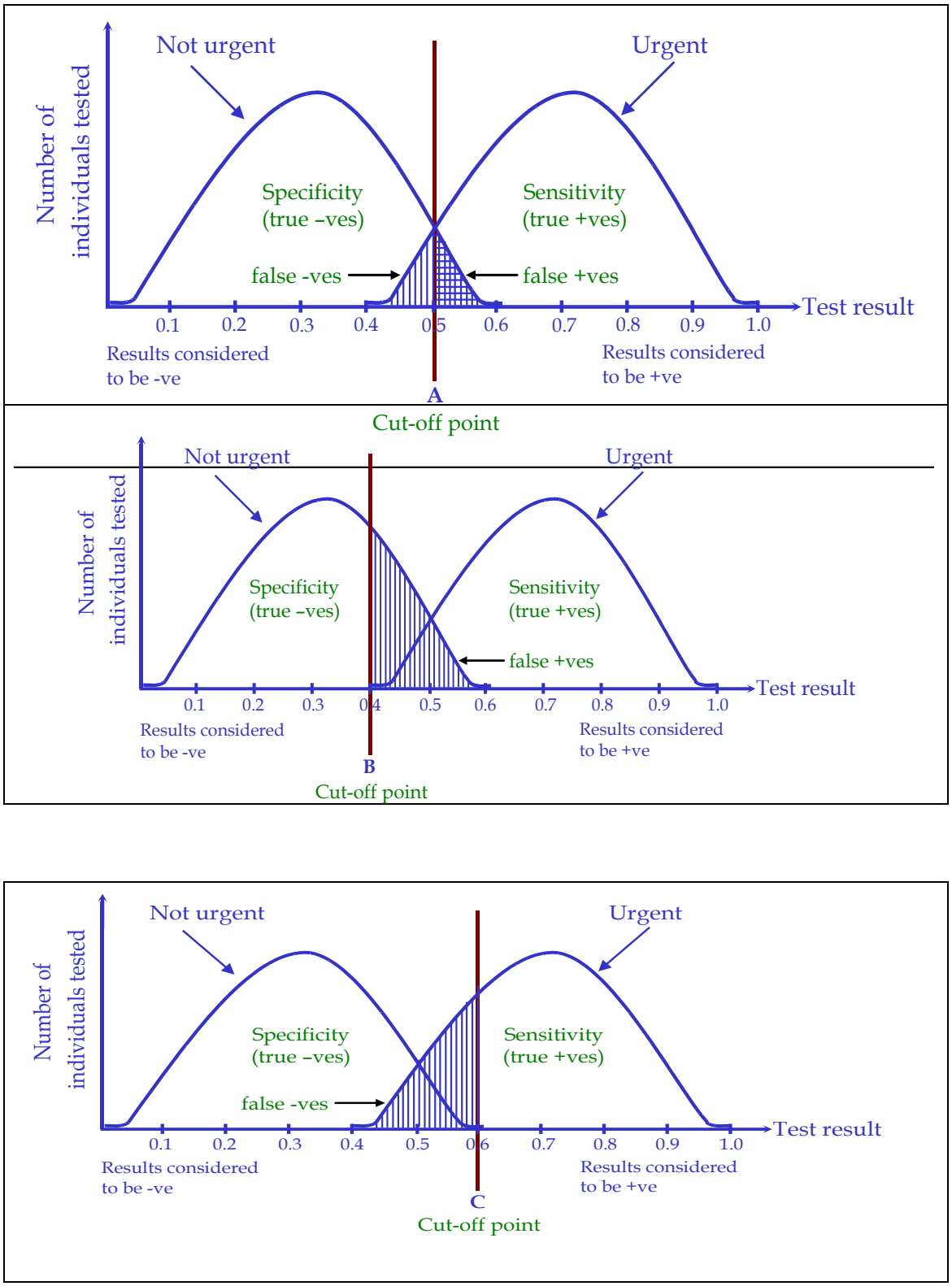


Figure 3: Hypothetical distribution of test results

Moving the cut-off point to 0.4 (i.e. choosing cut-off point B) eliminates false negative results but increases the proportion of false positive test results. In this case, the test would have 100% sensitivity but low specificity. Choosing cut-off point C= 0.6 eliminates false positive results, but increases the proportion of false negative test results. In this case, the test would have 100% specificity but low sensitivity. As illustrated by Figure 3, an important use of the concepts of sensitivity, specificity and predictive values is in the determination of an optimal cut-off value or clinical decision limit for a test. Sensitivity and specificity are dependent on the cut-off value selected – the decision on what cut-off value to choose is arbitrary and dependent upon the perceived relative benefits and disadvantages for each model and hence cut-points for each model need to be viewed in the context of patient versus provider interests. It is important to note that whenever a cut-off value is changed, there is a trade-off between the sensitivity and specificity of a test and that choosing a cut-point for Model 1 necessarily impacts on the accuracy of Model 2 at various cut-points.

For example, maximising sensitivity (i.e. have few false –ves) may be a priority if there is an important penalty (social impact/political) for missing an urgent case. Or, maximizing specificity (i.e., have few false +ves) if it is important (in terms of equity and allocative efficiency) not to identify non-urgent cases as urgent.

3.4 Results

3.4.1 Characteristics of study participants

A total of 839 of the required 1200 sampled patients requesting emergency care were recruited across SA and NSW. Overall, this was 69.9% of the targeted sample size. Nine clinics were recruited to conduct the study. All dentists providing care in these clinics during the study period were recruited as examiners for the clinical assessment.

Table 3.1 shows the percentage of respondents in each of several socio-demographic groupings for both South Australia (SA) and New South Wales (NSW), as well as for the overall sample. There is an over representation of females in the sample. The largest proportion of patients were in the 25-44 year age group (almost 40%) while the lowest

proportion of patients (8.5%) were in the youngest age group category (18–24 years). Almost two thirds of the respondents were born in Australia. There were very few people from an Aboriginal or Torres Strait Islander background. The majority of respondents had completed some or all of their secondary school education; 42.9% had some secondary school education while a further 19.4% had completed secondary school.

Just over 60% of patients presenting for emergency dental care held a full-entitlement pensioner concession card and over one-third of the respondents had a health care card. These are the two dominant categories of eligibility for public dental services.

Table 3.1 Distribution of sample socio-demographic characteristics by state

		SA (*n* = 427) col%	NSW (*n* = 412) col%	Total (*n* = 839) col%
		***n* = 427**	***n* = 412**	***n* = 839**
Sex of patient	Male	43.3	42.7	43.0
	Female	56.7	57.3	57.0
		***n* = 425**	***n* = 410**	***n* = 835**
Age group	18 – 24 years	7.1	10.0	8.5
	25 – 44 years	37.4	42.2	39.8
	45 – 64 years	32.5	25.1	28.9
	65+ years	23.1	22.7	22.9
		***n* = 426**	***n* = 412**	***n* = 838**
Born in Australia	Yes	65.0	64.3	64.7
	No	35.0	35.7	35.3
		***n* = 426**	***n* = 412**	***n* = 838**
Language mainly spoken at home	English	93.4	85.9	89.7
	Other	6.6	14.1	10.3
		***n* = 426**	***n* = 412**	***n* = 838**
Indigenous status	Non-indigenous	98.1	97.8	98.0
	Yes, Aboriginal	1.6	1.9	1.8
	Yes, Torres Strait Islander	0.2	0.2	0.2
		***n* = 426**	***n* = 409**	***n* = 835**
Highest level of education	Primary school	8.2	10.8	9.5
	Some secondary school	46.9	38.6	42.9
	Completed secondary school	16.4	22.5	19.4
	Some university, higher education	4.9	4.4	4.7
	Completed university, higher education	5.2	3.4	4.3
	Some TAFE, CAE or vocational course	5.4	4.4	4.9
	Completed TAFE, CAE, vocational course	10.6	15.9	13.2
	Other	2.3	–	1.2
		***n* = 427**	***n* = 412**	***n* = 839**
Health care card status	Pensioner Concession Card (Full) only	62.3	60.4	61.4
	Pensioner Concession Card (Part) only	1.9	3.2	2.5
	Health Care Card only	34.4	35.0	34.7
	Veterans Affairs Card only	0.7	0.5	0.6
	Commonwealth Seniors Card only	–	0.2	0.1
	Other eligible combinations	0.7	0.7	0.7

3.4.2 Distribution of responses to potential predictor variables

Potential predictor variables are displayed in Table 3.2 together with their frequencies and differences in frequency between the SA and NSW subsamples and significant differences are indicated.

Table 3.2 Frequency of independent variables by state and overall

In the last week, have you experienced…	**SA** *% within state (n=427)*	**NSW** *% within state (n=412)*	**Total** *% within total*	**Sig.**
Oral & facial pain symptoms				
- toothache	61.9	80.9	71.2	*
- pain in teeth with cold food or fluids	56.7	67.5	62.0	*
- pain in teeth with hot food or fluids	43.2	55.7	49.3	*
- pain in jaw while chewing	32.8	42.8	37.7	*
- pain in teeth with sweet food	28.9	41.3	35.0	*
- pain in front of ear	20.6	34.8	27.5	*
- shooting pain in face or cheeks	20.3	30.2	25.1	*
- pain in jaw when opening mouth wide	18.4	23.2	20.7	n.s
- burning sensation in tongue or other parts of mouth	8.5	8.9	8.7	n.s
- pain or discomfort from denture	5.6	7.8	6.7	*
Other oral symptoms				
- dryness of mouth	31.1	41.1	36.0	*
- sore gums	27.5	38.1	32.7	*
- unpleasant taste	25.9	44.3	34.9	*
- bleeding gums	25.4	31.1	28.2	*
- bad breath	24.7	39.3	31.9	*
- difficulty opening mouth wide	18.4	23.2	20.7	n.s
- clicking/grating noise in jaw joint	11.8	18.9	15.3	*
- changes in ability to taste	10.4	18.3	14.3	*
- mouth ulcers	9.4	9.5	9.5	n.s
- cold sores	7.1	5.1	6.1	n.s
Activities of daily living impact scale				
- have difficulty sleeping	44.7	65.3	54.8	*
- stay home more than usual	23.4	38.6	30.9	*
- avoid usual leisure activities	21.1	32.0	26.5	*
- be unable to do household chores	12.6	25.5	19.0	*
- stay in bed more than usual	10.3	25.0	17.5	*
- take time off work	2.4	3.2	2.8	n.s

Table 3.2 (cont'd)	SA	NSW	Total	Sig.
	% prevalence	*% prevalence*	*% prevalence total*	
Worry/concern impact scale				
- worry about health of teeth or mouth	84.5	88.7	86.6	*
- worry about appearance of teeth or mouth	64.6	75.2	69.8	*
Other symptoms				
- pain at night	35.4	53.3	44.1	*
- a lost filling	28.6	32.4	30.4	n.s
- a cracked tooth	24.2	30.5	27.3	*
- a broken filling	24.1	22.1	23.2	n.s
- swelling on gums	19.5	27.7	23.6	*
- a loose tooth	11.7	14.6	13.2	n.s
- swelling of your face or neck	11.3	17.3	14.3	*
- pain which is worse in the middle of the day	8.5	20.2	14.2	*
- high temperature	7.5	13.9	10.7	*
- a broken crown	2.8	5.8	4.3	*
- a lost crown	2.1	2.4	2.3	n.s
Other questions				
- Experienced pain	70.7	84.2	77.4	*
- Takes any regular medication	51.1	49.5	50.3	n.s
Dental Anxiety Scale (DAS) Score				
- DAS score ≥ 13	17.6	25.5	21.5	*
- DAS score < 13	82.4	74.5	78.5	
Dentists urgency assessment				
< 48 hours	36.7	34.8	35.8	n.s
2- 7 days	26.8	42.7	34.8	
8+ days	36.4	22.4	29.4	

* Statistically significant difference SA, NSW, Chi-square, P < 0.05

n.s Not statistically significant

An initial analysis of the data was carried out to determine if any of the potential predictor variables should be considered for use in a multivariate model. Bivariate associations between the potential predictor variables and 'urgency' were therefore examined.

Table 3.3 Bivariate associations between independent variables and urgency of treatment

Symptom	Response	Urgency *(%within urgency)*					Sig.	
		<48 hrs	2–7 days	8–13 days	14+ days	Total		
Oral & facial pain symptoms								
- toothache	Yes	79.9	82.1	61.5	45.7	72.3	0.001	*
- pain in teeth with hot food or fluids	Yes	51.2	58.3	47.4	30.0	49.2	0.001	*
- pain in teeth with cold food or fluids	Yes	61.9	70.2	62.8	49.3	62.5	0.001	*
- pain in teeth with sweet foods	Yes	38.6	38.5	29.5	20.7	34.2	0.001	*
- pain in jaw while chewing	Yes	49.5	41.1	16.9	23.8	38.4	0.001	*
- pain in jaw when open mouth wide	Yes	32.5	17.0	10.3	10.6	20.7	0.001	*
- pain in front of ear	Yes	37.2	26.7	23.4	15.2	27.9	0.001	*
- burning sensation in tongue/mouth	Yes	10.2	8.9	5.2	6.7	8.6	0.414	n.s
- shooting pain in face or cheeks	Yes	35.1	26.7	18.2	9.3	25.5	0.001	*
- pain or discomfort from denture	Yes	6.0	6.9	7.5	6.6	6.6	0.383	n.s
Other oral symptoms								
- mouth ulcers	Yes	9.9	10.6	11.4	7.3	9.8	0.678	n.s
- cold sores	Yes	7.8	4.8	7.6	5.3	6.2	0.445	n.s
- sore gums	Yes	37.9	32.6	19.0	31.6	33.0	0.016	*
- bleeding gums	Yes	27.3	34.5	18.8	24.5	28.4	0.018	*
- bad breath	Yes	34.4	37.1	23.8	21.3	31.8	0.002	*
- dryness of mouth	Yes	37.2	37.8	31.3	31.8	35.8	0.472	n.s
- unpleasant taste	Yes	41.5	38.5	22.5	23.8	35.2	0.001	*
- changes in ability to taste	Yes	18.9	15.3	8.8	7.9	14.5	0.008	*
- difficulty opening mouth wide	Yes	32.5	17.0	10.3	10.6	20.7	0.001	*
- clicking/grating noise in jaw joint	Yes	17.7	14.5	10.0	14.6	15.2	0.360	n.s

Table 3.3 (cont'd) Bivariate associations between independent variables and urgency of treatment

Symptom	Response	Urgency *(%within urgency)*					Sig.	
		<48 hrs	2–7 days	8–13 days	14+ days	Total		
Activities of daily living impact scale								
- have difficulty sleeping	all the time	29.0	15.3	7.5	4.6	17.3	0.001	*
	very often	12.4	9.1	5.0	2.0	8.5		
	often	6.0	13.8	6.3	5.2	8.6		
	sometimes	22.6	21.1	26.3	16.3	21.2		
	never	30.0	40.7	55.0	71.9	44.4		
- stay home more than usual	all the time	12.4	8.7	3.8	0.7	8.0	0.000	*
	very often	7.8	6.5	3.8	1.3	5.7		
	often	8.1	5.8	3.8	4.6	6.2		
	sometimes	12.7	12.0	11.3	6.5	11.1		
	never	59.0	66.9	77.5	86.9	69.0		
- stay in bed more than usual	all the time	3.9	2.5	1.3	0.7	2.5	0.001	*
	very often	5.7	5.1	5.0	–	4.3		
	often	5.3	2.2	2.5	2.0	3.3		
	sometimes	11.0	8.4	7.5	2.0	8.0		
	never	74.2	81.8	83.8	95.4	81.9		
- take time off work †	all the time	2.1	0.4	–	–	0.9	0.071	**
	very often	0.4	1.5	–	–	0.6		
	often	–	–	–	–	–		
	sometimes	1.1	1.9	3.8	–	1.4		
	never	96.4	96.3	96.3	100.0	97.1		
- be unable to do household chores	all the time	5.3	2.5	1.3	0.7	3.0	0.001	*
	very often	6.7	2.5	1.3	0.7	3.5		
	often	2.8	4.0	1.3	–	2.5		
	sometimes	11.3	10.9	7.5	5.2	9.6		
	never	73.9	80.0	88.8	93.5	81.3		
- avoid usual leisure activities	all the time	11.7	7.3	2.5	2.6	7.5	0.001	*
	very often	4.9	3.6	2.5	0.7	3.4		
	often	6.0	5.5	2.5	1.3	4.6		
	sometimes	12.0	13.1	17.5	2.0	11.0		
	never	65.4	70.5	75.0	93.5	73.6		

Table 3.3 (cont'd) Bivariate associations between independent variables and urgency of treatment

Symptom	Response	Urgency *(%within urgency)*					Sig.	
		<48 hrs	2–7 days	8–13 days	14+ days	Total		
Worry/concern impact scale†								
- worry about appearance of teeth or mouth †	all the time	31.4	34.3	32.5	24.2	31.1	0.047	*
	very often	9.9	8.4	18.8	9.8	10.3		
	often	9.9	10.6	8.8	6.5	9.4		
	sometimes	21.6	16.1	18.8	20.3	19.1		
	never	27.2	30.7	21.3	39.2	30.1		
- worry about health of teeth or mouth	all the time	35.1	43.6	33.8	28.8	36.7	0.010	*
	very often	20.8	12.1	18.8	15.0	16.4		
	often	12.5	16.5	10.0	13.1	13.8		
	sometimes	19.4	17.2	23.8	22.2	19.6		
	never	12.2	10.6	13.8	20.9	13.5		
Other symptoms								
- pain worse in the middle of the day	Yes	19.4	16.6	9.1	4.6	14.6	0.001	*
- pain at night	Yes	57.6	49.1	35.1	20.5	45.3	0.001	*
- swelling on gums	Yes	32.6	23.3	7.5	16.6	23.7	0.001	*
- swelling of face or neck	Yes	24.5	12.8	6.3	5.3	14.9	0.001	*
- a lost filling †	Yes	26.6	32.7	38.8	28.1	30.3	0.130	*
- a lost crown	Yes	3.2	0.7	1.3	4.0	2.3	0.096	*
- a broken filling †	Yes	25.5	24.7	18.8	15.7	22.7	0.074	*
- a broken crown	Yes	6.0	4.4	1.3	3.9	4.6	0.312	n.s
- a loose tooth	Yes	19.9	12.4	11.3	5.3	13.6	0.001	*
- a cracked tooth †	Yes	30.5	28.1	22.5	19.7	26.8	0.078	*
- high temperature	Yes	14.9	11.7	7.5	3.3	10.8	0.002	*

Table 3.3 (cont'd) Bivariate associations between independent variables and urgency of treatment

Symptom	Response	Urgency (%within urgency) <48 hrs	2–7 days	8–13 days	14+ days	Total	Sig.	
- experienced pain	Yes	85.5	84.0	78.8	53.6	78.1	0.001	*
- takes any regular medication †	Yes	47.0	48.5	57.5	55.9	50.3	0.161	n.s
Socio-demographic variables								
- age group	18–24 yrs	10.0	7.7	7.5	9.2	8.8	0.001	*
	25–44 yrs	45.2	43.8	32.5	25.7	39.6		
	45–64 yrs	26.7	25.5	40.0	33.6	29.0		
	65+ yrs	18.1	23.0	20.0	31.6	22.6		
- maximum education	Primary	8.5	9.5	15.0	6.6	9.1	0.049	*
	Some secondary	48.8	42.9	28.8	41.4	43.3		
	Completed secondary	19.2	18.9	21.3	17.8	19.0		
	Some university	3.6	4.4	8.8	4.6	4.6		
	Completed university	6.0	2.2	6.3	4.6	4.4		
	Some TAFE	4.3	4.7	6.3	5.9	4.9		
	Completed TAFE	7.8	16.4	13.8	17.8	13.3		
	Other	1.8	1.1	–	1.3	1.3		
- sex of patient †	Female	53.0	56.7	66.3	60.1	57.0	0.154	*
	Male	47.0	43.3	33.8	39.9	43.0		
- language mainly spoken at home	English	89.7	91.3	86.3	90.2	90.0	0.620	n.s
	Other	10.3	8.7	13.8	9.8	10.0		
- country of birth	Australia	61.1	68.4	63.3	66.0	64.8	0.337	n.s
	Other	38.9	31.6	36.7	34.0	35.2		
Dental Anxiety								
- DAS score	DAS score < 13	73.5	80.0	73.8	87.6	78.5	0.004	*
	DAS score ≥ 13	26.5	20.0	26.3	12.4	21.5		

* Statistically significant Chi-square, P < 0.05

** Statistically significant Spearman's rho (ordinal-ordinal variables)

n.s Not statistically significant

† In the initial selection, a critical P-value of 0.25 was used to avoid rejecting potentially significant variables at this stage.

Each predictor variable with a bivariate association with a P value <0.25, was entered in a backward stepwise logistic regression in order to determine the strengths of the

independent association of these variables. These predictor variables included patient characteristics (age, education) and subjective oral health status indicators (experience of pain or other oral symptoms, ability to perform activities of daily living, social and psychological impact of oral disorders). For the purpose of analysis, 'urgency' was dichotomized into <48 hours *cf* 2 + days, and 2-7 days *cf* 8+ days.

3.4.3 The Parent study models

Table 3.4 shows the regression models derived by means of backward stepwise logistic regression from the potential predictor variables. These variables formed the questions which will be validated and tested in the research that follows to see how well they perform in prioritising patients into urgency categories for the receipt of emergency dental care.

The series of 9 and 7 questions that best match each wait time category were identified through the two statistical models referred to as Model 1 (<48 hours vs. 2+days) and Model 2 (2–7 days vs. 8+days) and were selected from a pool of 42 questions (significant in the bivariate associations at the level of P<0.25) relating to patients' socio-demographic characteristics, oral symptoms and oral health related quality of life (See Table 3.3).

For Model 2 regression analysis, all persons determined by Model 1 to be urgency <48 hours were removed from the dataset before Model 2 was run. This accounted for the reduction in the total numbers used in this stage of model development and indicates the two step sequential approach used in the Parent study to predict urgency of emergency dental care.

Table 3.4 Logistic regression analysis for predicting urgency of dental care: odds ratios, beta coefficients and 95% confidence intervals

	Model 1			Model 2		
	<48 hours vs. 2-7 days†			2 - 7 days vs. 8+days‡		
Independent variable	**OR**	**B**	**95% CI for OR**	**OR**	**B**	**95% CI for OR**
- toothache				2.629	0.967	(1.600, 4.319)
- pain in teeth with hot food or fluids			N/A	1.917	0.651	(1.248, 2.945)
- pain worse in the middle of the day				1.883	0.633	(0.945, 3.752)
- pain in teeth with cold food/fluids	0.704	-0.352	(0.488, 1.015)			
- pain in jaw when opening mouth wide	2.415	0.882	(1.572, 3.712)			N/A
- shooting pain in face or cheeks	1.490	0.399	(0.987, 2.249)			
- bleeding gums	0.663	-0.411	(0.451, 0.975)	2.009	0.698	(1.268, 3.184)
- a broken filling	1.650	0.501	(1.115, 2.441)	2.080	0.732	(1.238, 3.495)
- a loose tooth	2.352	0.855	(1.470, 3.763)			N/A
- difficulty sleeping						
All the time	4.829	1.575	(2.960, 8.024)	2.941	1.079	(1.361, 6.355)
Very often	2.877	1.057	(1.528-5.417)	2.920	1.072	(1.098, 7.761)
Often	1.153	0.143	(0.599, 2.220)	2.668	0.981	(1.224, 5.817)
Sometimes	1.933	0.659	(1.242, 3.007)	1.169	0.156	(0.686, 1.992)
- worried about health of teeth or mouth						
All the time	0.635	-0.454	(0.357, 1.131)			
Very often	1.661	0.507	(0.897, 3.076)			N/A
Often	1.147	0.137	(0.599, 2.193)			
Sometimes	1.204	0.186	(0.662, 2.191)			
- worried about appearance of teeth or mouth						
All the time				0.665	-0.407	(0.387, 1.144)
Very often			N/A	0.305	-1.189	(0.141, 0.659)
Often				1.309	0.270	(0.598, 2.866)
Sometimes				0.556	-0.586	(0.305, 1.014)
- DAS score ≥ 13	1.518	0.418	(1.018, 2.264)			N/A
Model constant		-1.436			-1.213	

‡Analysis used n = 750 cases with complete data on all variables

‡ Analysis used n = 476 cases with complete data on all variables

N/A = not applicable for this model

In order to generate a relative urgency prediction for each patient; either <48 hours and 2+ days from the model questions, answers to each question in Model 1 were assigned their

associated beta coefficient value as generated by the backward stepwise logistic regression and then summed across all variables and the constant or intercept in each model. This was repeated for Model 2. (Also see Table 3.3). These summed scores for both models could range from 0 to 1.

3.4.3.1 Emergency Model 1

Sensitivity, specificity, positive predictive values (PV+) and negative predictive values (PV-) were calculated for emergency Model 1 at varying cut-off values are presented in Table 3.5.

Table 3.5 Sensitivity, Specificity, and Predictive Values for Emergency Model 1

Cut-off	Sensitivity	Specificity	PV+	PV-
0.2	0.88	0.36	0.43	0.84
0.3	0.73	0.61	0.51	0.81
0.4	0.58	0.77	0.59	0.77
0.5	0.45	0.88	0.67	0.74
0.6	0.30	0.94	0.75	0.71
0.7	0.16	0.98	0.78	0.68

The following is an interpretation of Emergency Model 1. Suppose we have 100 patients presenting for emergency dental care. Using the dentists' assessment of urgency proportions reported in Table 3.2 around 36% need care < 48 hrs and 64% are able to wait 2 or more days. Using these same proportions, 35 patients should be positive thus requiring care within 48 hours according to dentist urgency assessment and the remaining 65 patients should be classified as able to wait 2 or more days.

However, of those patients classified as urgent (i.e., requiring care within 48 hours) the number predicted to need to be seen within 48 hours will depend upon the cut-off value selected. To illustrate this, Model 1 is interpreted for a low cut-off of 0.4.

1. Decision 1: cut-off=0.4

Cut-off	Sensitivity	Specificity	PV+	PV-
0.4	0.58	0.77	0.59	0.77

Figure 4. Example interpretation of Model 1 cut-off at 0.4

The model has higher specificity but lower sensitivity when using a cut-off of 0.4. This indicated that the model tended to identify most non-urgent people (have fewer false positive results) but at the same time also identified more urgent people as non-urgent (have more false negative results).

Therefore, using a cut-off value = 0.4, the model sensitivity was 58% whilst specificity was 77% indicating that of those 35 people actually requiring care within 48 hours, 20 (58% of 35) were correctly identified as urgent and would therefore be seen within 48 hours, but 15 people would be misclassified and receive care in 2 or more days time (i.e.15 people end up with false negative results).

		Clinician urgency (clinical assessment of urgency)		
		<48 hours +ve	**2-7 days -ve**	**Total**
Test result (based on predictor variables)	**<48 hours +ve**	20	15	**35**
	2-7 days -ve	15	50	**65**
	Total	**35**	**65**	**100**

Of the 65 people who are considered able to wait 2 or more days for treatment, 50 (77% of 64) of the people without urgent need will actually test negative, but 15 will be misclassified (i.e. 15 people end up with false positive results) and receive care within 48 hours.

3.4.3.2 Emergency Model 2

Sensitivity, specificity, positive predictive values (PV+) and negative predictive values (PV-) calculated for emergency Model 2 at varying cut-off values are presented in Table 3.6.

Table 3.6 Sensitivity, Specificity, and Predictive Values for Emergency Model 2

Cut-off	Sensitivity	Specificity	PV+	PV-
0.2	0.97	0.12	0.56	0.79
0.3	0.91	0.35	0.62	0.76
0.4	0.84	0.49	0.66	0.73
0.5	0.75	0.65	0.71	0.69
0.6	0.67	0.71	0.73	0.65
0.7	0.63	0.77	0.76	0.64

The following is an interpretation of Emergency Model 2. When a cut-off of 0.4 was used for emergency model 1, 65 of the 100 people were not classified as needing to be seen immediately, i.e. of the 100 patients presenting for emergency dental care, 35 were classified as requiring care within 48 hours whilst the remaining 65 patients were considered able to wait 2+ days for dental treatment.

Let us now consider what happens to these 65 people when emergency Model 2 is used (assuming a cut-off value of 0.4 for emergency Model 1), remembering that Table 3.2 showed values of 42.7% for dentists assessment of 2-7 day priority and 22.4% 8+ days. This translates to 66% of the 65 people with DUA 2-7 days and 34% needing care in 8+days. To determine how many of these 65 patients are classified by the model as needing to be seen in the period 2–7 days or in 8+ days, a cut-off for Model 2 needs to be selected; the predictive ability of a model is dependent upon the cut-off chosen. To illustrate this, emergency Model 2 is interpreted for 2 different cut-off values, a low cut-off of 0.4 and a high cut-off of 0.7 (still using a cut-off for Model 1 at 0.4).

1. ***Decision 1: Model 2 cut-off=0.4 (Model 1 cut-off at 0.4)***

Cut-off	Sensitivity	Specificity	PV+	PV-
0.4	0.84	0.49	0.66	0.73

Based on the above values of sensitivity, specificity and positive and negative predictive values, and solving the relationships between the test result and the clinician's urgency assessment presented in Table 3.7, the following results are obtained.

Table 3.7 Example interpretation of Model 2, cut off at 0.4

		Clinician urgency (clinical assessment of urgency)		
		2–7 days +ve	**8+days -ve**	**Total**
Test result (based on predictor variables)	**2–7 days +ve**	36	11	**47**
	8+ days -ve	7	11	**18**
	Total	**43**	**22**	**65**

The results presented in Table 3.7 show that 18 of the 65 people initially presenting for emergency care were predicted to be able to wait 8 or more days for dental care.

2. ***Decision 2: Model 2 cut-off=0.7 (Model 1 cut-off at 0.4)***

Cut-off	Sensitivity	Specificity	PV+	PV-
0.7	0.44	0.90	0.84	0.58

Using a higher cut-off value increases the specificity at the expense of the sensitivity. Therefore there will be fewer false positive results, but more false negative test results.

Table 3.8 Example interpretation of Model 2 cut-off at 0.7

		Clinician urgency (clinical assessment of urgency)		
		2–7 days +ve	**8+days -ve**	**Total**
Test result (based on predictor variables)	**2–7 days +ve**	19	2	**21**
	8+ days -ve	24	20	**44**
	Total	**43**	**22**	**65**

The results presented in Table 3.8 show that when using 0.7 as the cut-off value, 44 of the 65 people initially presenting for emergency care would be predicted to be able to wait 8 or more days for dental care.

Similar calculations were made for the other cut-off values but will not be reported here.

Table 3.9 shows the RNI Models 1 and Model 2 questions with their associated coding, coefficient values and cut points for each priority category are given.

Table 3.9 RNI Model questions

In the last week, have you had…			Model 1	Model 2
			B	B
pain in teeth with cold food or fluids	Yes		-0.352	-
pain in jaw when opening mouth wide	Yes		0.882	-
shooting pain in face or cheeks	Yes		0.399	-
bleeding gums	Yes		-0.411	0.698
a broken filling	Yes		0.501	0.732
a loose tooth	Yes		0.855	-
a toothache	Yes		-	0.967
pain in teeth with hot food/fluids	Yes		-	0.651
pain which is worse in the middle of the day	Yes		-	0.633
During the last week, how often has pain, discomfort or other problems with your teeth, mouth or dentures caused you to have…				
difficulty sleeping	all the time		1.575	1.079
(one response only)	very often		1.057	1.072
	fairly often		0.143	0.981
	sometimes		0.659	0.156
	never		0	0
During the last week, how often have you…				
worried about the health of your teeth or mouth	all the time		-0.454	-
(one response only)	very often		0.507	-
	fairly often		0.137	-
	sometimes		0.186	-
	never		0	
worried about the appearance of your teeth or mouth	all the time		-	-0.407
(one response only)	very often		-	-1.189
	fairly often		-	0.27
	sometimes		-	-0.586
	never		-	0
Dental Anxiety Scale (DAS)*				
Imagine you had an appointment to go to the dentist tomorrow, how would you feel about it?	I would look forward to it as a reasonably enjoyable experience	1		-
(one response only)	I wouldn't care one way or the other	2		-
	I would be a little uneasy about it	3		-
	I would be afraid that it would be unpleasant and painful	4		-
	I would be very frightened of what the dentist might do	5		-

Table 3.9 (cont'd) RNI Model questions

Dental Anxiety Scale (DAS)*(cont'd)		Model 1 B	Model 2 B
Imagine you are waiting in the dentist's waiting room for your turn in the chair, how would you feel?			
(one response only)	Relaxed		
	a little uneasy	2	-
	tense	3	-
	anxious	4	-
	So anxious that I sometimes break out in a sweat or almost feel physically sick	5	-
Imagine you are in the chair waiting while the dentist gets the drill ready to begin working on your teeth, how would you feel?		1	-
	Relaxed		
(one response only)	a little uneasy	2	-
	tense	3	-
	anxious	4	-
	So anxious that I sometimes break out in a sweat or almost feel physically sick	5	-
Imagine you are in the dentist's chair to have your teeth cleaned. While you are waiting and the dentist is getting out the instruments to be used to scrape your teeth around the gums, how would you feel?	I would look forward to it as a reasonably enjoyable experience	1	-
	Relaxed		
(one response only)	A little uneasy	2	-
	tense	3	-
	anxious	4	-
	So anxious that I sometimes break out in a sweat or almost feel physically sick	5	
DAS >13		0.418	
Constant		-1.436	-1.213

*DAS scores are summed and a person scoring => 13 is given a coefficient value of 0.418

3.5 Summary

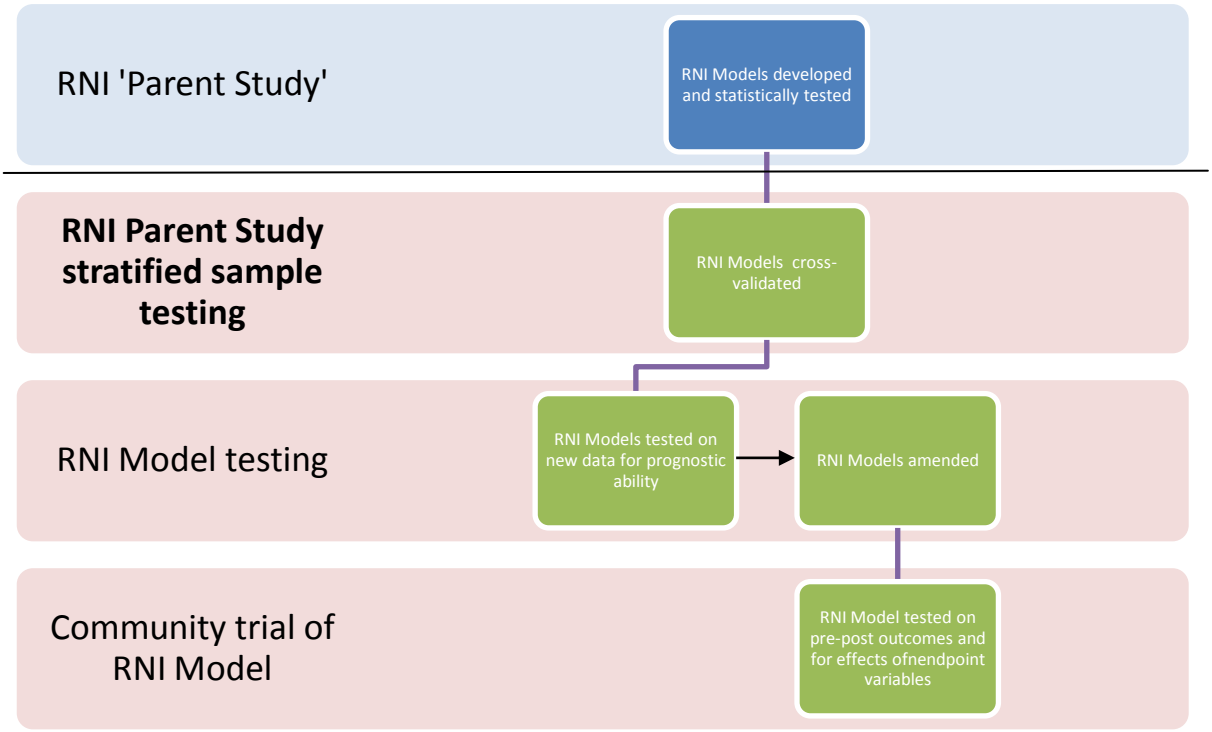
The multivariate logistic regression equations presented offer a more scientific approach to prioritising care within the public dental system and provide a more consistent, transparent and objective method than that used to currently allocate dental care. The traditional approach which involves offering care on a 'first come, first served basis' to all those requesting dental care for a specific dental problem or for the relief of dental pain can be viewed as flawed as it offers none of these qualities that predictive models do.

Predictive models take the pressure away from reception staff to allocate appropriate appointment times to patients and eliminate the subjective nature of the way in which care is currently offered. Additionally, they can be easily implemented within public dental clinics by installing a computer algorithm on clinic computers, incorporating the formula of the logistic regression equation and beta coefficients which generates the predicted probability of being urgent, and hence priority, of persons requesting emergency dental care.

The results presented in this chapter report on preliminary data which provide the foundation for the later model testing process which is reported in Chapter 4, Stratified sample testing and Chapter 5, RNI model testing.

These analysis presented in Chapter 3 were performed as a part of the original RNI Parent study of which the author was a significant contributor but does not form a part of the original research undertaken for this research. They have been presented to aid an understanding of the conceptual underpinnings and development of the research undertaken and reported for the purpose of this thesis.

4 Stratified sample testing



The next stage of the prognostic model development was validation. A decision was made for the purpose of this validation to stratify the Parent study sample into SA patients only and to re-specify the prognostic model on the stratified data to determine whether the models derived from the two-State sample was suitable to be used on a cohort of SA only patients (See Section 2.5.1). The rationale behind this decision was the fact that validation of the models and potentially implementation to aid priority decision making was to be performed on a sample of exclusively South Australian public dental patients. The original coefficients, odds ratios and model diagnostics derived from the backward step-wise regression performed in the Parent study were compared with new coefficients, odds ratios and diagnostics developed when the models were re-run on the stratified data.

4.1 Stratified sample prevalence of priority

Table 4.1 shows the stratified sample prevalence of dentist's urgency assessment. The proportion of persons falling into <48 hours category was similar in SA and NSW, however differences were apparent in the proportion of people in the 2–7 days category and 8+ days category. SA dentists' urgency assessment prevalence for 2–7days was 34.8% and NSW was 26.8% and SA had a lower proportion of those assessed as needing care 8+days than found in NSW (29.4 *cf* 36.4%) suggesting that overall, more people in SA had more urgent dental assessments.

Table 4.1 Proportion of dentist urgency assessment, by State

	SA N=395 (%)	NSW N=396 (%)	Overall N=791 (%)
< 48 hours	36.7	34.8	35.8
2–7 days	26.8	42.7	34.8
8+ days	36.4	22.4	29.4
Total	**100.0**	**100.0**	**100.0**

4.2 Stratified Model 1

As reported above, the original coefficients, odds ratios and model diagnostics derived from the backward step-wise regression performed in the Parent study were compared with new coefficients, odds ratios and diagnostics developed when the models were re-run on the state-level stratified data. Table 4.2 shows a comparison of a binary logistic regression analysis for predicting urgency of dental care for Model 1 (<48 hours) when the models were re-run on stratified SA and NSW data. The coefficients and odds ratios for both SA and NSW were generally similar. The magnitude of difference in odds ratios were small and the direction of the coefficients mostly remained stable.

Table 4.2 Multivariate regression analysis for predicting urgency of dental care < 48 hours *cf* 2+ days: odds ratios and 95% confidence intervals on a stratified sample

	Parent study			SA			NSW		
Model 1 variables	**B**	**OR**	**95% CI for OR**	**B**	**OR**	**95% CI for OR**	**B**	**OR**	**95% CI for OR**
- pain in teeth with cold food/fluids	-0.352	0.70	0.488-1.01	-.522	.594	.361-.976	-.149	.862	.498-1.49
- pain in jaw when opening mouth wide	0.882	2.41	1.57-3.71	.473	1.60	.959-2.68	.215	1.24	.722-2.13
- shooting pain in face or cheeks	0.399	1.49	0.98-2.24	.394	1.48	.805-2.73	.601	1.82	1.04-3.17
- bleeding gums	-0.411	0.63	0.45-0.97	-.030	.970	.563-1.67	-.666	.514	.297-.888
- a broken filling	0.501	1.65	1.11-2.44	.983	2.67	1.56-4.55	-.361	.697	.385-1.26
- a loose tooth	0.855	2.35	1.47-3.76	.744	2.10	1.07-4.13	.898	2.45	1.27-4.71
- difficulty sleeping									
All the time	1.575	4.82	2.96-8.02	1.74	5.72	2.65-12.35	1.86	6.47	3.10-13.48
Very often	1.057	2.87	1.52-5.41	1.09	2.98	1.02-8.65	1.35	3.86	1.67-8.95
Often	0.143	1.15	0.59-2.20	.626	1.86	.741-4.71	-.201	.818	.298-2.24
Sometimes	0.659	1.93	1.24-3.00	.521	1.68	.922-3.07	.755	2.12	1.06-4.24
- worried about health of teeth or mouth									
All the time	-0.454	0.63	0.35-1.13	.634	.659	.904-3.93	1.08	2.95	1.53-5.69
Very often	0.507	1.66	0.89-3.07	.672	1.95	.949-4.02	.113	1.12	.467-2.68
Often	0.137	1.14	0.59-2.19	.325	1.38	.703-2.72	1.06	2.91	1.36-6.21
Sometimes	0.186	1.20	0.66-2.19	.272	1.31	.588-2.93	.585	1.79	.784-4.10
- DAS score ≥ 13	0.418	1.51	1.01-2.26	.227	1.47	.69-2.28	.658	1.93	1.11-3.34
Constant	-1.436			-1.256			-1.732		

4.2.1 Model 1 comparative diagnostic test values

Applying the same diagnostic tests to the stratified samples as were applied to the Parent study (Sensitivity, Specificity and PV- and PV+) allowed assessment of how accurate the models were on the stratified SA sample when determining urgency.

Table 4.3 shows a comparison of sensitivity values from Model 1 developed from the Parent Study backward stepwise logistic regression compared with Model 1 predictors when run as a normal binary logistic regression and stratified by state. The diagnostics for sensitivity in SA on the stratified data are almost identical to the original Model 1 sensitivity values across all cut offs.

Table 4.3 Comparison of Sensitivity Values for Model 1

Model 1	**Sensitivity**		
Cut-off	**Parent study**	**SA**	**NSW**
0.2	0.88	0.88	0.87
0.3	0.73	0.73	0.77
0.4	0.58	0.59	0.67
0.5	0.45	0.41	0.50
0.6	0.30	0.25	0.34
0.7	0.16	0.15	0.20

Table 4.4 shows a comparison of specificity values between the original Parent study backward stepwise logistic regression Model 1 data compared with Model 1 when run as a normal binary logistic regression and stratified by state. The specificity achieved for the SA sample was almost identical to that produced by the Parent study, indicating continued model stability on the stratified sample.

Table 4.4 Comparison of Specificity Values for Model 1

Model 1		Specificity	
Cut-off	**Parent study**	**SA**	**NSW**
0.2	0.36	0.32	0.50
0.3	0.61	0.60	0.64
0.4	0.77	0.75	0.77
0.5	0.88	0.87	0.86
0.6	0.94	0.94	0.94
0.7	0.98	0.97	0.98

Table 4.5 shows the comparison of predictive values (positive) derived from the Parent study backward stepwise logistic regression Model 1 compared with Model 1 when run as a normal binary logistic regression and stratified by state. Positive predictive values for the model on the SA split data showed slightly lower positive predictive values to those produced at every cut-off from the Parent study.

Table 4.5 Comparison of Predictive Values (positive) for Model 1

Model 1		PV+	
Cut-off	**Parent study**	**SA**	**NSW**
0.2	0.43	0.40	0.46
0.3	0.51	0.48	0.51
0.4	0.59	0.55	0.59
0.5	0.67	0.62	0.64
0.6	0.75	0.68	0.74
0.7	0.78	0.72	0.83

Table 4.6 shows the comparison of predictive values (negative) derived from the Parent study backward stepwise logistic regression for Model 1 compared with Model 1 when run as a normal binary logistic regression and stratified by state. Again, the SA estimates of predictive value were slightly lower at each cut point but overall showed comparability with Parent study estimates.

Table 4.6 Comparison of Predictive Values (negative) for Model 1

Model 1		PV-	
Cut-off	**Parent study model**	**SA**	**NSW**
0.2	0.84	0.83	0.88
0.3	0.81	0.80	0.84
0.4	0.77	0.77	0.82
0.5	0.74	0.73	0.77
0.6	0.71	0.70	0.73
0.7	0.68	0.68	0.70

4.3 Stratified Model 2

Table 4.7 shows a comparison of a binary logistic regression analysis for predicting urgency of dental care for Model 2 (2-7 days *cf* 8+ days) and Model 2 when the models were re-run on stratified SA and NSW data. The coefficients and odds ratios for both SA and NSW were generally similar. The magnitude of difference in odds ratios were small and the direction of the coefficients mostly remained stable.

Table 4.7 Multivariate regression analysis for predicting urgency of dental care: odds ratios and 95% confidence intervals on a stratified sample

	Parent study			SA n=471			NSW n=269		
Model 2 variables	**B**	**OR**	**95% CI for OR**	**B**	**OR**	**95% CI for OR**	**B**	**OR**	**95% CI for OR**
- toothache	0.967	2.62	1.60-4.31	-1.41	.244	.122-.487	-.377	.686	.322-1.46
- pain in teeth with hot food or fluids	0.651	1.91	1.28-2.94	-.899	.407	.218-.791	-.366	.649	.374-1.28
- pain worse in the middle of the day	0.633	1.88	0.95-3.75	-.085	.919	.290-2.91	*.994	.370	.147-.930
- bleeding gums	0.698	2.00	1.26-3.18	.591	1.80	.906-3.59	.434	1.54	.823-2.89
- a broken filling	0.732	2.08	1.23-3.95	-1.37	.253	.114-.565	-.138	.871	.445-1.70
- difficulty sleeping									
All the time	1.079	2.94	1.36-6.35	1.12	3.08	1.01-9.41	.857	2.35	.806-6.89
Very often	1.072	2.90	1.09-7.76	.943	2.59	.497-13.28	1.09	2.97	.869-10.17
Often	0.981	2.66	1.22-5.18	.819	2.26	.625-8.25	.916	2.50	.908-6.88
Sometimes	0.156	1.16	0.68-1.99	.059	1.06	.494-2.27	-012	.988	.466-2.09
- worried about appearance of teeth or mouth									
All the time	-0.404	0.665	0.38-1.14	-.689	.502	.255-1.12	-.169	.844	.394-1.81
Very often	-1.189	0.305	0.14-0.65	-1.46	.232	0.64-.843	-.953	.386	.146-1.02
Often	0.270	1.309	0.59-2.86	.304	1.35	.440-4.17	.274	1.31	.425-4.07
Sometimes	-0.586	0.556	0.30-1.01	-.920	.399	.177-.896	-.180	.836	.328-2.12
Constant	-1.213								

4.3.1 Model 2 comparative diagnostic test values

Table 4.8 shows the comparison of sensitivity values derived from the Parent study backward stepwise regression for Model 2 compared with Model 2 when run as a normal binary logistic regression and stratified by state. Model 2 showed reduced sensitivity values across all cut–offs for the SA sample when compared to the Parent study estimates.

Table 4.8 Comparison of Sensitivity Values for Model 2

Model 2		Sensitivity	
Cut-off	**Parent study**	**SA**	**NSW**
0.2	0.97	0.90	0.98
0.3	0.91	0.84	0.98
0.4	0.84	0.77	0.95
0.5	0.75	0.62	0.86
0.6	0.67	0.53	0.69
0.7	0.63	0.34	0.57

Table 4.9 shows a comparison of specificity values derived from the Parent study backward stepwise logistic regression for Model 2 compared with Model 2 when run as a normal binary logistic regression and stratified by state. Specificity is higher across the majority of cut-off points for the state stratified sample when compared to the Parent study estimates. This result is may be explained by the NSW data driving the outcomes from Parent study data. Different experiences in oral health status and management between the states may contribute to differences in diagnostic testing.

Table 4.9 Comparison of Specificity Values for Model 2

Model 2		Specificity	
Cut-off	**Parent study**	**SA**	**NSW**
0.2	0.12	0.40	0.04
0.3	0.35	0.54	0.06
0.4	0.49	0.61	0.14
0.5	0.65	0.80	0.32
0.6	0.71	0.89	0.63
0.7	0.77	0.96	0.81

Table 4.10 shows comparison of positive predictive values derived from the Parent study backward stepwise logistic regression for Model 2 compared with Model 2 when run as a normal binary logistic regression and stratified by state. Model 2 predictive values (positive) for the SA sample are noticeably lower across all cut-offs except the 0.7 level.

Table 4.10 Comparison of Predictive Values (positive) for Model 2

Model 2		PV+	
Cut-off	**Parent study**	**SA**	**NSW**
0.2	0.56	0.32	0.41
0.3	0.62	0.36	0.42
0.4	0.66	0.38	0.43
0.5	0.71	0.49	0.46
0.6	0.73	0.60	0.56
0.7	0.76	0.72	0.67

Table 4.11 shows comparison of negative predictive values derived from the Parent study backward stepwise regression of Model 2 compared with Model 2 when run as a normal binary logistic regression and stratified by state. As expected, due to high specificity achieved of Model 2 on the SA split sample, the negative predictive values (negative) are higher for the SA sample than the Parent study.

Table 4.11 Comparison of Predictive Values (negative) for Model 2

Model 2		PV-	
Cut-off	**Parent study**	**SA**	**NSW**
0.2	0.79	0.92	0.72
0.3	0.76	0.91	0.81
0.4	0.73	0.89	0.80
0.5	0.69	0.86	0.76
0.6	0.65	0.85	0.74
0.7	0.64	0.82	0.73

4.4 Discussion

There were differences in the proportions of people allocated to dentist urgency assessment categories between the SA and NSW samples which indicated a population level difference in oral health status or differences in dentists' criteria for assessment of urgency at the state level.

When comparing the odds ratios derived from regression models by state, there was some shift in the odds ratios of the independent variables but the magnitude of change was small and the direction of the ratios mostly remained stable, providing confidence that the model would still perform as expected.

Diagnostic test indicators of sensitivity and specificity for Model 1 also showed almost identical values when compared to the parent study values across all cut-offs, varying only by very small magnitudes. Consequently, the PV+ and PV- values showed almost identical values derived from the SA only data to the predicted values.

Diagnostic test indicators for Model 2 shows that the stability for the cut-offs at all values was not as good as Model 1 with lower sensitivity values, but higher specificity at all thresholds.

4.4.1 Summary

These results show the derivation and diagnostic testing of the models stratified by state, comparing them with the test results from the Parent study backward stepwise logistic regression models.

The results from Model 1show that the diagnostic outcomes from the SA data compared well against the original diagnostics, indicating relatively stable estimates, i.e., the model did not suffer from undue shrinkage when applied in this SA population alone, indicating relative stability of Model 1. This was a consequence of the fact that reported prevalence of urgency <48 hours did not differ markedly between the states.

The results from Model 2 show that this model did not fit as well when applied on SA data alone. The relatively large differences in prevalence of an urgency of assessment 2–7 days between SA and NSW (26.8% *cf* 42.7%) meant that the stability of Model 2 on the SA stratified sample was not optimal.

The diagnostic results indicated that it would be reasonable to further test the models on a new set of SA people requesting access to care at SA Dental Service clinics.

5 RNI model testing - validation and further development of the Relative Needs Index

5.1 Introduction

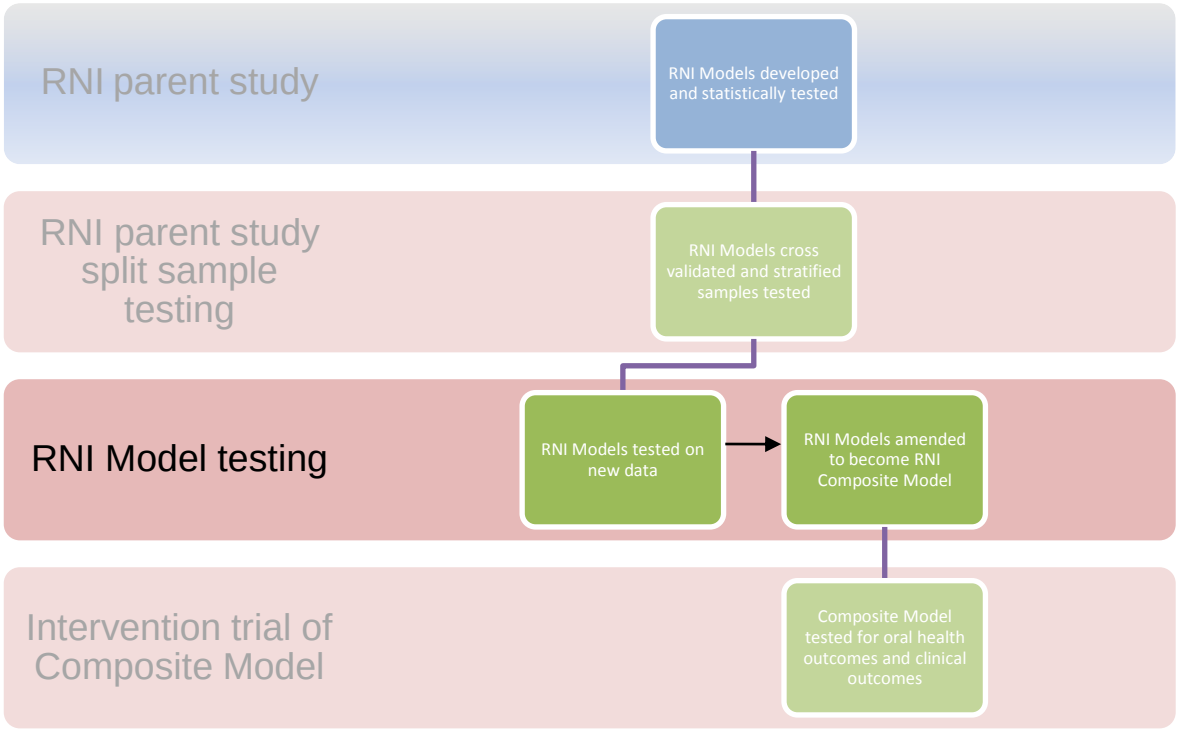
This chapter reports on the results of an exercise to validate the RNI questions on a *new set* of people seeking access to dental care in SA Dental Service clinics. A further comparison with the existing receptionists' urgency assessment was also conducted. Dentist urgency assessment was used as the gold standard.

The Parent study derived prognostic Models 1 and 2 comprised predictor variables selected by backward, stepwise regression modelling. The literature on validating such prognostic models recommends that these selected independent variables be re-tested for significance on a new set of data (See Section 2 Literature review). Such re-testing of the predictor variables allows assessment of whether the change in size or value of the coefficient associated with each independent variable is sufficient enough to warrant concern, potentially rendering the prognostic variables, and hence the models, less accurate. What size difference is significant has not been clarified in the literature, so is somewhat of an arbitrary judgment.

As a part of the validation of the RNI models, the RNI model variables were applied to a new set of data. This was done in order to generate regression coefficients to test the stability and transferability of the model.

Additionally, as the models were designed to replace receptionists' judgment, the status quo approach to decision making, the models were also compared against receptionists assessment of urgency.

5.2 Schema – RNI Model testing



5.3 Aims

The aim of RNI model testing was to determine the accuracy of the RNI questions in predicting urgency on a new sample of patients within the SA Dental Service.

Aim 1. To determine the distribution of urgency in SA patients presenting for emergency dental care.

Aim 2. To compare dentists urgency assessment with receptionists urgency assessment

Aim 3. To test the performance of the RNI model on a new, independent set of public dental patients.

Aim 4. To test the performance of a RNI model against that of receptionists on a new independent set of public dental patients.

Aim 5. If necessary to refine or derive a new model to determine urgency and test its performance.

The purpose is to quantify just how well the models classify patients into the urgency care categories: <48 hours; 2–7 days; or 8 + days as determined by the gold standard dentist urgency assessment.

5.4 Chapter overview

As illustrated in the schema in Section 5.2, this chapter presents the methods and results of RNI model testing on a *new set* of patients and the evaluation of the performance of these models. It will also describe the reasoning behind the development of a Composite model by way of merging Parent study Models 1 and 2 and the subsequent testing of the Composite model.

5.5 Methods

5.5.1 Study design and participants

The study was an observational study of patients selected from two SA Dental Service clinics.

The data used to measure prognostic accuracy were patient responses to the questions which make up the RNI model. The questions were the independent predictor variables derived from the backwards stepwise logistic regression models reported in Chapter 3 which were subsequently transformed into questions appropriate to use for telephone consultation. The term 'the model questions' will be used throughout this Chapter when referring to the application of the RNI models being used as an urgency or priority setting tool. Additionally, receptionists' urgency assessment of patient urgency, and dentists' urgency assessment of patient urgency are used to provide the remaining data to evaluate the accuracy of the models.

The target population was those persons calling one of the two study clinics seeking a same day dental appointment or relief of dental pain during the study period, January – August 2004, and excluded those requesting access to general dental care.

Every day, the first five eligible adults calling or presenting at the two community dental clinics were recruited by reception staff. The criteria used to select patients were adults (18 years or older) holding a current government health care or concession card who were requesting a same day appointment or requesting to be treated for relief of pain related to a natural tooth resulting from a dental condition. Patients who reported 'acute' emergency symptoms (trauma; haemorrhage uncontrolled bleeding; and, facial swelling) were excluded from the recruitment process and were given an emergency appointment as per the usual protocol (See Table 5.1 Inclusion criteria for RNI).

Table 5.1 Inclusion criteria for RNI model testing Phase

Inclusion criteria	• All eligible adult public dental care patients seeking access to dental care
Exclusion criteria	Persons reporting: • life threatening dental symptoms, • trauma, • haemorrhage, • patients calling requesting a check up, scale and clean, • patients calling to place their name on the general dental care waiting list, • fully edentulous patients, • supported residential facility (SRF) patients, • patients speaking limited English

After being informed of the study by reception staff, patients were asked to complete the model questions. Patients who consented to answer the model questions were allocated an appointment *irrespective* of their responses to the questions.

The sample size was estimated based on prevalence of urgent care as reported by SA dentists found in the Parent study. Prevalence levels of urgency of 36.7% needing care <48 hours and 26.8% needing care within 2–7 days were used, resulting in a total prevalence of around 64% needing care within 7 days. This prevalence was assumed to be 70%. This prevalence of 70% needing care <7 days (derived from the SA data) was used to calculate a sample of 510 patients (an alpha of 5% and power of 80%) required to detect a 2% difference in estimated proportions between the model estimates and dentists urgency assessment (See Table 4.1 Proportion of dentist urgency assessment, by State).

5.5.2 Data collection and measures

Model questions were asked by reception staff over the telephone when patients first contacted the clinics. Demographics were also recorded during this call. The same receptionist then completed a subjective assessment of patient urgency. Each telephone station in participating clinics was allocated a booklet of record forms for responses to the model questions and receptionist urgency (See Appendix B). This urgency assessment made by the receptionist recorded the length of time they thought the patient could wait for an appointment: < 48 hours, 2–7 days, 8+ days. Attending dental officers recorded their dentist urgency assessment (DUA) at the subsequent treatment visit using the same categories of waiting time and were blinded to the model question responses and receptionists' assessments. See Figure 5.

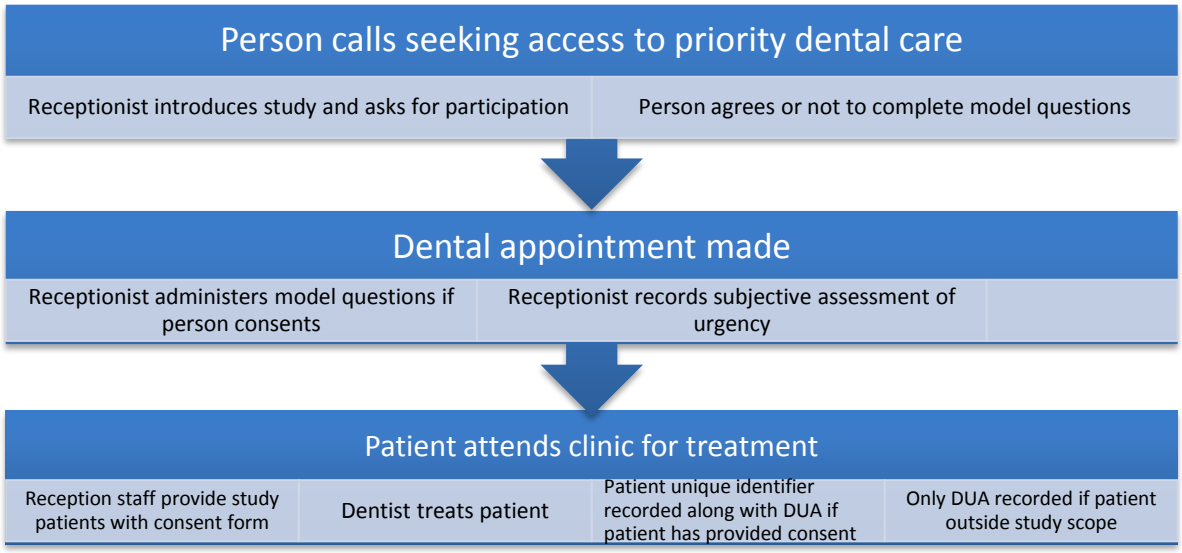


Figure 5: Phase 1 data collection showing temporal sequencing and data collected at each stage

Each dental chair in participating clinics was allocated a booklet of DUA record forms in which to record a dentist's urgency assessment and for those comprising the 'new test set' also to record patients unique identifying code. Those consenting to participate comprised the 'test set' of patients whose DUA was used as the gold standard against which the models performance was validated and against which the receptionist urgency assessment was compared. The 'test set', as well as those who did not provide consent to participate in the full study, comprised the 'prevalence sample' for urgency. Recording DUA on non-study participants was approved by the SA Dental Service ethics committees and subsequently the University of Adelaide as collection of DUA was deemed to be a part of SA Dental Service quality assurance program.

5.5.3 Data analysis

Bivariate associations between predictor variables and 'urgency' were examined using chi-square testing of proportional differences. A new binary logistic regression model was generated using the same model question items as used in the earlier phases. As sensitivity and specificity are dependent upon the cut-off values selected for a test, i.e., the numeric threshold above which the test is interpreted as urgent, the relationship between various cut points and sensitivity/specificity were again examined. Model 1 was specified first, followed by Model 2. Model 2 analysis was done on a reduced sample as all those classified by the gold standard as needing care <48 hour was removed for data analysis.

Analysis was done using SPSS v.15.

5.5.4 Ethical review

The University of Adelaide's Human Research Ethics Committee approved the study on 16 July 2003 (H-29-2003). Ethical clearance by the SA Dental Service was also given. A patient consent form, information sheet and complaints procedure documentation were provided to all patients who gave their telephone consent.

5.6 Results

5.6.1 Sample

Data from 459 consenting patients were collected, although only 294 of these had an associated dentist gold standard urgency rating. A total of 924 patients were collected for the Prevalence sample.

A majority, 68.5%, of patients were female. The 25-44 year old group represented 46.2% of the sample.

Table 5.2 Distribution of age and gender in the RNI model testing sample

Age		N	%	% valid
	18-24 years	37	12.6	14.0
	25-44 years	122	41.5	46.2
	45-64 years	74	25.2	28.0
	65+ years	31	10.5	11.8
	Missing	30	10.2	
Total		294		
Sex	Male	89	30.3	31.5
	Female	194	66.0	68.5
	Missing	11	3.7	
Total		**294**		

5.6.2 Urgency

Of the 294 patients assessed by dentists, 40.5% of the sample population needed treatment within <48 hours and almost a quarter of the sample was able to wait >8 days (24.8%).

Receptionists rated urgency for 287 patients and reported that 53.1% needed care < 48 hours while 12% needed care >8 days.

The prevalence sample of urgency ratings by dentists yielded 32.1% of patients needing care <48 hours.

Table 5.3 shows comparisons of the prevalence of urgency assessment s made by dentists' in the three sets of data used in this validation study. The RNI model testing sample had the highest proportion of patients assessed as needing care <48 hours (40.5%). The proportion of patients assessed as needing care <48 hours in the RNI prevalence sample (32.1%) was marginally lower than the proportion in the Parent Study SA sample (36.7%). Changes over time to demand management strategies and clinic structures may account for some of these differences in proportions from the Parent study. There was also the possibility of changes to the perceptions of appropriate wait times for dental conditions due to changes in management strategies.

Table 5.3 Comparison of dentists' assessment of urgency in the Parent, RNI Model testing, and prevalence samples.

Urgency	RNI Parent Study SA sample % (n)	RNI RNI Model testing new set % (n)	RNI Prevalence sample % (n)
< 48 hours	36.7 (145)	40.5 (119)	32.1 (297)
2–7 days	26.8 (106)	34.7 (102)	45.5 (422)
8+ days	36.4 (144)	24.8 (73)	22.1 (152)
Total	100 (395)	100 (294)	100 924

Additionally, the differences in proportions of patient urgency as assessed by dentists when comparing the RNI model testing new data with both the Parent study data and the Prevalence sample may reflect differences in sample selection, due to being explicitly drawn from an emergency care seeking population and the other from a non-specific treatment receiving population.

5.6.3 Analysis of predictor variables in the models

A comparison of proportions of responses to the questions which make up the RNI model showed some significant differences in the proportions reported in the new test set.

Table 5.4 shows significant differences in the proportion of responses between many of the independent predictors which comprise Model 1 when comparing the responses to variables new set data with the Parent study data. For all significant differences reported, the reported proportions increased, except for those responses which related to better oral health, indicating a rise in the proportions of people self-reporting poor oral health conditions in the urgent care seeking population.

Table 5.4 Comparisons of proportions of responses for predictor variables in Model 1

Model 1 " In the last week have you…"		Data set (% within data set) RNI Parent Study SA sample %	RNI Model testing new set %	Sig.
Had pain with cold foods or fluids?	Yes	56.7	71.1	*
Had shooting pain in your face or cheeks?	Yes	20.3	49.6	*
Had pain in your jaw when you open your mouth wide?		18.4	37.6	*
Had bleeding gums?	Yes	25.4	33.1	*n.s*
Had a broken filling?	Yes	24.1	38.3	*
Had a loose tooth?	Yes	11.7	18.4	n.s
Had difficulty sleeping?	Never	45.1	32.0	*
	Sometimes	21.5	18.8	
	Fairly often	8.5	14.3	
	Very often	8.2	14.3	
	All the time	16.7	20.7	
Worried about the *health* of your teeth or mouth?	Never	13.4	17.3	n.s
	Sometimes	19.6	18.8	
	Fairly often	13.7	17.3	
	Very often	16.7	15.4	
	All the time	36.6	31.2	
Dental Anxiety Score (DAS)	DAS > 13	17.6	30.1	*

*Statistically significant Chi-square, P<0.05

Table 5.5 shows comparisons of the proportions of responses for predictor variables for Model 2. There were significant differences in proportions for all the predictor variables, except the proportion of persons reporting having bleeding gums. Of notable interest for Model 2 is the reporting of having a toothache by all patients in the new patient data (100.0%).

Table 5.5 Comparisons of proportions of responses for independent variables in Model 2

Model 2 " In the last week have you…"		Data set (% within data set)		Sig
		RNI Parent Study SA sample %	RNI Model Testing new set %	
Had a toothache?	Yes	61.9	100.0	*
Had pain with hot foods or fluids?	Yes	43.2	82.7	*
Had pain that is worse in the middle of the day?	Yes	8.5	32.3	*
Had a broken filling?	Yes	24.1	38.3	*
Had bleeding gums?	Yes	25.4	33.1	*n.s*
Had difficulty sleeping?	Never	45.1	32.0	*
	Sometimes	21.5	18.8	
	Fairly often	8.5	14.3	
	Very often	8.2	14.3	
	All the time	16.7	20.7	
Worried about the *appearance* of your teeth or mouth?	Never	30.2	32.3	*
	Sometimes	19.2	18.4	
	Fairly often	9.4	15.8	
	Very often	10.0	7.9	
	All the time	31.1	25.6	

*Statistically significant Chi-square, P<0.05

5.6.4 Regression modelling

Model 1 was re-run using the new set data to test the goodness of fit of the model on these new set of patients. The Hosmer–Lemeshow test ($P = 0.12$) indicated that the assessments made by dentists of patients needing care <48 hours were not significantly different from those predicted by the model and that the overall model fit was good.

Table 5.6 shows that all coefficients are in the same direction and many were of comparable magnitude. However, some coefficients showed considerable changes and this may reflect the typical over-fitting of regression models when used for prognostic purposes as referred to in Chapter 2 due to different patient populations and prevalence of specific dental conditions in the new population.

Table 5.6 Binary regression model beta coefficients for Model 1 using RNI Model testing cohort compared with the RNI parent study

Model 1 series " In the last week have you…"		RNI Model testing new set (n=310)	RNI Parent study SA sample (n=395)
		(B)	(B)
Had pain with cold foods or fluids?	Yes	-.371	-.522
Had shooting pain in your face or cheeks?	Yes	.320	.394
Had pain in your jaw when you open your mouth wide?		.556	.473
Had bleeding gums?	Yes	-.263	-.030
Had a broken filling?	Yes	-.089	.938
Had a loose tooth?	Yes	.658	.744
Had difficulty sleeping?	Sometimes	.657	.521
	Fairly often	.402	.626
	Very often	1.25	1.09
	All the time	1.60	1.74
Worried about the *health* of your teeth or mouth?	Sometimes	.245	.272
	Fairly often	.302	.325
	Very often	.001	.672
	All the time	.000	.634
Dental Anxiety Score(DAS)*	DAS>=13	.265	.227
Constant		-1.436	-1.256

Reference category for odds ratio is never
*Minimum score = 0, maximum score=20

Table 5.7 shows Model 2 using the RNI model testing data to test the goodness of fit of the model on this new set of patients. The Hosmer–Lemeshow test (P = 0.81) indicated that the assessments made by dentists of patients needing care 2–7 days were not significantly different from those predicted by the model and that the overall model fit was good.

All patients answering the RNI model questions reported having a toothache. Subsequently, the variable was automatically dropped from the logistic regression equation.

Table 5.7 Binary regression model beta coefficients for Model 2 on RNI model testing cohort compared with the RNI Parent study

Model 2 series " In the last week have you…"		RNI model testing new set (n=158*)	RNI Parent Study SA sample (n=395)
		(B)	(B)
Had a toothache?	Yes	-	-1.41
Had pain with hot foods or fluids?	Yes	-.605	-.899
Had pain that is worse in the middle of the day?	Yes	.352	-.085
Had a broken filling?	Yes	-1.73	-1.37
Had bleeding gums?	Yes	.515	.591
Had difficulty sleeping?	Sometimes	.518	.059
	Fairly often	.769	.819
	Very often	.696	.943
	All the time	.957	1.12
Worried about the *appearance* of your teeth or mouth?	Sometimes	.282	-.920
	Fairly often	.740	.304
	Very often	-.269	-1.46
	All the time	.319	-.689
Constant		-.323	-1.213

* Model 2 has a reduced N as all those persons classified as <48 hours by the gold standard have been removed from the analysis for the new set data(see Section 5.5.3)

Again the coefficients are in the same directions and of comparable magnitude between the two data sets yet differ due to the same reasons as suggested for Model 1. The differences in the population groups from which the subjects were drawn for the two data sets, one a general dental care population sample and the other an urgency dental-care seeking population may have driven the coefficients seen in the RNI model testing new set.

5.6.5 Diagnostic test indicators – sensitivity, specificity, and predictive values

5.6.5.1 Model 1 diagnostic test indicators

Sensitivity, specificity, positive predictive values (PV+) and negative predictive values (PV-) calculated for Model 1, Model 2 and receptionists are presented in the tables below at various cut-off points for inclusion into one urgency group or another.

Table 5.8 shows that in the RNI Model new test set, Model 1 is performing with higher sensitivity than predicted by the Parent study across all cut–offs. Specificity of the Testing cohort Model 1 is not as high as predicted by the Parent study modelling. Such a result may suggest the presence of a more homogenous population regarding symptoms in this new test set. Alternatively, the results may reflect changed oral health conditions within the community, changed prevalence of presenting conditions, changes in practise and/or demand management and associated patient demands for care.

Table 5.8 Model 1 (<48 hours) classification and prediction measures of accuracy –sensitivity and specificity, PV+, PV- comparing Parent study and RNI model testing results.

	Predicted from RNI Parent study *		Achieved in RNI Model Testing new test set		Predicted from RNI Parent Study *		Achieved in RNI Model Testing new test set	
Cutoff	Sensitivity	Specificity	Sensitivity	Specificity	PV+	PV-	PV+	PV-
0.2	0.88	0.32	0.97	0.13	0.40	0.83	0.97	0.13
0.3	0.73	0.60	0.85	0.27	0.48	0.80	0.78	0.44
0.4	0.59	0.75	0.73	0.45	0.55	0.77	0.64	0.64
0.5	0.41	0.87	0.71	0.53	0.62	0.73	0.44	0.81
0.6	0.25	0.94	0.54	0.71	0.68	0.70	0.28	0.91
0.7	0.15	0.97	0.33	0.84	0.72	0.68	0.08	0.99

*Predicted results refer to those values predicted by the models to be statistically achievable at each given cut–point. † The cut-off is the numeric threshold of the predicted proportion from the logistic regression models used to classify people into categories of urgency.

A cut-off value of 0.40 in Model 1 was chosen as this cut–off value most closely represented the proportion of people in the care seeking population that were classified by the gold standard as needing care <48 hours (40.5%). Table 5.8 shows that at this cut–off, Model 1 is 73% sensitive, meaning that 73% of urgent patients test positive (27% are hence misclassified; therefore 27% of urgent people will be given lower priority). Specificity for the test is 45% meaning that 45% of non-urgent patients test negative (55% of non-urgent patients will be misclassified as urgent). If the test is positive, the probability of being urgent is 64%. Hence, even though the test is positive, there is a 36%

chance that the patient is not urgent. If the test is negative, the probability of being urgent is 36%. This indicates that there is a 64% chance that the patient is not urgent if the test is negative.

This indicates that the RNI Model testing will tend to identify most urgent cases (have fewer false negative results) but at the same time will also identify more non-urgent patients as urgent (have more false positives results) compared to the RNI Parent study SA stratified sample.

5.6.5.2 Model 2 Diagnostic test indicators

Using the cut-point of Model 1 at 0.4, Model 2 diagnostic testing was then performed on the RNI model testing new test set data using only those participants who had a DUA of 2+ days (excluding those determined to be less than 48 hours from analysis). Table 5.9 shows measures of test accuracy - sensitivity and specificity, PV+, PV- for Model 2 (2–7 days) for both the predicted values as derived from the SA stratified sample and the RNI Model testing new set.

Model 2 performed with higher than expected sensitivity across most cut points. Specificity of the model did not reach expected proportions across all cut–points. Model 2 performed with lower positive predictive values than expected across all cut–points. Likewise, the negative predictive values were also lower than expected across all possible cut–points.

Interpretation for the performance of Model 2 can be made at each cut–point and depending upon the outcomes of interest either a stronger positive or negative predictive capacity of the model can be obtained.

Table 5.9 Model 2 (2–7 days) measures of test accuracy – sensitivity and specificity, PV+, PV-

	Predicted from Parent study*		Achieved in RNI model new set		Predicted from Parent study *		Achieved in RNI model new set	
Cut–off†	Sensitivity	Specificity	Sensitivity	Specificity	PV+	PV-	PV+	PV-
0.2	0.90	0.40	0.95	0.06	0.32	0.92	0.49	0.60
0.3	0.84	0.54	0.75	0.39	0.36	0.91	0.54	0.62
0.4	0.77	0.61	0.97	0.04	0.38	0.89	0.49	0.66
0.5	0.62	0.80	0.85	0.13	0.49	0.86	0.48	0.50
0.6	0.53	0.89	0.78	0.18	0.60	0.85	0.47	0.47
0.7	0.34	0.96	0.46	0.41	0.72	0.82	0.43	0.45

* using a Model 1 cut–off at 0.4

† The cut-off is the numeric threshold of the predicted proportion from the logistic regression models used to classify people into categories of urgency.

An example interpretation of Model 2 using a cut-off value of 0.3 (and based on Model 1 cut-point at 0.4) follows. If we select Model 2 cut-point the same way as Model 1; using the proportion of patients with a DUA of 2-7 days (34.8%), the cut-off was an urgency score of 0.3. At this point the test is 75% sensitive meaning that 75% of 2-7 day urgent patients test positive (25% are misclassified; hence only 25% of people classified as needing care 2–7 days will be given a lower priority). Specificity for the test is 0.39 meaning that 39% of non–urgent patients test negative (61% of non-urgent patients will be misclassified as urgent). If the test is positive, the probability of being urgent is 0.54 or 54%. Hence, even though the test is positive, there is a 46% chance that the patient is not urgent. If the test is negative, the probability of being urgent is 62%. This indicates that there is a 38% chance that the patient is not urgent if the test is negative.

As can be seen from Table 5.9, as the cut-off is lowered, the sensitivity increases at the expense of specificity. Hence, as the cut-off is lowered, fewer false negative results are obtained but the proportion of false positive results increases. The opposite is true when higher cut-offs are selected.

5.6.5.3 Comparing RNI test model cohort diagnostics with receptionists assessment of urgency

In addition to validating the predictive accuracy and hence the usefulness of the RNI models in determining relative patient urgency, it was important to determine whether the models were actually more accurate at discriminating patient need than the method being replaced, receptionist judgment. This had been the traditional method by which urgency has been determined. Receptionist judgment is also the method reflected in the pre-implementation period reported in the Implementation trial in Chapter 6.

Table 5.10 shows the proportions of assessments made by dentists (the gold standard) and receptionists in the RNI model testing new set data. A significant difference existed between the proportions of patients assessed by receptionists and dentist for urgency of care. Receptionists perceive that more patients who call requesting dental care require urgent care than do dentists.

Table 5.10 Distribution of assessment of urgency by dentists and receptionists

	N	< 48 hours %	2+ days %	Sig.
Dentist	294	40.5	59.5	*
Reception staff	294	53.1	46.9	

Chi Square ,P<0.05

Table 5.11 shows that when receptionists' ability to predict which patients need care <48 hours was compared with the predictive accuracy of Model 1 (cut-off at 0.4), the Model was more sensitive than receptionists assessment (73% *cf* 46%), indicating that 73% of urgent patients were actually urgent when Model 1 was used compared to only 46% when receptionists make urgency judgments on needing care <48 hours. Model 1 had lower specificity (54%) when compared with receptionists (66%), meaning that only 54% of the non-urgent patients will test negative when Model 1 is used compared with 66% as determined by receptionists. Overall, Model 1 showed a higher positive predictive value (64% *cf* 51%) and negative predictive value (64% *cf* 62%) than receptionists, essentially suggesting that Model 1, if employed, would more accurately identify patients requiring care <48 hours more often than if receptionists remain making judgments of relative urgency <48 hours.

Table 5.11 Predictive accuracy, comparing receptionists and Model 1 for < 48 hours

	Sensitivity	Specificity	PV+	PV-
Receptionists	0.46	0.66	0.51	0.62
Model 1 Testing Cohort cut-off at 0.4	0.73	0.54	0.64	0.64

Table 5.12 shows that when receptionists' ability to predict those patients needing care 2–7 days was compared with the accuracy of Model 2 (cut at 0.3), we can see that Model 2 performed with higher sensitivity but lower sensitivity, than receptionists.

Table 5.12 Predictive accuracy, comparing receptionists and Model 2 for 2–7 days

	Sensitivity	Specificity	PV+	PV-
Receptionists	0.52	0.62	0.63	0.50
Model 2* Testing Cohort cut-off at 0.3	0.85	0.13	0.48	0.50

* Model 1 cut at 0.4

Receptionists perform at 52% sensitivity, meaning that they identified 52% of patients needing care within 2–7days, 48% were hence potentially misclassified and therefore 48% of people needing care in 2–7days will be missed by receptionists. This is compared with Model 2 (cut-off at 0.3) which correctly identifies 85% of all patients who need care 2–7 days misclassifying only 15% of patients as needing care in 2–7 days. Specificity for receptionists is 62%, meaning that 62% of non–urgent patients were identified (38% of non-urgent patients were misclassified as urgent) compared with Model 2 which identified only 13% of non-urgent patients.

If patients really need care within 2–7 days, the PV+, the probability of being identified as such by receptionists, was 63%. Hence, even though the receptionist decides they need care in 2–7 days, there is a 37% chance that the patient does not. If the receptionist judgement was that the patient does not need care 2–7days, then the PV-, the probability of being identified as needing care 2–7days of receptionists' judgement is 50%. This indicates that there is a 50% chance that the patient does not need care within 2–7 days. This is compared with Model 2 prediction which has a PV+ probability of identifying those that do need care 2–7 days of 48% and a PV- probability of 50%, the same PV- as reception staff.

5.7 Composite RNI model

A decision was made to alter the way in which the model questions would potentially be delivered and which questions would be used for implementation in clinical settings and to combine the two sequential models into a single 'composite model'. Model 2 is specified only for those patients with a DUA of 2+ days and determining such classification in a 'real world' setting was problematic. Further, a single 'composite model' was favoured for pragmatic and administrative reasons in light of the restrictions of the computerised Management Information System used by the public dental service.

In addition, the Dental Anxiety Scale (DAS) was removed from the potential battery of the model questions. This decision was made after consultation with reception staff who felt that the anxiety questions were inappropriate at the moment of triage for a treatment seeking population. The question 'Do you have a toothache?' was reintroduced into the model as it was felt by some on Executive Committee of the SA Dental Service that omitting the question was contrary to the conventional assessment of urgency that was dominant in the organisation.

Development of a single model, using a battery of questions amended by consensus with the SA Dental Service, needed to be validated to ensure that similar results could be obtained as when using the statistically derived sequential two model approach. The same diagnostic indicators of sensitivity, specificity and predictive values were employed to test the accuracy of this revised Composite model.

In studies of diagnostic tests with quantitative test results and a dichotomous reference standard, the relation of sensitivity and specificity for possible cut-off points can also be presented as a receiver operating characteristic (ROC) curve and its summary statistic, the area under the curve (AUC). A ROC curve was constructed by plotting sensitivity (true positive rate) against the false positive rate (1-specificity) over a range of cut-off values. ROC curves show the performance of a diagnostic test over all possible decision points, and the area under the curve (AUC) can be used as a measure of the discriminative ability/power of the prediction rule/test. The area under the ROC curve (AUC) is the probability that a prognostic model will correctly discriminate between two individuals when one individual is urgent and the other is not. It is a value that ranges from 0 to 1. A value of 0.5 means the model cannot discriminate any better than a coin toss, and a value

of 1 represents perfect discrimination. ROC curves show trade-off between sensitivity and 1-specificity as the cut-off is varied. The AUC is used as an overall measure of the discriminative ability of the prediction rule over all possible cut-offs.

5.7.1 Methods

New coefficients for the Composite model were generated using Model 1 and 2 predictor variables, excluding DAS and including toothache, using a normal logistic regression on the new set data.

Table 5.13 Regression coefficients for the RNI Composite model

Composite Model " In the last week have you…"		**RNI model testing new set (n=310)**
		B
Had pain with cold foods or fluids?	Yes	-0.407
Had pain in your jaw when you open your mouth wide?		0.807
Had shooting pain in your face or cheeks?	Yes	0.420
Had bleeding gums?	Yes	-0.262
Had a broken filling?	Yes	0.353
Had difficulty sleeping?	Never (Ref.)	0.0
	Sometimes	0.680
	Fairly often	0.079
	Very often	1.09
	All the time	1.556
Worried about the *health* of your teeth or mouth?	Never (Ref.)	0.0
	Sometimes	0.174
	Fairly often	0.064
	Very often	0.431
	All the time	-0.392
Had a toothache	Yes	0.163
Constant		-1.28

Table 5.13 shows the new beta coefficients were similar in direction and many were close in magnitude to Parent study estimates (See Table 5.6 and Table 5.6) indicating that the

Composite Model was appropriate for further testing. Cut-off values for each urgency category (<48 hours, 2–7 days, 8+days) were derived by summing the beta values from the regression coefficients and the constant for each. A predictive value was derived from every participant score (potentially ranging from 0 to 1) and was then ranked from the highest generated to the lowest generated predictive sum score. This ordered ranking of predictive sum scores was then 'cut' at the value that reflected the new set proportions of DUA urgency categories obtained from the Prevalence sample for each urgency grouping of <48 hours, 2–7 days, 8+days. The cut-off values that best mimicked the gold standard proportions for each urgent assessment grouping (36.7, 26.8, and 36.4%) were selected. These were 0.871 and 0.415. These proportions from the Prevalence sample were selected as it was felt they best represented up-to-date and potentially unbiased population prevalence estimates.

5.8 Results – Composite Model

The RNI model testing new set data was used to test the predictive accuracy of the Composite model. Table 5.14 shows a comparison between the Composite model predictions of urgency with the gold standard assessment, the DUA from the new set data. Accuracy of the Composite model can be calculated by summing all three 'true' ratings made by the composite model divided by the total number of patients screened (69+39+30/294) giving an accuracy rating of 46.9%.

Table 5.14 Dentist urgency assessment compared with Composite model predictions

	Dentist urgency assessment			
Composite Model	< 48 hours	2–7 days	8+ days	**Total**
< 48 hours	(69)	34	16	**119**
2–7 days	36	(39)	17	**102**
8+ days	14	29	(30)	**73**
	119	**102**	**73**	**294**

When testing congruence against the gold standard, the rating was moderate for receptionists' assessment, where receptionist felt that almost 53% of patients were deemed to need an appointment within 48 hours.

Table 5.15 Comparisons of dentists, receptionists and patient's predictions of urgency

	Urgency		
Assessment	< 48 hours %	2–7 days %	8+ days %
Dentists' "gold standard" urgency	35.8	34.8	29.4
Receptionists' rating of urgency	53.1	35.7	11.7
Composite Model*	40.0	35	25

* Screening score thresholds of 0.871 for <48 hrs , 0.415- <0.871 for 2–7days and <0.415 for 8+ days selected to reflect gold standard proportions .

5.8.1 Predictive test indicators – sensitivity, specificity predictive and AUC values

Sensitivity, specificity, positive predictive values (PV+) and negative predictive values (PV-) of the Composite model <48 hours compared with 2–7 days are presented in Table 5.16 and are compared with the traditional method of determining patient urgency, receptionist judgment.

Table 5.16 Sensitivity, specificity and predictive and AUC values for the Composite Model <48 hours compared with receptionists and parent study stratified SA sample Model 1.

	Sensitivity	Specificity	PV+	PV-	AUC
Receptionists	0.67	0.57	0.51	0.72	.500
Model 1*	0.73	0.45	0.65	0.64	.734
Composite Model**	0.54	0.70	0.55	0.70	.707

* Model 1 cut at 0.4
**Composite model < 48 hrs *cf* 2+ days

Table 5.16 shows that when compared with receptionist's judgement of urgency for <48 hours compared with 2 days, the Composite model has lower sensitivity and higher specificity. The composite model has a higher PV+ than receptionists and a slightly lower PV -. Using the AUC, both models outperform receptionist decision making which is equivalent to the toss of a coin. Model 1 slightly outperforms the Composite model.

When we look at predicting urgency 2-7 days compared with 8+ days (See Table 5.17), the Composite model has higher sensitivity and specificity than receptionists resulting in both higher PV+ and PV-. When comparing AUC values, again, receptionist decision making is slightly better than random chance but again, the models outperform receptionist decision-making on urgency, with Model 2 again slightly outperforming the Composite model.

Table 5.17 Comparing sensitivity, specificity and predictive and AUC values for the Composite Model 2-7 days *cf* 8 + days for receptionists and Parent study SA stratified sample

	Sensitivity	Specificity	PV+	PV-	AUC
Receptionists	0.52	0.62	0.63	0.50	.563
Model 2*	0.75	0.34	0.54	0.62	.767
Composite model	0.57	0.64	0.70	0.51	.737

*Model 2 diagnostic based on Model 1 cut at 0.4 which represents the proportion of urgency in this group.

5.9 Summary

The results of the validation show that Model 1 performed better than expected (as predicted by the Parent study) at various cut-points for sensitivity, with values ranging from 0.33 to 0.97 (See Table 5.8). Sensitivity refers to the accuracy of predicted urgency among those patients deemed independently to be in need of urgent treatment by SA Dental Service dentists. However, specificity was lower across the majority of cut–off points (0.13 to 0.84) (See Table 5.8). Specificity refers to the accuracy of predicted need among those patients deemed independently not to be in need by SA Dental Service dentists. PV+ for Model 1 was higher than predicted by the Parent Study data at the cut-point of 0.4 and expected PV- for Model 1 was lower than predicted at the cut–off of 0.4.

When Model 1 was compared to receptionist capacity to accurately identify patients' requiring/not-requiring care within <48 hours and 2–7 days, Model 1 has both higher PV+ and PV- than receptionists. Hence Model 1 performs with more accuracy both for those who need care and those who do not need care within 48 hours.

Model 2 performed with higher than expected sensitivity (0.54 to 1) however specificity was lower than expected across the majority of cut-points (0 to 0.65) (See Table 5.9).

Expected Model 2 positive and negative predictive values were not achieved when using the Model 1 cut-point of 0.4 (on which Model 2 predicted values were developed).

Model 2 had higher sensitivity in identifying patients who do not need care. Again, when compared to receptionists and patients, Model 2 performed better at accurately identifying those patients who do not require care within 2–7 days.

As the cut-off was modified (i.e., as the numeric point that separated non-urgent patients from urgent patients was changed), the sensitivity and specificity of the test also changed; sensitivity was enhanced at the expense of specificity and vice versa. Cut-offs used for the Composite model were selected to reflect the proportion of urgency in the population as identified by the prevalence sample and the Executive Committee of the South Australian Dental Service supported this approach so as to maximise concordance.

The Composite model when compared with the traditional receptionist method of determining patient urgency for <48 hour care performed with 'lower' sensitivity but higher specificity and had both higher PV+ and PV- and AUC value than reception staff. When comparing accuracy for predicting care required within 2–7 days compared with 8+ days, the Composite model had both higher sensitivity and specificity than reception staff and higher PV+ and PV- and higher AUC values.

The methods used to determine accuracy; predictive testing using sensitivity, specificity and PV+ and PV- do not however reveal if one model was categorically better than the other. As sensitivity and specificity are determined statistically at a series of arbitrary "cut-points" specified for each model, optimal thresholds can be difficult to identify. AUC of ROC curves help to solve this dilemma and the AUC statistics showed the models performed better than the traditional method of receptionist determination of priority, one of the conditions of the implementation of a new screening or triage was that it worked at a more optimal level than the procedures it replaced.

What was important was for the South Australian Dental Service to make decisions about cut-offs and thresholds when using prognostic models based upon its aims and objectives of service delivery; whether it is more important to identify and treat true positives (ie. those who have urgent need, and who are correctly predicted by the model to have that same level of urgency) or whether it is more important to identify true negatives (ie. those who do not have urgent needs and who are correctly predicted by the model not to have

urgent needs). Cut points need to be selected based on intended outcomes for implementing such a prognostic tool. Such a decision on cut-points needs to account for the relative value that is placed on true positives (as indexed by sensitivity) versus true negatives (as indexed by specificity).

The decision to maximize either sensitivity or specificity depends upon the relative cost of a false positive or false negative test results. Higher false positive (poor sensitivity) performance leads to 'unnecessary' and therefore inefficient treatment for less urgent patients and higher false negative (poor specificity) results place more patients at risk of subsequent experience of pain and infection.

Performance of all models was acceptable with regard to predictive values. There were differences in prediction between the Composite model and receptionists' judgement of urgency, but the determination of whether they are acceptable, i.e. reflect organisational objectives, was a matter for the SA Dental Service to decide. If the Composite model met expectations and was approved for use in clinics, then the next step became to determine how effective was such a tool when used in the clinics of the SA Dental Service.

Dental officers recorded urgency status for all patients who gained access to care in each clinic in the data collection period in order to obtain up-to-date prevalence estimates of urgency proportions. Table 5.3 showed that 36.7% of all patients seen in the SA clinics during the RNI Parent study period had an urgency rating of <48 hours. This proportion is very similar to the proportion of patients in this urgency category in the Prevalence cohort (32.1%). The largest proportion of patients in the Parent study SA sample fell in the wait < 48 hours days category (36.7%), this proportion is similar to the proportions found in the other cohorts. Patients assessed as being able to wait 8+ days at the time of their dental appointment accounted for 36.4% of patient load in the Parent study SA sample period compared to 24.8% in the RNI model testing new data and 22.1% in the Prevalence cohort. It should be noted that RNI Parent study and Prevalence sample proportions of urgency may reflect patient load (as triaged by reception staff) in the study period and do not necessarily reflect relative proportions of such urgency within the care seeking/user population.

The higher proportion of patients assessed as needing care < 48 hours from the RNI model new test data when compared with both the Parent Study and the Prevalence

cohort could reflect real differences in sample selection. Changes to demand management strategies and clinic structures may have influenced this proportion. The first five patients calling for care may have had more acute needs than those calling later in the morning or the rest of the day. It may also indicate some bias among dentists assessing urgency, as participants in the RNI model testing study were not anonymous; however dental officers were not told of participant responses to the questions hence they were unaware of their predicted urgency rating by the models. Patients in the Prevalence cohort are potentially a mixture of acute, relief of pain and general care patients, unlike the Parent study and the RNI model new test data which were sampled from persons calling for same day 'emergency' dental appointments.

In summary, the Composite Model performed better than reception staff at identifying non-urgent people seeking access to dental treatment. Although the Composite model performed similarly to parent study Models 1 and 2 and SA Stratified model from the Parent study data, it was considered more readily implementable by the SA Dental Service.

6 Implementation trial

6.1 Introduction

Validating a prognostic model requires confirmation of the diagnostic accuracy of the tool of interest [120] (See Section 2.5.2.). When a tools diagnostic accuracy has been assessed and confirmed as acceptable using the parameters of interest, questions then turn to the implications of implementing such a tool. What will be the effects of introducing the tool and will the objectives of introducing such a tool be achieved? After determining the accuracy of the Composite model (See Chapters 3, 4, 5), this second phase, an Implementation trial, is necessary in order to quantify and describe patient and clinic level effects that will occur after its introduction.

The primary rationale for the introduction of an algorithm based priority-setting approach in the context of the SA Dental Service, was the potential capacity for the dental system to reorient away from recidivistic attendance for relief-of-pain towards more preventively oriented general dental care. Hence, it is essential to measure whether this has been achieved. The approach therefore was not one of further estimating the parameters of the model but rather assessing the Composite model as an experiment to which patients are exposed and to assess the outcomes measured ultimately by a change in the sum of hours of emergency and general dental care provided and to a lesser degree by the change in patient self-reported oral health problem and receipt of treatment and dental goal attainment.

This experimental trial assesses patient - and clinic- level effects that occurred after the implementation of the prognostic model. The effects were measured using three domains: self-reported oral health problem; receipt of treatment; and system performance.

6.2 Background

The research intervention is a prognostic model questionnaire behind which sits an algorithm, the Composite model. Each response to the questions has an associated value

and upon completion of the questionnaire, all response values are summed to generate a final score. This final score has a corresponding wait time for treatment. Implementing the evaluation of the Composite model involved testing the intervention in four community dental clinics operating under conditions of 'real time'. Consequently, this aspect of the research required considerable investment and alterations to clinic operations.

Significant changes were made to front of desk operations, where a specifically developed computer system with concealed numerical capacity was installed on every SA Dental Service reception computer in each community test clinic. This enabled computation of the model question responses into a priority score. Reception staff required instant access to the calculated priority scores in order to appoint patients according to their priority rating derived from the question responses. This allowed for complete preservation of operational integrity of the patient management information system (MIS) used by the SA Dental Service.

6.3 Aims and outcome measures

6.3.1 Aims

The purpose of this phase of the research was to examine the usefulness and acceptability of the prognostic model in SA Dental Service public dental clinics. Usefulness and acceptability are judgements to be made from the evidence of change in self- reported oral health problems, receipt of treatment and overall system performance when the Composite model was implemented among a sample of priority seeking public dental patients across multiple SA Dental Service clinic settings.

The specific aims of this phase of the research were:

1. To evaluate change between model pre- and post- implementation of the Composite model in a number of outcome measures
2. To describe change in other co-variates after implementation of the Composite model
3. To examine the consequences for those denied priority care.

6.3.2 Outcome measures

The outcome measures were in the following domains:

1. Self- reported oral health problem

2. Receipt of treatment

3. System performance

6.4 Methods

6.4.1.1 Study design and participants

A multi-site, pre-post- implementation trial was selected as the most appropriate design with which to examine changes resulting from the implementation of the Composite model. Pre-post- study designs have been described as best for use in health services research or any evaluation where randomised trials are not practical due to the constraints of provision of service delivery and the requirement of staff to meet duty of care obligations[188]. The trial population was those eligible adults calling one of the four participating SA Dental Service clinics during the study period. The four community dental clinics were selected by the researcher in consultation with the SA Dental Service.

The target population for the implementation of the model were those persons eligible for public dental care in South Australia who called seeking same day priority dental care and whose needs were not considered acute, i.e. presenting with life threatening oral conditions such as haemorrhage or orofacial trauma. Patients presenting with life threatening oral conditions were directed into the standard emergency triage system.

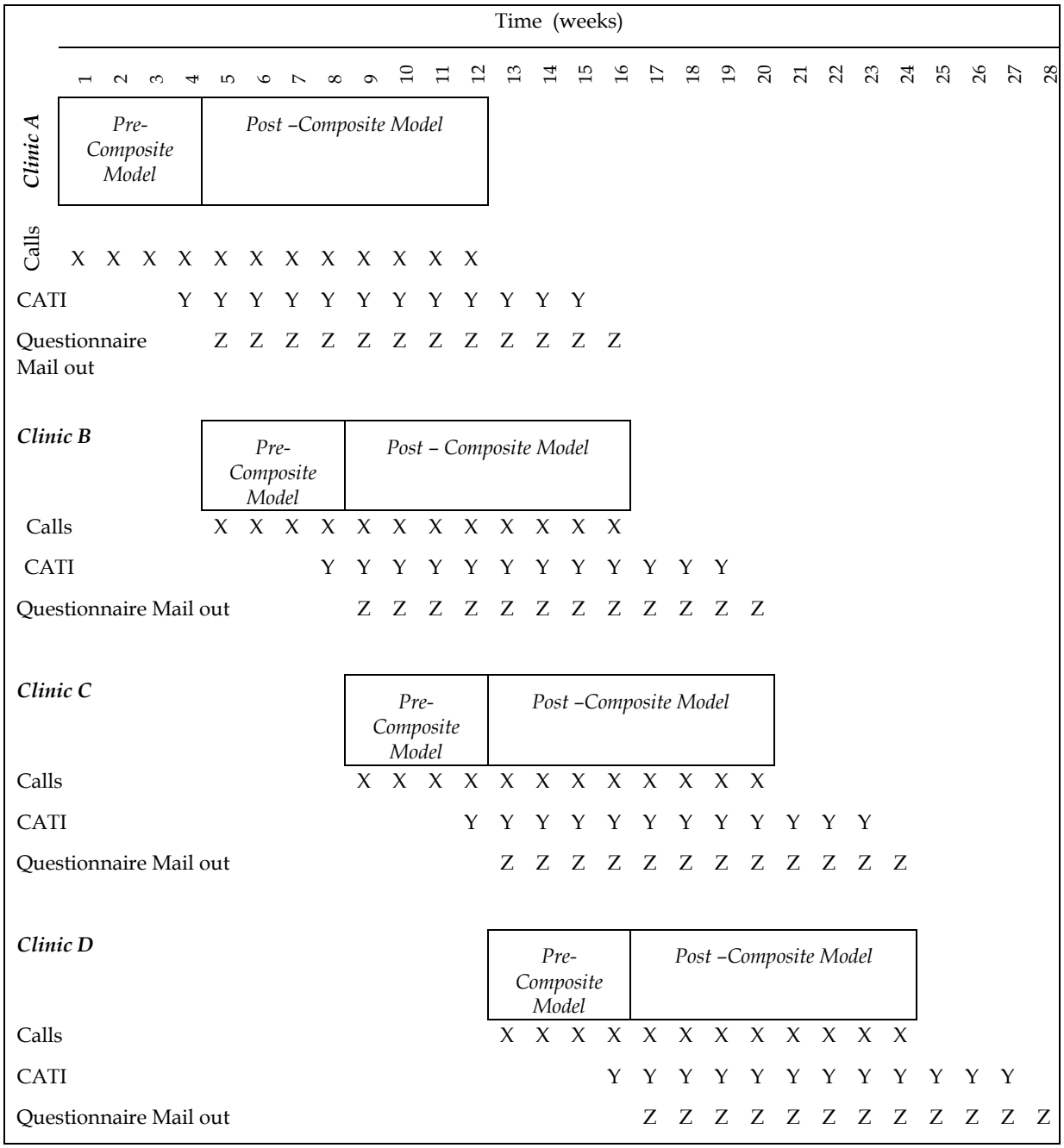
This trial was designed to capture all calls made requesting priority, same-day dental care in the study period. All calls for care by eligible persons were included in the sample. A record of all calls to the clinics was made. Clinics were selected by the SA Dental Services to represent regional differences in dental visiting and potentially different oral health profiles of potential participants in each study clinic.

Pre-intervention observations in each clinic ran for four weeks. In the pre-intervention period, reception staff triaged persons calling for care using the receptionist judgement, the traditional method of determining patient priority. Commencement of the pre-intervention observations was staggered between the clinics by four weeks, making a 16-week period of pre-intervention observations. Post- intervention sampling in each of the four clinics ran for eight weeks. Again, commencement of the post- intervention observations was staggered by four weeks, making the post-intervention observation period 16 weeks and a total pre- and post- observation period of 28 weeks (See Figure 6. Planned intervention design.)

All patients calling the test clinics in this period that were eligible for care and met the inclusion criteria were administered the telephone interview questions, the questions comprising the Composite model, by reception staff and each patient call was logged. Dental appointments were allocated based upon the calculation of priority as determined by the Composite model, which used responses to the model questions and their associated coefficients to generate a priority score. Each score carried an association with an urgency category, <48 hours, 2-7 days, 8+ days.

Receptionists then appointed care using the priority score generated by the Composite model and its associated urgency category. All persons classified by the Composite model as not requiring priority care (8+ days) *did not* have an appointment for dental care made but their call *was* logged. If a receptionist judged that the category allocated to a patient by the Composite Model was inappropriate and a more or less urgent appointment was deemed to be necessary, then an override of the generated priority score was allowed. Under such circumstances, a case report was filed, patient- symptoms recorded and any other presenting information relevant to the receptionist decision entered into the MIS. Patients were categorised according to the Composite model judgement for the purpose of analysis.

Figure 6. Planned intervention design.



Persons who called for care and reported dental symptoms requiring acutely urgent care were excluded (Table 6.1). These persons were unconditionally given a same day emergency appointment for a potentially life threatening oral health condition. Persons were also excluded from the sample if they were calling to request general dental treatment such as preventive treatment or denture repairs. Other inclusion and exclusion criteria are listed in Table 6.1.

Table 6.1 Inclusion and exclusion criteria for implementation trial

Inclusion criteria	All eligible adult public dental care patients calling seeking access to priority or same day dental care
Exclusion criteria	Persons reporting orofacial trauma or haemorrhage
	Patients calling requesting a check-up, scale and clean
	Patients calling for preventive care
	Fully edentulous patients
	Supported residential facility (SRF) patients
	Patients requesting exclusively denture related problems

6.4.2 Data collection and measures

Data were collect by four methods (see Table 6.2). Staff at all four clinics attended induction sessions informing them of the purpose of the research and the importance of the integrity of the intervention, best practice delivery of the model questions, computer interface training, research protocols and troubleshooting problems. Manuals were provided which outlined rules for inclusion and exclusion for persons calling for dental care, computer interface descriptions and examples of use. Data collection protocols for pre- and post- intervention periods were the same. Some bias in receptionist decision making for traditional triage may have been present due to these induction sessions; however as the intervention involved a series of questions to which they were unaware of the answer combinations required to deliver a priority appointment, it is believed such bias was minimal.

Table 6.2 Data collected during each research stage

Time of data collection	Method	Data collected Pre-implementation	Data collected Post-implementation
Patients first contact	**Receptionist telephone interview**	Name Date of birth UR number Clinic number Date of call to clinic Date of appointment Current residential address Contactable phone number	Composite model questions Name Date of birth UR number Clinic number Date of call to clinic Date of appointment Current residential address Contactable phone number
1-2 weeks after first contact	**Computer assisted telephone interview**	Socio-demographic characteristics Self- reported oral symptoms Access to dental and health care Satisfaction with way problem was handled Self- reported oral health status (better, same, worse)	
Two weeks after CATI	**Mailed questionnaire**	Reported oral symptoms Access to care Perceptions of equity Dental treatment received Dental Goal Attainment Oral health related quality of life (OHIP-14)	
Patient clinic visit	**Treatment /services provided (MIS data)**	Commencement and completion dates Type of care received (priority or general) Services provided (ADA treatment codes)	

6.4.2.1 Receptionist telephone interview

Significant changes were made to front of desk procedures. All SA Dental Service reception computers in each of the test clinics had a purpose-built application with an inbuilt algorithm calculator installed within the existing management information system (MIS). This application transformed the Composite model into a computer aided telephone interview format which could generate an urgency score using participant responses. Telephone systems and headsets were also upgraded to facilitate smooth delivery of the interview and to promote better client service when using the algorithm calculator by enabling a holding queue capacity for persons waiting for their call to be answered. Reception staff required instant access to the calculated urgency score in order to appoint patients in the post-intervention phase. Computer software upgrades to chair-

side computers used by attending dentists was also performed to enable attending dentists to record their clinical assessments of patient priority directly into the MIS.

Upon meeting the basic eligibility criteria for access to public dental care during the trial period, all persons who called requesting priority care or who made an in-person contact were logged in the SA Dental Service MIS. Pre-implementation, receptionists appointed patients using their traditional, non-standardised triage approach. Post- implementation, receptionists appointed patients using the priority category generated by the prognostic model.

Data retrieved from this call were demographic data, residential address and phone number, clinic location and date of both the phone call and date of appointment if an appointment was made. Post-implementation, Composite model question responses were collected as was the sum score from the model calculations and final triage priority score and category generated.

6.4.2.2 Computer assisted telephone interview (CATI)

All eligible patients who called or presented to the clinic requesting priority care during the trial period were re-contacted by telephone within two weeks of their original telephone contact with the clinic to collect further information. Several dental reception staff from the SA Dental Service were employed to conduct this computer assisted telephone interview (CATI). Those patients agreeing to complete the CATI were reminded of the date on which they first made contact with a clinic during the study period, referred to as the 'anchor date'. If participants could recall making that contact, they were then asked to complete the telephone interview. If they reported not remembering contacting the clinic, they were thanked for their time and the call was terminated.

Participants were asked about the outcome of their call to the clinic, if an appointment was allocated as a result of that call, other health care providers that may have been contacted subsequent to contact with the SA Dental Service, satisfaction with the way their dental problem was handled, level of education, and dental insurance status. The interviewers recorded responses directly into the computer using pre-coded response categories. Upon completion of the CATI, participants were also asked if they would

consent to a more comprehensive self-compete mailed questionnaire being sent to their postal address. If the participant agreed, their current postal address was confirmed (See Appendix D).

6.4.2.3 Self-complete mailed questionnaire

A self-complete 'SA Dental Service Evaluation' questionnaire was mailed to consenting participants (see Appendix E). Attached to the front page of each questionnaire was a sticker that listed the date of first call to a study clinic, the anchor date. Participants were asked to refer to the anchor date on this sticker when answering questions relating to temporal sequencing of oral health, symptoms or service contacts.

The questionnaire asked participants about self-reported oral health indicators, satisfaction with experience contacting the SA Dental Service, assertiveness, dental satisfaction scale, general and oral health rating, and psychosocial and oral health impact from the dental problem which prompted them to call the SA Dental Service on the recorded anchor date. Oral health impact was measured using the shortened version of the Oral Health Impact Profile (OHIP-14)[189].

Dental visiting factors (e.g. experiences of previous encounters with the SA Dental Service and length of time the SA Dental Service had been used as a provider of dental services) and ratings of equity and fairness in priority-setting in public dental services were explored.

Assertiveness behaviours were measured using a modified Rathus assertiveness schedule [190]. The modified Rathus Assertiveness Schedule consisted of four items adapted from a 12–item schedule was used to assess patient's ability to assert themselves in situational or in this case clinical circumstances. The four questions were in Likert format and each response category ranged in value from 0–10, 0 representing 'very unlike me' and 10 representing 'very like me'. Responses to the four questions were summed to generate a summary score from which a single mean score could be derived. It was hypothesized that those who rated higher on the scale would be more likely to gain access to dental care pre–implementation of the Composite Model and less likely post–implementation.

A dental goal attainment ladder was used to measure goal attainment. The dental goal attainment scale ladder quantifies a patient's assessment of the extent to which they felt they achieved a self-nominated goal [191]. Using this method, patients were first asked to nominate the 'dental' health goal they had in mind when calling the clinic for care and to subsequently choose a numeric rating of the extent to which they were able to attain that goal. Dental goal attainment was measured using a visual scale, ratings from 0 to top rung of 7, giving scope for scoring 7.5 (Figure 7).

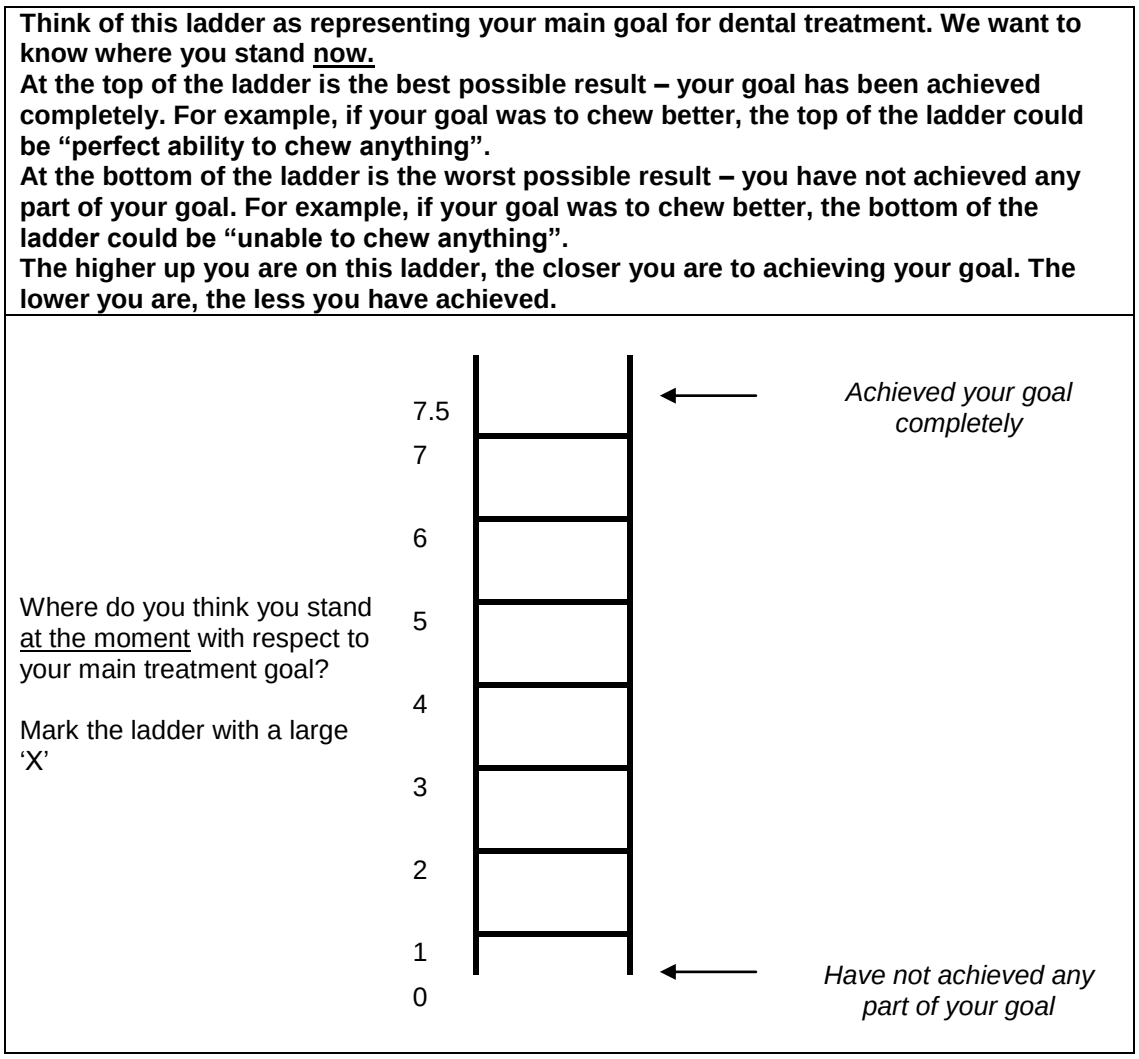


Figure 7. Self-nominated goal and coding of dental goal attainment on a visual scale ladder

The delivery schedule and protocol for the mail questionnaire followed a version of the 'Total Design' methodology proposed by Dillman [192]. The questionnaire was accompanied by a cover letter introducing the research, its objectives and desired outcomes. Up to three reminder letters and/or replacement questionnaires were sent to people who did not return a completed questionnaire.

The questionnaire, cover letters and reminder card are located in Appendices E and F.

6.4.2.4 Service Provision Data

Attending dentists provided treatment according to usual standards of care of the South Australian Dental Service. Pre-implementation this included those judged as urgent by receptionists, post-implementation this included those judged <48 hours and 2-7 days by the Composite model. Additionally, attending dentists rated how long they perceived the patient could have waited for care using three categories of <48 hours, 2–7 days, and 8+days. Dentists were blind to the priority allocated to each patient by the Composite model.

At the end of the combined pre- and post- intervention data collection period, records of treatment provided to study participants by the SA Dental Service were extracted from the MIS.

Service provision data extracted from the MIS related to number of visits made and services provided to complete the course of care and subsequent treatments, visits and courses of care (CoC). Judgements of when a second or subsequent CoC is required are somewhat arbitrary, reflecting current clinical practice. A new CoC can be based on the occurrence of a new dental examination being conducted for a newly defined dental problem or a new treatment plan being generated. CoC were defined using this standard procedure by SA Dental Service staff.

Community clinics in the SA Dental Service are able to outsource public dental treatment to a private dental practitioner, at their discretion. Such treatment of dental problems is provided by means of publically subsidised private dental care and has been included in the service provision analysis.

Treatments were coded using Australian Dental Association (ADA) item numbers [193] (Table 6.3.).

Table 6.3 Ten areas of dental service and associated ADA codes

Area of dental service	ADA Codes
Diagnostic services	Items 011-099
Preventive services	Items 111-199
Periodontal services	Items 211-299
Oral surgery services	Items 311-399
Endodontic services	Items 411-499
Restorative services	Items 511-599
Crown and bridge services	Items 611-699
Prosthodontic services	Items 711-799
Orthodontic services	Items 811-899
General/miscellaneous services	Items 911-979/981-999

System performance data was also extracted from the MIS. Service level data used was percentage of staff time devoted to providing priority or general dental care and emergency dental care.

6.4.3 Analysis

Analysis was done using the Statistical Package for the Social Sciences (SPSS) v15.0 for Windows. Where appropriate, both P values and 95% CI are reported in results. Where overlapping of the reported 95% CI occurred, P value estimates were used as the subsequent indicator of statistical significance[194].

6.4.3.1 Statistical testing

Statistical testing involved the examination of univariate distributions of the primary outcome measures. Statistical testing of the pre- and post- implementation differences in these outcomes was then conducted, followed by analyses, stratified by other co-variates and outcomes for further comparison.

6.4.3.2 Ethical review

Ethical approval for Phase 2 'Relative Needs Index – clinical impact study' was sought from The University of Adelaide's Human Research Ethics Committee who approved the

study on 19 December 2005 (H-158-2005). The researcher completed a SA Dental Service Research, Ethics and Impact Sheet and subsequently SA Dental Service also approved ethical clearance (see Appendix C).

6.4.4 Response rates and attrition

The total number of clinic records received from the SA Dental Service was initially 5326. After duplicates and unusable records (missing critical data) were removed, a yield of 3338 usable records was achieved which then comprised the CATI sampling frame. A total of 2642 SA Dental Service clients completed the CATI of whom 2567 consented to being sent a mailed questionnaire. A yield of 1741 was achieved for the completed mailed questionnaires. See Table 6.4. MIS data was matched to all persons with a returned questionnaire and treatment data were extracted for 1095 of there people. No clients were removed from the sample due to not being able to recall the contact referred to by the interviewer.

Table 6.4 Response rates at each study stage

Study stage	**Total**
First contact- SA Dental Service Records	5326
Usable records	3338
Completed CATI*	2642
Consented to questionnaire	2567
Questionnaire completed	1741
MIS matched data **	1741
MIS matched data - SA Dental Service treatment records	1095

*Computer assisted telephone interview
** Only those with a completed questionnaire had MIS data extracted

6.4.4.1 First contact – generating a sample population

All persons calling one of the four trial clinics were logged to provide the pool of participants for the study for the duration of the project. Data collected from each of the 12-week data collection period at the four trial sites comprised a sample of 5326 unit records. Duplicate person unit records were removed from the data set by matching person unit records on the criteria of time of call, date called and RNI unique record.

Additionally, records missing essential matching data, unique identifiers etc were removed from this sample. This resulted in an in-scope sample of 3338.

6.4.4.2 Computer Assisted Telephone Interview (CATI)

The cleaned first contact sample (usable records) was used as the data set for the CATI (n=3338) (see Table 6.5). The overall yield of completed interviews from the CATI was 2642 (79.1%).

Table 6.5 Listing of all possible initial responses to the CATI

Completed	**2642**
Out of scope	100
Disconnect	136
No answer	197
Answer machine	105
Refusal	156
Not qualified	69
Other	52
Busy	22
Total	**3338**

6.4.4.3 Mail questionnaire

Persons completing the CATI and who consented to being sent a further mail questionnaire (n=2567) were then mailed an in-depth self-complete questionnaire. The overall yield for returned questionnaires was 1741, or 68.4%.

6.4.5 Participant characteristics

Persons who completed *both* the CATI and mail questionnaire (n=1741) comprised the final dataset on which most analyses were conducted. Socio-demographic characteristics of respondents' overall and pre– and post- implementation of the model are reported in Table 6.6.

Table 6.6: Socio-demographic characteristics of respondents

		Pre-implementation* n=728	Post-implementation* n=1013	All n=1741	P
Sex – Female %	CATI	57.8 54.9,60.7	56.6 54.1,59.0	57.1 55.2,59.0	0.278
	Mail Q	57.8 54.2, 61.4	55.9 52.8, 58.9	56.7 54.3, 59.0	0.233
	MIS	57.8 54.2, 61.4	55.9 52.8, 58.9	56.7 54.3, 59.0	0.233
Mean age	CATI	49.8 48.7, 50.9	48.9 48.0,49.8	49.3 48.2,50.0	0.893
Mean age	Mail Q	53.4 52.0, 54.7	53.2 52.2, 54.3	53.3 52.5, 54.1	0.223
	MIS	53.4 52.0, 54.7	53.2 52.2, 54.3	53.3 52.5, 54.1	0.223
English spoken at home %	CATI	71.3	73.3	72.5	0.130
	Mail Q	74.3 71.0, 77.4	76.7 74.0, 79.2	75.7 73.6, 77.7	0.138
	MIS	74.3 71.0, 77.4	76.7 74.0, 79.2	75.7 73.6, 77.7	0.138
+Year 12 %	CATI	24.3 21.8,27.0	25.8 23.6,28.1	25.2 23.5,26.9	0.207
	Mail Q	24.5 21.5, 27.7	24.2 21.6, 26.9	24.3 21.2,25.2	0.182
	MIS	24.5 21.5, 27.7	24.2 21.6, 26.9	24.3 21.2,25.2	0.182
Have private dental insurance %	CATI	6.9 5.6,8.6	6.7 5.5,8.1	6.8 5.9,7.8	0.441
	Mail Q	7.9 6.1, 10.1	7.7 6.2, 9.5	7.8 6.6, 9.2	0.482
	MIS	7.9 6.1, 10.1	7.7 6.2, 9.5	7.8 6.6, 9.2	0.482

* actual numbers per data item may vary slightly due to missing responses

No statistically significant differences in socio-demographic characteristics were shown between pre- and post-Composite Model participants at all stages of the trial indicating that there were no differences or bias in sampling participants before and after the intervention or inherent in participation at each stage.

6.4.6 Participants self-report of their oral problem

Table 6.7 Participants self-report of their oral health problems showed significant changes in the distribution of some of the types of dental problems reported which prompted contact with a dental clinic pre- and post-implementation.

Table 6.7 Participants self-report of their oral health problem

			Pre-implementation % 95% CI	Post-implementation % 95% CI	All N=1740**	P
Reported problem	Pain	%	51.7 48.0, 55.3	55.0 51.8, 58.0	53.6 51.3, 56.0	0.001*
	Broken tooth	%	24.1 21.2, 27.4	24.0 21.4, 26.7	24.0 22.1, 26.1	
	Lost filling	%	9.5 7.5, 11.8	14.0 12.0, 16.3	12.1 10.6, 13.7	
	Other	%	14.7 12.3, 17.5	7.0 5.7, 8.9	10.2 8.9, 11.8	
Self- reported oral health	Good/very good/Excellent	%	30.9 27.6, 34.3	30.1 27.3, 33.0	30.4 28.2, 32.6	0.398
	Poor/Very poor	%	69.2 65.7, 72.4	70.0 67.0, 72.7	69.6 67.4, 71.8	
OHIP	Prevalence†	$\bar{x}$	62.0 58.0-65.0	67.2 64.0-70.0	65.0 62.7, 67.2	0.023*
	Extent††	$\bar{x}$	3.02 2.76-3.28	3.49 3.26-3.72	3.29 3.12, 3.47	0.009*
	Severity score†††	$\bar{x}$	20.6 19.70-21.67	22.2 21.36-23.04	21.57 20.9, 22.2	0.022*

†The '**prevalence'** score was calculated as the % of people reporting 1+ impacts fairly/very often

††The '**extent'** score was calculated as the number of items reported fairly/very often

†††The '**severity**' score (potential range 0–56) was calculated by summing ordinal values for the 14 items. Higher scores indicated poorer oral health and disability.

*χ^2 P<0.05

**Actual numbers per data item may vary slightly due to missing responses

Significant changes were evident in the percentage of persons reporting a lost filling, which increased after the introduction of the Composite model (9.5% *cf* 14.0%) and those persons reporting 'Other' as their main dental problem which decreased after the introduction of the Composite model (14.7% *cf* 7.0%). The increase in people reporting a lost filling may reflect the new triage criteria introduced with the Composite model which captures relative ratings of urgency based on symptoms and impacts. The decrease in undisclosed 'Other' may reflect the more stringent criteria and conditions in accessing

dental treatment after the introduction of the Composite model. Such a decrease may have been due to the effect of advertising in the clinics of the new changes to the way dental clinics would be triaging access to dental care and hence impacting the nature of calls for care. The data indicate a change in the case mix for particular dental problems following implementation of the Composite model.

When asked about their self–reported oral health, overall 69.6% of respondents reported their dental health to be poor/very poor. No significant differences were seen between the proportions of people reporting their oral health was poor/very poor pre- and post-implementation of the Composite model. The reported overall proportion of persons reporting their dental health to be fair or poor (69.6%) are almost triple the current population level estimates of perceived oral health status reported as fair or poor (16% in 2006) [29] . This however is not surprising for the study population is a treatment seeking one for symptomatic oral health disorders.

The OHIP-14 was used to measure oral health impact [83]. This scale evaluates the consequences of oral conditions across dimensions of functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap. Responses to the questionnaire items are made on a five–point ordinal scale ranging from never (coded 0) to very often (coded 4). An OHIP-14 prevalence, extent and measure of impact, severity score, were calculated. Prevalence was measured by calculating the percentage of people reporting 1 or more OHIP-14 impacts fairly often or very often. Extent was calculated as the number of items that were reported very often or fairly often. The overall OHIP-14 severity ranged from 0-56. Those participants who had three or more missing OHIP items or 'don't know' responses were omitted from analysis. For participants with one or two missing OHIP items, the values were replaced with the sample mean for the group. Higher scores indicated poorer oral health and disability. The mean severity score was 21.57. All three measures: prevalence, extent and severity showed significant differences between pre- and post-implementation scores indicating higher impacts from oral health conditions in the post- implementation group.

6.4.7 Receipt of treatment and outcomes

Table 6.8 shows that significant differences exist between the percentage of persons reporting they had received dental treatment pre- and post-introduction of the Composite model, with a reduction post-implementation in the percentage reporting they received dental treatment (74.8 *cf* 65.6%) and a commensurate increase from 25.2% *cf* 34.4% reporting they received no treatment at all. This is no doubt in response to tighter criteria for access to care and the associated shift in management of appointment making.

Significant differences were found pre- and post-intervention between proportions of participants reporting location of the service provider. A significant decrease in the number of people able to access publically subsidised private dental care was seen (23.3 *cf* 17.4%)as well as a significant increase in the proportion of participants reporting access self funded private dental treatment (7.6 *cf* 14.7%).

Over half of all respondents felt they could wait less than two days for care, 36.4% of whom felt they could wait <24 hours only. A significant difference exits between pre- and post- implementation in the assessment of time could have waited for treatment, but no significant difference in categories was evident when using 95% CI as criteria for significance with all categories showing overlapping CIs.

Dental goal attainment was measured on a visual goal ladder and captured a person's perception of attainment of their self-defined dental goal. Dental goal attainment scores were marked on the ladder by participants and ranged from 0.5 to 7.5. The most frequently reported ladder score was 7.5 (13.5%) and the midpoint of distribution of scores was 4.0. The mean goal attainment score was 4.13. A significant difference between pre- and post-implementation mean dental goal attainment score was found, decreasing significantly from 4.43 to 3.91 post-implementation. Decreases in goal attainment are most likely related to reduction in access to treatment and time waited for treatment. Additionally, system wide changes to case mix and criteria for treatment and management of requests for treatment could affect goal attainment scores.

Table 6.8 Participants self-reported experience of treatment and outcomes

			Pre-implementation %	Post-implementation %	All N=1738** %	P
Received treatment	Yes	%	74.8 71.4-77.9	65.6 62.6-68.5	69.4 67.1, 71.6	0.001*
	No	%	25.5 22.1, 28.6	34.4 31.5, 37.4	30.6 28.4, 32.9	
Service provider (for those who received treatment)	SA Dental Service	%	70.2 66.1,74.0	67.9 64.2,71.4	69.8 666.2,71.5	0.001*
	Private - Subsidised		22.2 18.9,26.1	17.4 14.7,20.5	19.0 17.4,21.9	
	Private – not subsidised	%	7.6 5.6,10.2	14.7 12.2,17.6	11.2 9.8,13.5	
Self assessment of time could have waited for treatment	<24 hours		38.6 35.0-42.3	34.8 31.9-37.9	36.4 34.1, 38.7	0.044*
	24–48 days		19.5 16.7-22.6	23.7 21.1-26.4	21.9 20.0, 24.0	
	2–7 days		21.4 18.5-24.6	20.0 17.6-22.6	20.6 18.7, 22.6	
	8–13 days		4.5 3.2-6.3	7.0 5.5-8.7	6.0 4.9, 7.2	
	14+ days		16.0 13.5-19.0	14.5 12.5-16.9	15.2 13.5, 17.0	
Dental goal attainment	mean score	$\bar{x}$	4.43 4.25, 4.60	3.91 3.77, 4.06	4.12 4.01, 4.23	0.001*
Stability in dental problem since approach for care	Better		67.7 64.1, 71.2	59.7 56.8, 62.6	62.7 60.4, 65.0	0.001*
	Same		27.4 24.1, 30.9	28.6 26.0, 31.4	28.1 26.1, 30.3	
	Worse		4.9 3.5, 6.8	11.7 9.9, 13.7	9.1 7.8, 10.6	
Assertiveness			6.25 6.10, 6.39	6.13 6.10, 6.39	6.18 6.08, 6.27	0.238

**Actual numbers per data items may vary slightly due to missing responses

† A score of 10 indicating that dental goal was perceived as being met, a score of 0 indicating that dental goal had not been met

Assertiveness scores range from 0 (totally unlike me) to 10 (totally like me) The Assertiveness Schedule was modified to consist of four items from a 12– item schedule developed by Rathus. Respondents were asked to indicate on a ten-point scale how well they identified with the statements. The scale was scored by summing the responses to obtain a mean score.

*χ^2 P<0.05

ns=not significant

As reported in the literature review, past experience may shape patient satisfaction with services and the significant decrease in goal attainment *for those receiving care* may reflect

the shaping of current experience by past experiences and satisfaction with treatment and services provided. Needs and expectations shape attitudes.

Stability of the dental problem is used as one of the main outcomes of interest as it describes improvement or change in a person's oral health. It is not intended to act as an indicator of treatment received. The data showed that the majority of persons (62.7%) who had contacted a SA Dental Service clinic requesting a same day appointment reported that their dental problem was better, however post-implementation the proportion reporting their dental problem was better fell significantly (67.7 *cf* 59.7%). The proportion of respondents reporting their dental problem was worse rose significantly after the implementation of the model (4.9% *cf* 11.7%). Again, system level changes post-implementation are most likely driving these differences whereby a greater proportion of persons are not receiving any dental treatment and potentially any dental treatment received is minimal due to changed treatment rules in the public system or reduced capacity for the receipt of comprehensive treatment in the private system.

No differences pre- and post- implementation were found in the reporting of high levels of assertiveness although mean assertiveness scores did drop post-implementation but not to a level that was significant.

Significant differences pre- and post-implementation were found for the percentage reporting treatment by the reported oral health problem (Table 6.9). Significant decreases in the percentages receiving treatment were found among those reporting pain, a broken tooth and a lost filling. This result aligned with the overall reduction in the proportion of those receiving treatment post-implementation.

Table 6.9 Percentage of people receiving treatment by reported problem pre- and post-implementation

	% received treatment			
Reported oral health problem	**Pre-implementation 95% CI**	**Post-implementation 95% CI**	**All**	**P***
Pain	78.9 74.3,82.8	69.5 65.5,73.2	73.2 70.2,76.0	0.01
Broken tooth	74.4 67.0,80.5	60.9 54.5,67.0	66.4 61.6,70.9	0.01
Lost filling	79.7 68.1,87.8	63.0 54.5,70.7	68.3 61.6,74.4	0.01
Other	58.2 48.2,67.5	55.9 44.0,67.2	57.2 49.6,64.5	0.77

χ^2 P<0.05

Table 6.10 shows service provider by reported dental problem, pre- and post-implementation for those who received treatment. Although the change pre- and post-implementation in the proportions receiving treatment from the service providers was significant for only one reported dental problem (broken tooth), the results show interesting changes in percentage of people receiving care at specific service provider locations. The proportion of people receiving treatment for pain increased for those receiving unsubsidized private care. Those persons receiving treatment for a broken tooth reduced for those receiving care with SA Dental Service and doubled for those using private, non-subsidized care. A reduced percentage received treatment at a SA Dental Service clinic and those reporting using a private unsubsidized dentist quadrupled amongst those reporting a lost filling. The percentage of persons receiving treatment increased for those receiving unsubsidized care at a private dentist but the proportion reporting receiving subsidized private dental care fell to a third of its previous proportion for those reporting an 'Other' problem.

Table 6.10 Percentage of people receiving treatment from different service providers who reported a problem pre- and post-implementation

		% received treatment			
Reported dental problem	**Service provider**	**Pre-implementation 95% CI**	**Post-implementation 95% CI**	**All 95% CI**	**P***
Pain	SADS	68.2 61.8,73.9	68.1 62.8,73.0	68.1 64.1,71.9	0.38
	Private – subsidised	26.5 21.1,32.6	23.7 19.3,28.7	24.8 21.3,28.6	
	Private- not subsidised	5.4 3.1,9.2	8.2 5.6,11.8	7.0 5.2,9.5	
Broken tooth	SADS	69.5 59.5,77.9	58.4 49.1,67.1	63.5 56.7,69.7	0.04
	Private – subsidised	17.9 11.4,26.9	15.0 9.6,22.9	16.3 11.9,22.0	
	Private- not subsidised	12.6 7.3,20.9	26.5 19.2,35.4	20.2 15.3,26.2	
Lost filling	SADS	82.1 66.8,91.2	69.2 57.0,79.2	74.0 64.8,81.6	0.11
	Private – subsidised	12.8 5.4,27.3	10.8 5.2,20.9	11.5 6.7,19.2	
	Private- not subsidised	5.1 1.3,18.3	20.0 12.0,31.5	14.4 8.9,22.6	
Other	SADS	62.5 37.7,82.1	55.6 25.1,82.3	60.0 40.2,77.0	0.06
	Private – subsidised	31.3 13.6,56.7	11.1 1.5,50.0	24.0 11.2,44.2	
	Private- not subsidised	6.3 0.9,33.6	33.3 11.1,66.7	16.0 6.1,35.7	

*χ^2 P<0.05

Table 6.11 shows the percentage of people receiving treatment among those reporting an impact or not. The table shows a non-significant difference in the percentage receiving dental treatment pre-and post- implementation, although there was an increase in the percentage of people reporting treatment among those with 1 or more impacts and a decrease amongst those people reporting no oral health impacts.

Table 6.11 Percentage of people receiving treatment by reported impact

	% received treatment		
	Pre-implementation 95% CI	Post-implementation 95% CI	P*
Reported an impact - Yes	60.6 56.3,64.8	64.4 60.6,68.8	0.106
Reported an impact - No	39.4 35.2,43.7	35.6 32.0,39.4	

*χ^2 P<0.05

Table 6.12 shows the proportions of people receiving treatment from specific service providers by report of an oral health impact and by service provider type pre- and post-implementation. While the proportions did not vary significantly for those reporting an impact, those proportions of those treated with no impact shifted from the SA Dental Service to private non-subsidized care. For those reporting no impacts, there was a substantial increase in the proportion of persons who received treatment by accessing unsubsidized private dental treatment.

Table 6.12 Percentage of people receiving treatment from different service providers by reported impact pre- and post- implementation

		% received treatment			
Reported an impact	Service provider	Pre-implementation 95% CI	Post-implementation 95% CI	All 95% CI	P*
Yes -impact	SA Dental	65.6 59.3,71.3	68.8 63.6,73.6	67.4 63.5,71.2	0.71
	Private - subsidised	25.7 20.6,31.6	18.7 14.38,23.3	21.7 18.5,25.2	
	Private *not* subsidised	8.7 5.7,13.0	12.5 9.4,16.6	10.9 8.6,13.8	
No impact	SA Dental	75.3 68.2,81.3	64.0 57.0,70.4	69.1 64.2,73.7	0.003
	Private - subsidised	19.9 14.5,26.7	20.3 15.3,26.5	20.1 16.3,24.6	
	Private *not* subsidised	4.8 2.4,9.3	15.7 11.3,21.5	10.7 7.9,14.4	

*χ^2 P<0.05

Table 6.13 presents the stability of the dental problem by whether people received treatment or not. A considerably higher percentage of those who received treatment reported their dental problem better than those who did not receive treatment, pre- or post –implementation. For those who received dental treatment, no differences were found pre- and post-implementation in the reported stability of their dental problem with

similar proportions reporting better, the same, and worse of their dental problem. For those who did not receive any dental treatment, there was a significant decrease in the proportion of people reporting that their dental problem was 'better' and an increase in the proportion of people who reported it 'worse', post- implementation of the Composite model.

Table 6.13 Stability of dental problem (better, same, worse)by received dental treatment, pre- and post-implementation

		Stability of dental problem			
Received treatment		**Pre-implementation 95% CI**	**Post-implementation 95% CI**	**All 95% CI**	**P***
Yes	better	73.0 69.0, 76.7	76.4 72.9, 79.5	74.9 72.3, 77.3	0.431
	same	21.2 19.9, 25.0	17.3 14.5, 20.4	19.0 16.8, 21.4	
	worse	5.8 4.0, 8.2	6.4 4.7, 8.5	6.1 4.9, 7.6	
No	better	46.8 39.4,54.3	38.1 27.1,37.0	36.9 32.7, 41.1	0.001
	same	43.9 36.6,51.4	49.7 44.4, 55.0	47.7 43.5, 52.2	
	worse	9.4 5.8, 14.7	18.5 14.7, 23.0	15.4 12.5, 18.8	

*Chi square test for trend P<0.05

Table 6.14 shows stability of dental problem as represented by better, same or worse by provider type for those received dental treatment. The percentage of people who received treatment from the SA Dental service who reported their dental problem 'better' increased, but this was of borderline significance. There was no significant changes in percentages reporting their dental problem 'better' pre- or post-implementation among those treated in unsubsidized or subsidized in private practices.

Table 6.14 Stability of dental problem by provider type

			Stability of dental problem			
Received treatment			**Pre-implementation 95% CI**	**Post-implementation 95% CI**	**All 95% CI**	**P***
Yes	SA Dental	better	80.1 75.1,84.4	87.2 83.3,90.3	84.0	0.05
		same	15.2 11.5,19.9	9.7 7.0,13.3	12.2 9.8,15.0	
		worse	4.6 2.7,7.8	3.1 1.7,5.6	3.8 2.6,5.6	
	Private - subsidised	better	88.3 80.1,93.4	89.1 81.4,93.9	88.7 83.5,92.5	0.88
		same	7.4 3.614.8	7.9 4.0,15.1	7.7 4.7,12.4	
		worse	4.3 1.6,10.8	3.0 1.0,8.8	3.6 1.7,7.3	
	Private *not* subsidised	better	75.9 57.3,88.0	87.5 77.7,93.4	84.2 75.7,90.1	0.15
		same	20.7 9.6,39.1	12.5 6.6,22.3	14.9 9.1,23.2	
		worse	3.4 0.5,20.8	0.0 -	1.0 0.1,6.7	

*χ^2 P<0.05

Table 6.15 shows Dental goal attainment mean scores pre- and post- implementation for those who did and did not receive treatment. Goal attainment scores were significantly higher among those who received treatment. Post-implementation goal attainment scores were lower for both those treated and not treated. A difference of borderline significance was found for those receiving treatment, where mean scores dropped from 4.91 to 4.54 post-implementation. No difference in mean scores was found for those not receiving treatment.

Table 6.15 Dental goal attainment scores by treatment received

		Dental goal attainment score			
		Pre-implementation 95% CI	**Post-implementation 95% CI**	**All 95% CI**	**P**
Received treatment	Yes	4.91 4.72, 5.10	4.54 4.37, 4.71	4.71 4.58, 4.83	0.001
	No	3.03 2.67, 3.39	2.72 2.49, 2.95	2.83 2.63, 3.02	

*ANOVA P<0.05

That goal attainment scores were similar for SA Dental Service and private non-subsidized pre-implementation. Both were significantly higher than private subsidized care. Post-implementation the goal attainment scores for the SA Dental Service decreased,

while for private practice non-subsidized care the score increased. The goal attainment score for private subsidized care decreased to be further below the two other service providers.

Table 6.16 shows that this result may be indicative of the post-implementation change to treatment policy and the reduction in the number of people receiving a second course of care within the SA Dental Service. Post- implementation policy restricted treatment to providing care only for the presenting problem and not for treatment of other dental conditions. Post- implementation this goal attainment score fell for those who received treatment from the SA Dental Service, but rose for those who received treatment from private dentists without subsidy.

Table 6.16 Dental goal attainment scores by service provider

	Dental goal attainment			
Service provider	**Pre-implementation 95% CI**	**Post-implementation 95% CI**	**All 95% CI**	**P***
SA Dental	4.89 4.67, 5.12	4.63 4.43, 4.83	4.75 4.60, 4.90	0.035
Private *not* subsidised	3.39 2.65, 4.14	3.01 2.52, 3.49	3.12 2.71, 3.53	
Private - subsidised	4.88 4.48, 5.28	5.19 4.83, 5.55	5.03 4.76, 5.30	

*ANOVA P<0.05

6.4.8 SA Dental Service system performance

Table 6.17 shows the pre- post- implementation differences in the location of service provider for those receiving dental treatment. Overall there was a significant shift in proportions receiving treatment from different service providers. Of those who received treatment, no differences were found in the proportion of those receiving treatment at the SA Dental Service or receiving subsidized care. A significant difference was found amongst those reporting paying to see private dentist, with proportions increasing 7.1% to 13.7%. These figures reflected the shifting criteria for access to dental care post-implementation and changes in demand management strategies. These data are subtly

different from those presented in Table 6.8 because they were collected from the questionnaire some two weeks after the CATI interview which drove the data in Table 6.8.

Table 6.17 System level indicators – service provider

Treatment received		Pre-implementation %	Post-implementation %	All N=1123** %	P
Yes	SA Dental Service clinic care	69.5 64.9,73.8	67.0 62.8,70.9	68.1 65.0,71.0	0.004*
	Private dental care – subsidised	23.3 19.5,27.7	19.3 16.1,22.9	21.1 18.6,23.8	
	Private dental care – not subsidised	7.1 5.0,10.1	13.7 11.0,17.0	10.8 9.0,13.0	

*χ^2 P<0.05
**N reduced due to data reduction occurring when matching questionnaire items

Interestingly a number of persons who reported they had received no care in the CATI subsequently reported they received dental treatment in the mail questionnaire. This increased the number of people who received SA Dental Service treatment who were the focus of the results presented in this section.

Results reported in the bulk of Table 6.18 reflect responses from those participants who received public dental care from a SA Dental Service clinic, excluding the variable regarding number of calls made to the clinics to try to access care. All other variable responses do *not* include those participants who received treatment in private dental practices.

The number of calls made to the clinic significantly increased after the -implementation of the Composite model, increasing from a mean of 1.12 to 1.18 calls. This most likely reflected the increase in refusal rates for a same day priority appointment due to the prognostic model criteria.

No differences were found in the mean number of days waited until a logged appointment or actual logged time waited for treatment. Neither of these measures of timeliness of care differed pre- and post-implementation. When using modal number of days as the measure of timeliness, pre-implementation the modal number of days was zero compared with three and two days respectively for time waited to appointment date and treatment date. This indicates a shift away from same-day appointing to a booking system.

Table 6.18 also shows the percentage agreement with the perceived appropriateness of the time waited until their appointment among those who received an appointment. A significant difference was found for the distribution of responses pre- and post-implementation, with percentages for those 'agreeing/strongly agreeing' that their waiting time until appointment was appropriate dropping after the introduction of the prognostic model (82.3 *cf* 76.1 %) and the proportion of those reporting disagreement to their wait time being appropriate increasing from 17.7 to 23.9 %. This drop in the proportion of people who perceived that their wait time to appointment was appropriate and the increase in time waited for treatment was not surprising as the anticipated effect of the model was the delay or deferring of access to dental care due to altered prioritising and admission procedures and protocols.

Dentist's assessment of urgency differed significantly pre- and post-implementation showing a drop in the proportion of people needing care <48 hours and 8+ days and an increase in the proportion needing care 2-7 days. These data may reflect the predictive accuracy of the Composite model in action when compared to receptionists' assessment of urgency or a level of bias introduced in perception of urgency when the Composite model was implemented.

The highest rate of service type provided for a first course of care, by main service code, was diagnostic services (2.07) followed by surgical services (0.54). Significant differences in the delivery of services were found post-implementation for diagnostic services increasing from 1.97 to 2.17. There was a significant decrease in the percentage of patients accessing urgent treatment receiving a second course of care (15.5 *cf* 7.9%) post-implementation possibly reflecting new access and treatment criteria.

Differences in satisfaction mean scores for handling of the dental problem dropped but this was of borderline non-significance following the implementation of the Composite model (8.21 *cf* 7.35).

No significant difference was found between mean summary scores of experience of the service, treatment and dental environment pre- and post-implementation.

No significant differences were found amongst previous users of the dental service when comparing their visit to their previous encounter indicating that the new prognostic model did not influence the perception of experience of SA Dental Service care.

Table 6.18 Public dental clinic patient treatment profiles, services and perceived timeliness

		Pre-implementation n= 728	Post-implementation n=1013	All % N=1741	P
No. of calls made to the clinic	Mean	1.12 1.08, 1.50	1.18 1.15, 1.21	1.15 1.13, 1.17	0.001
		Pre-implementation	**Post-implementation**	**N=1095[#]**	**P**
Time until appointment date	mean no. of days	5.93 4.58,7.29	5.06 4.31,5.80	5.44 4.71,6.16	0.207
	median no. of days	0 same day	3	1	
Time waited until treatment	mean no. of days	12.1 9.98, 14.3	14.0 8.34, 20.1	11.59 9.84, 16.37	0.529
	median no. of days	0 same day	2 days	1.0	
Was the wait time for an appointment appropriate?	% Agree/ Strongly agree/Neither	82.3 78.3, 85.7	76.1 72.0, 79.8	82.9 80.5, 85.1	0.005
	% Strongly disagree/Disagree	17.7 14.3, 21.7	23.9 20.2, 28.0	17.1 14.9, 19.5	
% Dentists urgency assessment	< 48 hours	17.0 11.8-21.1	10.5 7.9-15.0	13.1 10.5,16.2	0.001
	2-7 days	59.2 55.6-67.9	76.2 70.0-79.7	69.3 65.3,73.1	
	8+ days	22.2 17.4-27.9	13.7 10.4-18.3	17.6 14.6,21.0	
Service type (dental codes) (mean and SE)	Mean no. of Diagnostic	1.97 (1.28)	2.17 (1.38)	2.07 (1.34)	0.013
	Mean no. of Preventive	0.28 (1.13)	0.18 (0.55)	0.22 (0.98)	0.103
	Mean no. of Periodontal	0.01 (0.09)	0.02 (0.21)	0.02 (0.17)	0.212
	Mean no. of Surgical	0.48 (1.16)	0.59 (0.88)	0.54 (1.03)	0.083
	Mean no. of Endodontic	0.08 (0.33)	0.11 (0.46)	0.10 (0.41)	0.404
	Mean no. of Restorative	0.73 (1.22)	0.66 (1.28)	0.69 (1.20)	0.359
Service type (dental codes)	Mean no. of Fixed prosthodontic	0.01 (0.07)	0.00 (0.00)	0.00 (0.05)	0.067
	Mean no. of Removable prosthodontic	0.05 (0.47)	0..02 (0.26)	0.04 (0.38)	0.146
Service type (dental codes cont'd)	Mean no. of General	0.23 (0.87)	0.23 (0.61)	0.23 (0.78)	0.983
% received second course of care?	Yes	15.5 13.1, 18.3	7.9 6.4, 9.7	11.1 9.7, 12.7	0.000**

Table 6.18 (cont'd). Public dental clinic patient treatment profiles, services and perceived timeliness

		Pre-implementation	Post-implementation	N=1095[#]	P
	No	84.5 81.7, 86.9	92.1 90.3, 93.6	88.9 87.3, 90.3	
Satisfaction with handling of dental problem[†]	Mean score	8.21 7.57,8.85	7.35 6.77,7.92	7.71 7.28,8.14	0.052
		Pre-implementation	**Post-implementation**	**All % N=1095*** **	**P**
Summary score of experience*	Mean score	3.58 3.55,3.62	3.55 3.51,3.58	3.56 3.54,3.59	0.147
% Comparison with past SA Dental encounter	Better	25.7 20.2,32.1	27.4 22.5,32.9	26.7 22.9,30.7	0.447
	Same	52.9 46.1,59.6	47.4 41.6, 53.2	47.9 45.3,54.1	
	Worse	21.4 16.4,27.5	25.3 20.5,30.6	23.6 20.1,27.6	

[†] 10 being highly satisfied, 0 being very unsatisfied

*Comparisons scores ranged from 1 (Strongly disagree) to 5 (Strongly agree).

Respondents were asked to indicate on a five-point scale how much they agreed with statements about services, treatment and environment

[#] N = only those patients receiving treatment at SA Dental Service

**ANOVA P<0.05

***Actual numbers per data item may vary slightly due to missing responses

Table 6.19 shows that the proportion of people receiving treatment <48 hours from the SA Dental Service dropped considerably post-implementation from 52.7% to 45.6%. The proportion receiving treatment 2-7 days increased significantly post-implementation rising from 15.3 to 26.0%. There was minimal shift in the number of people who waited 8+ days for treatment.

Table 6.19 Time waited to receive treatment with SA Dental Service

	% of people receiving treatment with SA Dental Service			
Time waited to receive treatment with SA Dental Service	**Pre-implementation 95% CI**	**Post-implementation 95% CI**	**All 95% CI N=1095****	**P***
<48 hours	52.7 48.4,57.0	45.6 41.3,50.0	46.0 43.1,49.0	0.001
2-7 days	15.3 12.4,18.6	26.0 22.6,29.8	20.9 18.6,23.4	
8+ days	32.0 28.2,36.2	34.0 30.3,38.0	33.1 30.4,35.9	

*χ^2 P<0.05

**Includes all people with a logged contact to clinic and who received treatment with SA Dental Service

6.4.9 System outcomes

Staff hours were summed across 2 months pre- implementation and for 6 months post-implementation for all clinics involved in the implementation to assess the capacity of the Composite model to reorient the system away from emergency towards the provision of more preventive, general dental care. These data represent a fully enumerated data set from the SA Dental Service for these clinics across the time periods represented. Table 6.20 shows that overall , the number of hours dedicated to the provision of emergency dental care fell following implementation of the Composite model and the number of hours dedicated to the provision of general, preventive dental care increased for all three two-month post- implementation time periods when compared to pre- implementation hours provided.

Table 6.20 Sum of total staff hours and proportion of staff hours spent on care by care type pre- and post- implementation of the Composite model*

		2 months pre-implementation	1-2 months post-implementation	3-4 months post-implementation	5-6 months post-implementation	All post-implementation
Staff hours (sum total)						
All	Emergency	1206.9	987.1	778.8	954.8	2720.7
	General	858.4	1026.0	1219.1	1366.0	3611.1
% total staff hours						
All	Emergency** (95%CI)	60.2 (57.4,62.9)	47.8	29.8	41.9	39.8 (37.9,41.6)
	General** (95%CI)	39.8 (35.7,42.2)	52.2	70.2	58.1	60.2 (58.6,61.8)

* Time allocated to screening patients has been removed from the analysis
**χ^2= P<0.05 for all pre- vs all post-implementation proportions.

The proportion of general dental care provided by dentists' as measured by percentage of staff hours spent on type of care, pre- and post- intervention for the intervention trial period is also shown in Table 6.20. Overall, the provision of general care as measured by a percentage of staff hours increased after the implementation of the Composite model. This percentage increase represented a substantial difference in the number of people treated and the amount of general, preventive care provided. The percentage of staff hours dedicated to emergency care decreased and the percentage of staff time dedicated to the provision of general, preventive care increased significantly.

6.5 Summary

The analysis conducted on the final sample of respondents showed no significant differences pre- and post- implementation between the two groups. They were similar regarding socio-demographic characteristics such as age, sex, language spoken at home and insurance status.

The two step RNI model was assessed as more accurate than receptionists in predicting dentist assessed urgency of treatment. However, a single step model was developed as a theoretically sounder, more parsimonious model and it incorporated questions which were in keeping with the management approaches of the SA Dental Service. The single Composite model was also more accurate than receptionists in predicting both those who needed care in <48 hours and 2-7 days within the consenting participants in the new test data set. Cut points in the Composite model were set to maximize area under the curve in receiver operator curves against dentist assessed urgency in the new data set.

The Composite model was implemented in a trial in four SA Dental Services clinic in 2006. Pre-implementation data collection was over four weeks, while post-implementation data collection was over eight weeks.

Pre- and post-implementation socio-demographic characteristics of people contacting the clinics for priority treatment were similar. However, post-implementation there were more lost fillings and fewer 'Other' oral health problems being reported, but no change in self-reported oral health. Post-implementation there was also an increase in persons reporting oral health impacts, whether prevalence, extent or severity. There was no difference in assertiveness scores between the groups pre- and post-implementation. There was minimal change in the self-assessment of time that all people seeking priority treatment could have waited for treatment pre- and post-implementation. The post-implementation group was similar in most respects, but fewer reported 'Other' dental problems and overall they had experienced more oral impacts.

Post-implementation a lower percentage of those making contact for priority treatment received any treatment. This decreased from 74.5 to 65.6%. This represented an important

level of 'denial' of priority dental care. Of those who received treatment a slightly lower proportion received their treatment from SADS (67.9 *cf* 70.2%) and private dentists with subsidy (17.4 *cf* 22.2%), while the proportion who received treatment from private dentists with no subsidy increased (14.7 *cf* 7.6%) post-implementation. So in addition to denial, a level of deflection to private dentists for non-subsidized care occurred. In combination this denial and deflection represented an approximate 15% decrease in the flow of 'Emergency' patients into the SA Dental Service. Implementation of the Composite model led to both some denial of care and a defection of care from SA Dental Service into private dental practices in comparison to the receptionist assessment which was the status quo. This was an expected result as the Composite model was set to proportions denied care similar to the proportion of 8+ days wait as assessed by dentists and this proportion was lower than that of receptionists pre-implementation of the Composite model.

As would be hypothesized, there was a decrease in the goal attainment score post-implementation indicating that several weeks after seeking treatment people were further away from their oral health goal. Further, post-implementation a lower percentage of people reported that their dental problem was better and a higher percentage reported it was worse some weeks after making contact for priority treatment.

The percentage who received treatment decreased for most oral health problems being reported. For those reporting pain the percentage receiving treatment decreased, but they were similarly distributed across the different service providers. For those reporting a broken tooth the percentage receiving treatment also decreased, but the proportion receiving treatment with SADS decreased, while the percentage receiving treatment from private dentists with no subsidy increased. For those reporting a lost filling the percentage receiving treatment also decreased, and the proportion receiving treatment with SADS decreased, while the percentage receiving treatment from private dentists with no subsidy increased. For those reporting an Other problem the percentage receiving treatment was similar pre- and post-implementation, but the proportion receiving treatment with SADS and with private dentists with subsidy decreased, while the percentage receiving treatment from private dentists with no subsidy increased. These shifts represent the consequence of the dental problems and their importance in predicting urgency of care within the Composite model.

The percentage who received treatment was higher among those with impacts than without, and this gap widened a little post-implementation. Again this reflected the manner in which impacts are captured in the Composite model and their importance in predicting urgency of treatment need. The distribution of those reporting an impact was similar across service providers pre- and post-implementation.

For those that received treatment both pre- and post-implementation a higher percentage reported their dental problem was better and lower percentage reported it was worse than those who received no treatment. This reflected the appropriateness and effectiveness of treatment provided in addressing the presenting dental problems. The percentage reporting their dental problem was worse was significantly higher post-implementation among those that received no treatment. When stability of the dental problem was assessed among those who received treatment by a specific service provider, the there was no significant difference post -implementation. While goal attainment was higher for those who received treatment than did not, goal attainment fell significantly among those who received treatment post-implementation. Goal attainment fell among those treated by the SA Dental Service, but rose among those treated unsubsidised in private practice.

The number of calls made to the SA Dental Service clinics increased post-implementation, possibly reflecting the advice to those not considered urgent on calling back if dental problems worsened. Within those who received their treatment from the SA Dental Service there was a decrease in the percentage that thought their wait time for treatment was appropriate. Dentist assessed urgency of those treated within the SA Dental Service clinics showed a decreased proportion of people with an urgency of <48 hours and an increased proportion of those assessed as 2-7 days. This coincided with a decrease in the percentage of those treated in SADS who were seen within 24 hours and who waited 8+ days.

There were no significant changes in rates of particular dental services provided, but there was a decrease in the percentage of those treated by SADS who received a second course of treatment. The expressed satisfaction with the way in which their dental problem was handled decreased post-implementation of the Composite model, but this was of borderline significance. However, the summary of their overall experience and

comparison with past experience also remained similar pre- and post-implementation within the group of people receiving treatment from the SA Dental Service. Overall, it seemed that those who got treatment from the SA Dental Service got similar treatment, and reacted to that care in a similar way pre- and post-implementation of the Composite model.

The reorientation of the system as shown by the changes in proportion of staff time and total sum hours of staff time devoted to type of service; emergency or general dental care was an important finding. The shift away from the provision of a majority of emergency dental care towards providing more preventive, general dental care was a key outcome and desired impact of the implementation of the Composite model by the SA Dental Service and represents a positive shift in care for the eligible public.

7 Pre- and post- implementation of the Composite Model: staff perceptions

7.1 Introduction

In addition to testing the effects of the implementation of the Composite model on a person/patient and a system performance level, capturing staff perspectives on issues regarding issues of access and equity was vital to understanding the strengths and weaknesses of the implementation trial and how the prognostic model may perform across a wider community setting. The literature reports that staff support for new priority-setting methods are a core component to the success and outcomes anticipated irrespective of how well calibrated and developed the model [115, 150, 195]. Effects of introducing triage systems for use by gate-keeping staff and the potential for these systems to be undermined in instances where staff were not supportive of the process or its outcomes are described (See Section 2.4.2). Capturing staff perspectives on the Composite model was regarded as imperative in developing a sound understanding of any potential constraints on its ultimate success. Additionally, such research would contribute to the literature in building theory on the impacts and experiences of staff using telephone delivered triage models. Research into staff expectations and experiences with the Composite model was viewed as a vital additional component of this research.

7.2 Objective

This qualitative component of the research was conducted via focus groups. The main objective of the qualitative component of this research was to develop an understanding of the attitudes, experiences and expectations of staff of the SA Dental Service. Of interest were comparisons of perceived pre-implementation issues of the impact of a prognostic model and the actual issues experienced post-implementation of a prognostic model.

7.3 Methods

Eight focus groups were held with SA Dental Service staff; four pre-implementation of the Composite model and four post- implementation of the Composite model, which were completed over a five month period in 2006/2007. The same clinics were used pre- and post- although the staff attending the focus groups may have somewhat differed.

The eight focus groups were organised through the local operations managers for each clinic. All staff rostered to work on reception on the day of the focus groups were encouraged to attend the focus group session and each clinic was closed for business for the duration of the discussions.

All focus groups discussions were digitally recorded after consent was taken from those staff present. Staff were advised that no identifying characteristics would be recorded and that individual participant comments would not be identifiable.

7.3.1 Participant characteristics

The participants were comprised of reception staff that may or may not have also performed dental assisting duties. Three of the focus groups were in metropolitan Adelaide and one at a regional centre. All participants were female and the time worked at SA Dental Service ranged from seven months to thirty years, with a majority having worked for the SA Dental Service for over 10 years.

7.3.2 Focus group protocol

The focus groups pre- implementation of the Composite model addressed what people enjoyed about their work with SA Dental Service and expectations about both positive and negative impacts of the Composite model trial and after implementation reflections on the actual impacts of the Composite model were discussed.

The focus group questions were intentionally not specific in their intent and aimed to provide a theoretical space in which similar findings to those from the literature could emerge if they were deemed important by the participants (See Section 2.4). The focus group questions were designed to broadly address key findings from the literature

regarding triage approaches (See Section 2.4) and to elucidate any thoughts or experiences which may be relevant and allow for new findings or findings specific to dental health, to emerge.

Key themes in the literature relating to staff compliance with new triage protocols and computerised triage systems were used to guide the approach taken to questioning in the focus groups and provided the theoretical foundation for the aims and outcomes of this research phase. These key themes were socially based models of care, flexibility of models, interpretation and management of gatekeeper roles and professionalism.

The aim of the focus groups was to:

1. Explore the attitudes, experiences and expectations of reception and clinical staff and to compare them pre-and post- implementation of the prognostic model.

In addressing this aim, the following outcomes of interest were explored as dimensions of attitudes and experiences:

1. What were the current perceptions of and how important are socially based models of care?
2. How important to staff was flexibility within the system?
3. How did staff interpret and manage their gatekeeper roles?
4. How did staff perceive professionalism?

Focus questions:

Pre-implementation trial

1. How long have you been working for SA Dental and what do you like about working there?
2. What are you looking forward to about the triage tool being introduced into your clinic?

3. What are you *not* looking forward to about the triage tool being introduced into your clinic?

Post-implementation trial

1. Reflecting back to what you said previously about the triage tool (examples given of main findings from pre-implementation interviews) can you describe how you think that it is actually going and what's been achieved?

Digital recordings of the focus groups were transcribed by an independent transcription service. This approach to transcribing was deemed appropriate as thematic analysis methodology, not content or discourse analysis of the recordings was intended for the analysis. Digital transcriptions were uploaded into a computerised coding package called NVivo 8.

7.4 Analysis

Analysis of the focus groups was performed using NVivo8.

A grounded theory approach to analysis was used[196, 197]. The transcribed focus group interviews were read and then coding of the data was undertaken. Coding was done in several stages. Emergent concepts were broadly coded and then recoded into groupings. These grouped concepts were then classified into themes which became apparent during the coding and grouping refinement process. These themes were then analysed for key concepts which could stand alone. Analysis involved use of both deductive and inductive approaches to the data which were informed by both the data and the literature.

7.5 Results

Five key themes emerge in the analysis of the focus group data. All of the themes identified in the literature review were raised by the focus groups and additional themes, specific to the local context of the implementation trial also emerged.

7.5.1 Issues with a computerised approach

The most prevalent issue to emerge from the focus group discussions was a conceptual issue with the computerised or computer-driven approach. Concerns were expressed about computerisation of the decision making process inbuilt into the Composite model and its computer-driven algorithm, effectively removing receptionist responsibility for primary triage and hence change the relationship between gatekeeper and patient and access to urgency public dental care. There were four sub-themes clustered within the computerisation issue: the ability of the system to deliver equity; transparency of decision making and hence support for decision making; the loss of the social model of care; and, the potential learning or gaming of the system by patients over time.

7.5.1.1 Equity

The focus of discussion on equity pre-implementation of the Composite model trial was around the perception that 1) the Composite model would effectively remove inconsistency between decision-making by reception staff and foster consistency in triage decisions between clinics and 2) would engender consistency in maintaining the criteria for access to care between both clinics and receptionists.

> " [if] someone's had a bad weekend or whatever and they're grumpy on the phone, and they don't want to speak to anybody or be compassionate, it won't make any difference and they'll get the same assessment..."

The model would remove the personal element and contain tendencies to feel too much empathy for clients at the expense of demand management and equitable distribution of scare resources:

> "Well it's fairer in the sense that those that have sensitive teeth and just want their fillings done, are kept out. "

> "I find that in terms of equity for people that live in different areas, I think it's great because if it's going to make other areas that I have worked in and that I do work in at the moment, make them more equitable, then I think it's a great thing. I think it's fantastic."

Consistency amongst criteria for access to care was viewed as promoting equity and hence a change for the positive.

Post-implementation, the discussions around equity still maintained their focus on the consistency between clinics and between receptionists. Due to the Composite model, clients could no longer 'shop around' for an appointment after not meeting eligibility criteria at the first clinic they contacted.

> "Before we would say no and they would jump up and down …and go [to another clinic] and they would be given an appointment. Now it is marked [in their file] and they don't get an appointment. So in that sense it is fairer."

However, additional issues of equity post-implementation arose over the perceptions of reception staff that people denied care were not able to be seen and therefore were denied timely access to care. Sometimes this would be in error. This is a natural factor of any triage system that is based on predictive values, to deny some people who do need care, but for staff, the prognostic model could produce outcomes which they viewed as unfair. False negatives and false positives were viewed as problematic to manage as an individual, particularly from an ethical standpoint.

Much discussion was had in the post–implementation trial focus groups about reception staffs' ability to perform a manual 'over-ride' of the computers 'misclassification'. Relating closely to the issue of equity was the issue of using the over-ride function which emerged as a possibility only after the implementation of the Composite model. This was not surprising as technical or system process issues were not focused on prior to implementation and usually broader theoretical issues would be expected to be discussed prior to an implementation.

This over–ride capacity was built into the system as a safety check to allow reception staff the ability to appoint if their professional judgement deemed it necessary. Most agreed that they offered the option of calling back again if a person's condition worsened, but did not generally perform an over-ride to the system unless they felt it was a very serious case:

> "we don't do by-passes of the model very often at [Clinic A] and we try and stick by what's there and what it comes up with. But on occasion we will do it and discuss it with our supervisor to make sure that we are doing the right thing."

There was some confusion about whether or not management was accepting of over-rides and whether staff were able to provide them. This suggested that more effective staff training would be useful to ensure consistency between clinics was maintained.

> "I just, yeah I mean don't know if it's possible, but I just guess I like to see the algorithms shifted a little, so maybe we just get a few more in the 'emergency 24 hour' slots and some of [those denied care] up to a 2–7 days time slot."

Contrarily, it was also felt that people who were seeking access to 'emergency ' appointments for dental problems that were less acute and had the means to pay for private care were more encouraged under the current system to do so than previously:

> "it's helped to screen out those people who are persistent, [presenting a problem that] isn't something that has to be dealt with straight away. But otherwise, most of what we're seeing is, does need to be seen, yes."

> "its reduced the amount of people who just ring up and get an appointment, which was the problem with the previous way."

The Composite model was perceived to have removed an element of entitlement that was thought to previously exist for the provision of treatment of all presenting dental problems irrespective of their urgency and irrespective of the needs of rationing care in a system under pressure from limited resources. The over-ride function allowed reception staff to feel some degree of independence in decision making when the decision made by the Composite model was felt to be incorrect. However, there was expression of general caution in non-clinical staff using this over-ride capacity and often clinicians were used to arbitrate in difficult cases.

> "to most of them you say "if your condition worsens come in or ring back" and I think you only do get ones that are genuine."

Receptionists reported feeling very well supported by management as a consequence of the implementation of the Composite model. As decision making is transparent and consistent under such a triage system, patient protest against being denied access to a dental appointment on the grounds of poor individual judgement on behalf of the receptionist could no longer be made to management. Patients did however have recourse to make further calls to clinics if their conditioned deteriorated and could be offerred an assessment appointment. This led receptionists to feel well backed-up in decision making which, unlike previously when patients could attack the individual staff member and were able to bypass the system by making complaints further up the decision- making ladder within the SA Dental Service. Computerised record keeping of the triage interview, responses and outcomes made referral to records possible and management could

reiterate the decision which the receptionist had made. This support was considered invaluable.

7.5.1.2 Social models of care

Concerns about the delivery of the Composite model prior to its implementation focused on issues around benevolence, compassion, community spirit and empathy for people's circumstances. All these issues were reported post-implementation of the Composite model. Many staff felt that the Composite model would inhibit expression and scope to convey empathy with a client.

> "the biggest concern I have for [the Model] is that you'll lose the sense of dealing with compassion at the level of the patient and there's another structure in the way that's going to block your interaction."

> "It'll just be hard because they'll say you've asked me those questions, you don't know how I feel"

Reception staff felt that despite being supportive of the aims of the trial, it was going to be an emotionally difficult adjustment to make. However, the capacity to suggest that people call back if their condition worsened was viewed as an important feature, as was the ability to over-ride the Composite model allocation of urgency. These were seen not only to aide receptionists to deliver care but also enabled them to some degree to show empathy with clients:

> "it has been a difficult thing overall for receptionists because to move from making the decisions themselves to suddenly relying on this system and feeling sometimes well perhaps this person should be helped and not doing it."

This ability to modify the outcomes of the Model for persons whom the receptionists felt 'got it wrong' aided them to deliver models of care which they perceived to be just.

An unexpected outcome reported post-implementation was the experience of the alleviation of a high degree of personal guilt which came with the responsibility of decision making for access to care:

> "I used to go home at the end of the day and feel guilty and wake up in the middle of the night and go "Oh God."

Many reception staff agreed that the weight of personal responsibility for the gate keeping requirements of the job fell away after the Composite model was implemented. The lack of public outcry following the implementation added to receptionists' feelings of relief, but many still felt they needed to be delivering compassion and respect**,** adhering to what they felt right using their 'clinical' as well as public dentistry principles and adhering to the results generated by the Composite model.

> "You might feel, like I mean the ones that we really feel strongly about we are still appointing and that's not many, but I think for a start, the ones that we feel as though we are turning away you feel terrible about, but it started to surprise me I think overall how well they took it. And you thought, well, obviously their problem wasn't that great or they will say things like, "Oh well, I will just go to my private dentist."

Receptionists often referred to the 'expectation of care' culture they felt had prevailed amongst reception staff within the SA Dental Service as well as clients. Many receptionists reported feeling quite compromised by the constraints on their ability to offer everyone an appointment for care that the Composite model enforced. This attitude suggested a major shift in the demand management capacity of the system after the implementation.

Pre-implementation, reception staff reported looking forward to the introduction of the Composite model in the hope it would diminish 'gaming' and the ability of clients to play upon weaker reception staff. This was perceived by receptionists to be bullying behaviour by care seeking clients and the tendency of less assertive reception staff to acquiesce to such demands, despite the inequity in such a method of urgency-setting. The support of a computerised decision coupled with management backing for that decision made them more secure that gaming behaviour would be reduced. Although brief mention was made by reception staff that patients were learning the system and able to alter responses for a call back, the gaming approach that many report in the literature was not evident from receptionist's reports of people seeking care:

> "What I like the most is like that case this morning, she came up this [person x] that rang up yesterday and then tried to get in today. She came up as a [8+ day], and I knew she wasn't in severe, severe pain you see, so I gave her a non-urgent appointment. Okay, so her mother didn't like it, she didn't like it and she went … higher and ended up with the CEO, who has had to back us because we have offered her a course of care. Finally at last, somebody backs us up. If it comes up as a low priority, their hands are tied in there because it is registered as that and they must back us up.
>
> "I love the back up. It's about time that we had something in writing that backs us."

These feelings were echoed post- implementation and experience supported this perspective:

> "I like it because I don't have to decide what to do with a patient and the model decides it for me and so I don't feel guilty that I haven't put that patient aside and it's all done and that takes that stress away."

The Composite model as a computerised decision making tool was regarded as easy to use, easy to learn, a user-friendly interface that was clear and transparent and perceived to have reduced the time spent asking dentists to make decisions where reception staff were unclear. The ability of people to bully and push their way into the system using various styles of 'gaming' had, according to staff, been significantly reduced.

7.5.2 Demand management

Staff consistently reported pre-implementation of the Composite model that being the gatekeeper for a system under stress with all the pressures and limited resources to meet the demand was difficult. Philosophical issues around 'demand management' were spoken of in terms of putting up more barriers to people seeking care and there was a real concern that the Composite model approach was not 'managing' demand per se but just altering the goal posts:

> "Its one thing to be rationing resources and prioritising but when you start creating barriers that, you know, for the people who arguably are the least able to jump those barriers, I think it's dishonest."

Prior to the implementation of the Composite model, pre-booked appointments for urgency care had never before been offered in the SA Dental Service. The implementation of the Composite model introduced a new system for demand servicing more akin to the private practice dentistry model where same day appointments are used for emergencies only, not relief of pain:

> "the appointment book is great now, you actually feel like you contribute."

Reception staff felt they were seeing more people coming in for preventive treatment and for more general courses of care off the long waiting lists for such care after the Composite model was implemented.

Reception staff also reported that the more demanding, regular users of the SA Dental

Service were not pressuring staff as much following the implementation of the Composite model due to the demand management structures in place and that the morning demand for dental care had eased due to emergency appointments being available to be booked throughout the day. Previously, patients knew to call early in the morning (and were in fact encouraged to call at this time) to try and garner one of the available urgency appointments allocated each day:

> "[before the model] we usually booked them in somewhere .We'd see them even if it was for a short appointment, we'd actually book them in somewhere and see them. Then we weren't really saying "no can't see you, you're on the waiting list".

These comments are in direct contradiction of the SA Dental Service's previous demand management protocols which recommended that only emergency patients be allocated an appointment:

> "[the Composite model] has reduced the amount of people that come in, and are so used to coming to this clinic for a lot of years, and they were all 'Mike, Mike', they want to see Mike. So it cut that down a little bit, you know, as far as just ring up and get an appointment, which was the problem with the previous way."

Previously, a large proportion of reception staff did not feel fully competent to deny those asking for care, access to it. Consequently, preventive services were not able to be provided at a level considered appropriate due to the systems ad hoc approach to urgent dental care. It appeared that the Composite model had implemented a consistent and transparent demand management process where none was perceived to have previously existed at the gatekeeper level.

The issue of fail to attend (FTA) appointments having been flagged as a potential problem by reception staff prior to the implementation of the Composite model was reported after the implementation of the Composite model as still a significant problem. This is a demand management and service provision problem that needs resolving.

Clarification of issues around over-riding the system appeared to not have been resolved after the implementation of the Composite model, with variation among staff as to what were considered to be the rules. Greater attention was needed to ensure that all staff were trained and periodically refreshed on these issues and that they were consistently delivered.

7.5.3 Oral and preventive health

Despite feeling that the Composite model had introduced a level of demand management and a systemic approach to decision-making, there were quite broad concerns about the impact of the new system upon the oral health of the eligible community and access to preventive health care. There was concern about unmet treatment needs from asymptomatic problems which, if left untreated, may become worse and possibly have greater long-term oral health impact for many.

The following quote was from a pre-implementation focus group and illustrated the perceptions about the consequences of lack of effective demand management at the gatekeeper level.

> "we feel that we should be seeing everybody but we don't have the money, we don't have the staff as we've all said, we don't have the dentists to do it, and I acknowledge exactly what you're saying, but if we start seeing everybody that's got a little problem, we don't get anybody off any waiting lists cause all we do all day from 8:30 to 4:30 is see people with little problems."

There existed strong perceptions that many receptionists in the SA Dental Service tried to accommodate everyone calling who wanted to access care. Reception staff felt significant empathy with clients and felt it was neither fair nor just to turn away those people requesting care for 'smaller' dental problems in direct contrast to the concerns illustrated in the text above. Many receptionists reported feeling significant levels of guilt when denying anyone care. At play were issues of the deservedness of those people who are looking to 'do the right thing' and look after their teeth and the lack of affordability for most of private dental treatment. Conversely, many staff felt that many patients seeking urgent care did not want to be booked ahead for general dental treatment.

> "a lot of them only want the emergency work done."

> "they're not used to being able to come for a check-up. They think they have to be in pain all the time"

> "I just can't wait for a low urgency to get to a high urgency and come in for an extraction. They go crazy. 'I told you three months ago I wanted to be seen.'

The quotes above illustrate the perception that those patients who are denied care using the computerised triage who were then triaged to receive care at a later date will be angry that they were only seen once their condition deteriorated.

> "I can't recall too many patients that are not in need of urgent treatment even though you might be able to delay some of that." [pre-implementation]

> "They want to get something fixed up when it happens and my concern is that if sometimes it's better to fix something up when it's small, it's not bad because often by the time they're getting a lot of pain or they've got facial swelling, often that tooth is either beyond repair or the work that you have to do for that tooth is very end stage work, and it's anyway. So if someone's motivated enough to want to get something fixed when it's not so much of an issue then in the long term it's usually better for the tooth and for the person as well." [pre- implementation]

Reception staff were essentially reflecting on changes to the system which acknowledge the realities of funding limitations and the inherent tensions between meeting needs that were considered urgent and fiscal limitations of the system. Receptionists were aware that the Composite model had enabled them to see many more people off the general dental care waiting list than they were previously seeing. Clinics were providing more general preventive care and this outcome reportedly made them feel like their work was worthwhile and valued. Many reported feeling much less guilt and more personal satisfaction as a result of the changes brought about to demand management as a consequence of the introduction of the Composite model.

Clearly, restricting access to only those who had 'relief of pain' or emergency needs was difficult for many reception staff to enforce, particularly after many years of providing service in a particular way and having developed relationships with clients. However, they did recognise that the booking system was better managed following the implementation of the Composite model as it allowed for more preventive treatment to be provided and their empathic approach prior to the introduction of the Composite model which effectively saw almost everyone receiving access to emergency care, did not fit with the capacity of the SA Dental Service to provide appropriate or managed care.

7.5.4 Change to the system

Reception staff were worried by the very structured question and response style that the Composite model necessitated. This was the greatest source of discontent pre-implementation. Reception staff were worried as to how people would respond, under what was perceived as an already emotionally charged circumstance. A social model- of-care delivery, which necessitates personalised interactions and individual responsiveness to patient inquiries was seen to be at risk with the implementation of a computerised model. They were also concerned with the potential disruption to clinic functioning. Prior to the implementation of the Composite model, staff were concerned about how such a radical change in decision making was going to be accepted by clients, particularly those who had been using the SA Dental Service for a long time. Post-implementation, staff were surprised by the level of compliance and goodwill shown by people seeking care with the SA Dental Service toward the new computerized approach. Staff admitted they were careful to deliver the questions in a way which facilitated a more 'social model' of care style of delivery.

> "It's like everything else, it's not perfect, but I think in most ways it works." [post-implementation]

Staff felt that some clients had developed certain expectations about how the SA Dental Service should operate. The Composite model provided staff with more authority to manage patient options and expectations about service delivery as frequent reports about patient demands for times and location frustrated receptionists' ability to manage demand and in some cases receptionists were undermined by varying approaches and tolerance of this practice. The standardisation that this computerised approach afforded was seen to lead to a long term normative change in the expectations of clients and the culture of service delivery within the SA Dental Service.

Of interest was the relative lack of contention from staff about judgement error when using the Composite model or feeling professionally disempowered by the new triage system. The literature had suggested that staff may be put offside when a system such as the Composite model is introduced. It is hypothesised that as the gatekeeping role was already being performed by reception staff and clinical decision making was made chair

side and *not* in the area of triaging patients, that all staff were already culturally well placed to accept such a decision-making intervention.

Additionally, concerns in the literature about clinician de-skilling due to perceptions of, or a real lack of variation in case-mix due to treating only acute conditions and the subsequent experience of boredom by clinicians has not been borne out in this research. Contrarily, clinicians reported feeling more useful treating primarily acute cases and perceived the apparent shift toward providing more preventive care as a reward facilitated by the implementation of the new triage system.

7.6 Summary

Reception staff reported that after the introduction of the Composite model they were still able to express empathy and approach clients in a caring manner, it was just the way in which caring was expressed that had changed. No longer appointing the majority of people seeking care; not just routinely saying 'Yes' to most requests for care was seen to have been replaced by the numbers of people seen from the waiting list for general dental treatment and full courses of care provided. Without swapping this cycle of emergency care with the ability to see people from the waiting list the Composite model would not have been as readily accepted by staff.

The Composite model appeared to have been well accepted by those charged with implementing it, despite prior concerns about possible longer term oral health issues for those patients denied care. Staff appeared to be integrating an alternative set of values into their practices, borne out of the financial constraints of the system and an appreciation that by not limiting access to those in real need of emergency care, the system would never be able to reorient itself to provide more preventive care. The system simply becomes clogged with same day care seekers.

Ad-hoc decision making using various clinical indicators in the past had meant that demand management by the SA Dental Service was not previously successful. By reducing the capacity for receptionist decision-making at the very micro-level and replacing it with a decision tool which is able to be over-ridden using experience and

personal discretion in cases of a perceived incorrect assignment by the computer, the SA Dental Service had been able to standardise decision-making within the system. Such standardisation appeared to have generated a capacity within the system for greater focus on people seeking routine preventively oriented dental care.

The core values which were identified by staff as being valuable in the workplace: caring; empathy; social justice, and provision of care to those who need it appeared to have been left intact to be expressed within the new system. Therefore, the Composite model was not seen as imposing work practices which were unsatisfactory and contradictory to core values. This was essential to supporting work satisfaction and staff retention within the system by supporting those core practices and interactive behaviours which are apparently integral to the delivery of service.

8 Discussion

This evaluation was undertaken at a time when demand management strategies within public dental services in South Australia, and other Australian states and territories, were newly emerging. The research was undertaken in response to an identified need within the public dental services to develop and test a systematic, transparent and fair method of allocating access to priority dental services based on a person's urgency of need for that dental care. The purpose of the research was to develop a prognostic model and to further test the acceptability of such a model in an implementation trial among priority care-seeking public dental patients.

The model testing and further development phase of this research project took nearly three years to complete, due to both the time required to collect the research data and system level delays which were inevitable due to the undertaking of health services research in a 'live' clinic setting. Whilst testing and further developing the prognostic model, various demand management strategies were simultaneously being employed in clinics around South Australia. The implementation of these strategies may account for the documented drop in the proportion of patients receiving emergency care in the year 2005 when compared to several years earlier. A primary aim of this research was to evaluate whether the Composite model, a purpose-built prognostic model, could prioritize people seeking access to urgent, same-day dental care in a manner which was acceptable to clients and staff. It also aimed to document whether system-level changes to the delivery of dental services and reorientation of the dental service to provide more preventive, general dental care could be facilitated through the implementation of such a model.

This chapter presents a discussion of the results of this research. The first part of the chapter addresses the findings from the Composite model building and implementation trial and the second part of the chapter considers the strengths and the limitations of the research with regards to design and methodology. Implications and outcomes of the research are then discussed in relation to their impact on dental service delivery and dental public health.

8.1 Research findings

Validation of the RNI models showed that the models performed with greater accuracy than receptionist's judgment. Further development of the models to derive the Composite model did not alter the models capacity to better predict urgency than receptionist judgment with AUC values for the Composite model showing a 20% higher accuracy in predicting urgency. Additionally, the implementation trial of the Composite model was successful in its primary objective of moving urgency assessments closer to those of dentists and reorienting the SA Dental Service to provide more general, preventive dental care. Post-implementation findings showed both denial and deflection of care, but most outcomes showed no or limited change. This research showed that when this prognostic model was used as a tool for prioritizing access to urgent dental care it would aid more effective management of public dental services as measured by the shift to preventive general care provided. This research provided an important understanding of treatment seeking patients in the SA Dental Service and of reception staff prioritizing access to that care.

8.1.1 Composite model testing

The Composite model sample represented a care seeking population of eligible adults. In the context of public dental health where access to services has been limited, the difficulty for reception staff was to triage between persons reporting the same or similar oral health conditions whilst simultaneously managing the distress of those persons requesting care. The Composite model testing showed that it was possible to choose model cut-offs that produced a very similar proportion (39%) of all persons seeking care who were predicted to be in need of urgent care as compared to the gold standard dentist assessment which showed the 'true' proportion to be 40.6%. This compared with the 53% determined to need care within 48 hours by reception staff, representing a 36% greater relative proportion based on the judgement of reception staff.

8.1.2 Prognostic Accuracy

When predicting those who need care, <48 hours, the Composite model performed with lower sensitivity than reception staff, but with higher specificity. The AUC showed a nearly 20% increase in accuracy of the Composite model compared with reception staff.

When predicting those who need care, 2-7 days, the Composite model underperformed when sensitivity was compared with the sensitivity value achieved by reception staff, but outperformed reception staff when comparing specificity. The negative predictive value of the model was higher than that of reception staff but slightly lower when comparing positive predictive value. Additionally, overall performance measures and AUC showed acceptable levels of external validity when tested on a new data set. The clinical credibility, accuracy and transferability of the model was also established. These outcomes suggested that the Composite model was an effective tool for priority setting among persons seeking emergency dental care with the SA Dental Service.

Regarding issues of overall equity and fairness, the Composite model outperformed reception staff in prioritizing care for those persons with more urgent need, hence meeting one of the aims of the research. However, it was important to remember that persons reporting acute need were not included in any of the modelling and modelling was restricted to those persons seeking same day care for relief of pain. Perhaps a reclassification of what is labelled a dental emergency is needed in the dental public health nomenclature as 'relief of pain' is used interchangeably with the status of an 'emergency'.

8.1.3 Implementation trial of the Composite model

The sampling frame for the implementation trial was a similar population of adults seeking access to urgent public dental care at four SA Dental Service clinics. The purpose of the implementation trial was to test whether the Composite model could be considered an acceptable tool in prioritizing demand for urgent dental care from the SA Dental Service. This judgement was dependant on an understanding of oral health problems, satisfaction with dental services and system performance. Self- reported oral health problem was measured and no significant differences in proportions were reported for the three main problems reported; pain, broken tooth and lost filling pre- and post-implementation. Significantly fewer people received treatment with SA Dental Service

post-implementation and overall there was a significant difference in the number of people reporting having received any treatment at all. Some people denied treatment by the SA Dental Service visited private dentists without subsidy, but overall there was a substantial level of denial of care for those not considered urgent. System performance as measured by an increase in the number of staff hours devoted to the provision of general, preventive dental treatment showed that the implementation of the Composite model enabled substantially more resources to be devoted to the provision of preventive, general dental care. System performance was important as the purpose of an oral health care system is "not only to cure and rehabilitate, but also to promote health and prevent disease" [160].

8.1.3.1 Self- reported oral health problem

There was a significant increase in the proportion of people reporting a lost filling as their main dental problem post-implementation and a decrease in those reporting 'Other' as their main dental problem. Post- implementation of the Composite model, the proportion of people who reported pain and received treatment decreased significantly as did those reporting having broken tooth and a lost filling. This suggested that the change in prioritizing protocols impacted upon the decision making of who received care for what kind of oral health problem.

8.1.3.2 Stability of the dental problem

A significant difference was found pre- and post- implementation of the prognostic model in the stability of the dental problem since first approach for care. For those people who did not receive treatment, a significantly greater percentage reported their dental problem was worse. When viewed overall, this result poses few surprises as more people seeking access to care with some level of symptomatic dental conditions post- implementation were denied treatment.

More of those who attended the SA Dental service reported their dental problem was better after the introduction of the Composite model. However this was of borderline significance.

8.1.3.3 Provision of dental treatment

The number of people receiving treatment overall dropped significantly post-implementation. The provision of treatment post-implementation of the Composite model showed some non- significant differences amongst many of the treatment variables measured. Such modest results does not necessarily equate to a poor outcome for the Composite model. When viewed from a service provision perspective changes to case mix do not have to be statistically significant to be meaningful; any shift can be clinically important. A change in the number of courses of care but with no change in service-mix provided still translates into differences in fiscal expenditure. This is especially important if resources are able to be devoted to providing preventive dental treatment post-implementation of the Composite model. It may also indicate increased treatment to those patients with more complex general needs.

8.1.3.4 Prevalence of impact

Prevalence of impact showed a significant increase among people seeking treatment after the introduction of the Composite model. However, of those reporting an impact an even higher percentage post-implementation reported receiving treatment than pre-implementation. Those people who did not report more adverse oral health impacts as measured by OHIP-14 prevalence impact score had a much lower percentage receiving treatment and this percentage decreased post-implementation supporting the predictive accuracy of the prognostic model.

8.1.3.5 Dental goal attainment

Dental goal attainment mean scores dropped after the introduction of the Composite model for those people who *received* treatment, as did mean scores for those receiving *no treatment at all*. Those receiving no care reported lower mean scores than those in receipt of care both pre- and post-implementation. This result was somewhat counter intuitive. This may be explained by those persons who received dental treatment previously presenting with an expectation of treatment for multiple dental problems and not just for the treatment of their main dental problem. However, the introduction of the Composite model was accompanied with a stricter approach to provision of dental treatment and attending dentists were instructed to provide treatment strictly for the presenting clinical condition only and were not to provide care for secondary dental conditions where disease was present or preventive dental treatment. Under these new operational conditions, dental goal attainment may have been curtailed. This finding supported the hypothesis that the restriction of treating only the presenting problem and not the entirety of the oral health condition may have impacted those with better oral health, as care once available, especially simple or preventive measures, was now no longer available. The qualitative findings from the focus group provided further support.

8.1.3.6 Reorientation from emergency to general dental care

The changes to 'case mix' following the introduction of the Composite model allowed for the system to shift away from providing primarily emergency treatment and focus more on providing an increase of preventive dental treatment to the eligible adult population seeking dental care. This was enabled additionally by the new booking system that the Composite model necessitated. Anticipated reductions in the proportion of persons seen as emergency patients as suggested from the Parent Study by Luzzi, et al., appear to have been realistic[24]. However, alternative demand management strategies in place when the implementation was undertaken may have already significantly reduced demand for urgent dental care by way of deferring, delaying or denying access to this care through receptionist assessment. Additionally, discussions with the SA Dental Service suggest that clinic wide strategies for managing excess demand may have led to some under-reporting of the numbers of those receiving emergency dental treatment. Additionally, the loss of one full time equivalent dentist during the intervention trial period is thought to

have reduced the capacity of the system to provide more general, preventive care curtailing expected differences in the provision of general dental care during the study period. When longer term follow up of clinic time devoted to general, preventive care was examined since the Composite model was implemented state-wide a reasonably steady increase in the proportion of time devoted to preventive dental care was seen, increasing from approximately 40% pre-implementation to 60 % of all clinic time. These data suggest long-term capacity of the Composite model to shift and maintain the reorientation towards more preventive care within the system.

The impacts on SA Dental Service clients of the Composite model should not be underestimated. Its' introduction represented a substantial shift in the service's approach to priorities and provision of 'emergency' dental care. A community-wide expectation of somewhat unlimited access to dental services for most dental conditions at several clinics seems to have existed as reported by receptionists in focus group discussions.

8.1.3.7 Design

Table 8.1 lists the stages of development required to validate a prognostic model. This table indicates the need for consideration of each phase of validation suggested in the literature. It is apparent that all suggested key criteria for prioritisation as proposed by McGinn et.al and Beattie and Nelson have been considered in the design, development, implementation and validation, further development and then implementation of the Composite model[198, 199].

Table 8.1 Stages of development and validation for a prognostic model

Stage of development	Rationale	Research strategy	Clinical utility	Model	Phase
Need	Concern for inadequate classification of urgent patients, concern for cost of care and poor outcomes			✓	Development Phase
Initial development	Identify relevant predictors and outcome measures	Literature review, clinical observations, expert clinical opinion, focus groups		✓	Development Phase
Derivation	Determine variables that are most powerful predictors	Sampling strategy, obtain measures, ensure complete follo- up	Proposed model only	✓	Parent study Development Phase
Level 4 validation	Provide preliminary information regarding the stability of the prediction rule for limited, well defined population	Stability with stratification of original data set	Needs further validation before clinical usage.	✓	Parent study stratified sample validation
Level 3 validation	Determine if the proposed model is stable for different but similar sample	Prospective, similar sample and processes	May be used for similar patients	✓	Model testing
Level 2 validation	Determine if the proposed model yields similar results for a variety of patients	Prospective with a variety of patients and clinicians. One large study or several smaller studies	May be used in a variety of settings	✓	Model testing again
Level 1 validation	Determine if the proposed model improves clinical practice and changes clinical behaviour. Determine if the use of the rule improves patient outcomes	Prospective studies with a wide variety of subjects and clinicians at least 1 impact study that describes improvement in clinical practice	May be used in wide variety of settings	✓	Community trial

The need, development and derivation stages and Level 4 validation recommended by McGinn et.al all formed key components in the development and initial phase of testing and validation of the Parent study models and subsequently the proposed Composite model[198]. Level 3 validation was achieved in the testing of the Parent study models. Level 2 validation was achieved in the further development and accuracy testing of the

Composite model using two clinics. These were standard clinical dental settings using multiple clinicians and reception staff. Level 1 validation produced results suggesting improved prioritizing procedures for self-reported oral health problems, acceptable receipt of dental services and patient satisfaction and a reorientation of services toward SA Dental Service objectives: the provision of more general dental care in four clinics from both regional and metropolitan areas of SA. Overall, the Composite model can be viewed as having been rigorously tested.

8.1.3.8 Staff satisfaction

In the medical decision-making literature, one of the primary issues in the implementation of any kind of computerised triage-system or prognostic model is the attitude and acceptance of staff towards such an approach. Acceptance of the Composite model appeared to come from the fact that there is some flexibility within the system at both the operator and client level. Not only can individual reception staff over-ride the system and prioritize someone in or out of the system but the client can additionally make a return call and be re-prioritized and possibly allocated an appointment. The findings from the focus group work supports research which shows that some flexibility for individual decision-making in a priority system is paramount if the guidelines are to be adhered to.

Receptionists had unwittingly been contributing to system inefficiencies by clogging the system with their compassion. This resulted from the lack of a standardised, system-wide approach and a management policy that did not allow booking ahead. The resulting bottle-neck in the system with relatively low urgency patients resulted in inefficiencies in service delivery and was additionally compounded by dentists who were providing additional services in a course of care for less acute problems among the 'urgent' patients seen. Training appears to be a key factor in managing and ensuring standardization of the service.

Reception staff reported being very happy with the security the Composite model provided as a compliment to their decision making. Where they felt the Composite model deviated seriously from their personal judgment, they felt supported to over-rule the system. However, most were satisfied to accept the priority made by the prognostic model. Reportedly, this capacity of the system to be flexible and accommodating

considerably reduced professional stress and many felt relieved to not be making what were effectively, clinical decisions. The tendency of reception staff to err on the side of caution when making decisions, evidenced by reception staff's inflated levels of requests judged as urgent and their tendency to acquiesce to more assertive patients was controlled when using the Composite model. This has the potential to free up time and resources which could then be allocated to provide more general, preventive care.

Considerations of justice and fairness that are a central principle of any priority model were also well supported by staff and perceived to be operating under the Composite model. Reception staff in particular perceived the prognostic model to be better able to provide consistency, transparency, fairness and equity than was able to be delivered by receptionists themselves. Decision-making was acknowledged as notoriously subjective and open to manipulation. Additionally, the support provided by higher levels of management and their confidence of the prioritization process was seen as contributing to better staff morale and reduced workplace stress associated with decision-making.

8.2 Limitations

8.2.1 Design

The design for testing the Composite model was a pre- and post- implementation non-randomized study of quasi-experimental design. Ideally, a randomized study would have been conducted to estimate the effectiveness of such an intervention and to determine whether the intervention was causally related to measured differences in the outcomes of interest. However, conducting randomised experiments in health services research is notoriously difficult in testing the effectiveness of policy and in the case of this research was deemed inappropriate by the health service involved.

8.2.2 Gold standard

Using dentists' urgency assessment as the gold standard measure against which all other methods of determining urgency were judged can be viewed as less than optimal as it was a relatively subjective assessment of patient need and its 'correctness' may be open to question. Clinical decision-making in dentistry has expected inaccuracies yet both the oral health and economic costs of a search for absolute diagnostic certainty is not feasible. Using dentists' urgency assessment as a gold standard measure appeared a pragmatic and adequate choice in the context of this research [200-202]. No alternative gold standard measure for clinical need of patients existed.

8.2.3 Fit of the model

It is apparent that the original Parent study models had optimistic sensitivity and specificity values due to over-fitting of the model. This was not unexpected however due to several reasons: 1) the time interval between data capture and model development; 2) the NSW state data were included in model development and oral health profiles of that state are considerably different, and; 3) predictive models like these are notorious for resulting in over-fitted models when used in human populations [127]. If viewed in the context of the rationale and objectives of the SA Dental Service (to reorient the public dental system away from emergency to general preventive care and to do so with the least amount of error) then a lower PV+ and higher PV- achieved when using the Composite model compared with the Parent study Model 1 is desirable. It is perhaps more important to be accurate about identifying those who do not need care (true negatives) than to accurately predict those who do need care (true positives) as the consequences of denying access to those who really need care is, from a distributive justice perspective, more problematic.

Additionally, the decision to combine an empirically derived two-stage model into a single composite model for reasons of parsimony may be questioned. However, the *raison d'etre* of predictive models is to predict outcomes or need with better accuracy and in the case of this research, to predict those needing access to urgent dental care. The transformation from a sequential testing approach, where the second model testing was

based on the result of the first, to a parallel design (a composite model) may be defended further on the grounds of parsimony as parallel tests are faster to implement and produce results with higher sensitivity[203].

8.2.4 Objective measures

No clinically objective measures were used as outcomes for this study. Oral examinations were not conducted to determine pre- or post- implementation clinical differences. All persons presenting at or calling the study clinics were eligible to participate on the condition they met all the criteria for eligibility. As there were two distinct data collection phases in the intervention trial, a CATI and a postal questionnaire, attrition to the sample occurred at both data collection phases. The CATI phase preceded the postal questionnaire and consent was required for both phases. System performance information from the MIS was further restricted to those prioritized to receive SA Dental Service care.

In this research, the Composite model testing phase allowed for testing of the predictive accuracy of the prognostic model. However the implementation trial design did not allow for further testing of predictive accuracy as dentists did not assess the urgency of those persons who were *not* allocated an appointment with the SA Dental Service. The implementation trial data did not allow for an assessment of negative predictive values as those persons not receiving care from the SA Dental Service were not clinically assessed. Hence only positive predictive values of the Composite model could have been calculated in this trial. As predictive values need to be assessed as a pair, the PV+ alone was not calculated and the calculation of predictive values in the test phase was considered adequate.

Using number of contacts as a proxy measure for adverse effects of the system, i.e.to capture those people who were a false negative and needed to re-contact a clinic for an appointment may not be sensitive enough to capture fully the effect of being assessed by the system as not needing care. Capturing more information than number of contacts made to the SA Dental Service may have been appropriate. Although the system had a safety net, the ability to recontact the clinic and re-do the prioritization, there may be perceived barriers to doing so.

8.2.5 Selection bias

A common problem with this type of approach to data collection is the possibility of selection bias. Those persons calling for care in the morning may present with systematic differences in their acute dental needs than those calling for care at other times of the day and therefore may introduce an element of bias into the validation. Additionally, bias may be introduced at this stage of data collection regarding those who *do* and those who *do not* provide consent to participate. However, when the findings of the RNI model testing phase were compared with previous findings from the Parent study, little difference between samples was found, suggesting reasonable comparability.

Derrett et al. cite one of the concerns of rationing to be the potential lack of consideration of the possible outcomes and experiences of those people who fail to meet the set threshold criteria or score, particularly for those groups that fall in the gap between the clinical and if relevant, financial thresholds [204]. In the case of the Composite model, it appears there could be a group of people with denture related problems who may be falling through a gap created by the predominantly 'natural teeth' orientation of the model questions.

8.2.6 Other possible bias

There was disproportionate sampling of women to men in the implementation trial phase (63.8% female) when compared to the distribution of gender amongst the care seeking population in the prevalence study (53.7% female). This over sampling of women may be due to a real difference in gender amongst persons seeking care calling first thing in the morning or it could reflect a trend by reception staff to differentially choose to ask women to participate, effectively ignoring the selection rules. This may have affected the performance and hence the accuracy of the model through the possibility of differences in oral-health problem presentation between the sexes. Differences in prevalence of important predictive variables can alter the accuracy of predictive models. However, in this research it remained unclear what the effects of such potential bias may have been.

8.2.7 CATI sample

The CATI data collection in the Composite model implementation trial included all persons contacting the clinics during the trial period. Non-response attrition occurred at interview. Statistically significant differences existed in the total sample identified by the SA Dental Service and those able to be contacted and who agreed to do the CATI. The first contact sample (n=3338) which was reduced to a CATI sample comprised more females and was younger on average. The CATI sample had a mean age of 49.3 years compared with the sample population mean age of 48.3 years ($P<0.05$). The CATI respondents were not totally representative of the age or sex distribution in the first contact population sample.

8.2.8 Short term follow-up

The short term follow-up of the implementation did not allow establishing whether the changes seen from pre- to post- were robust and would remain over the longer term. Longer term follow up studies would be desirable to compare with the four week baseline data. Additionally, this research phase did not include selection of those persons seeking general, preventive dental treatment, just a selection of adult public dental patients who called one of the four participating SA Dental Service clinics who were seeking same day, priority dental care for relief of pain and only the first five consenting persons calling the clinic were recruited.

8.2.9 Models of care

The literature shows administrative level support for systems of urgency-setting and explicit criteria for allocating appointments based on need, but these findings are somewhat tempered by studies which show considerable distress amongst both patients and staff at the impersonal nature of explicit criteria for patient access to care. The removal of social interactions in determining urgency, as within a social model of care,

remained somewhat of an issue in acceptability[73, 98]. Priority-setting using such decision-making tools, however, does tend to show greatest change in health status for those with highest needs. Quality of life deficits associated with being on lengthy waiting lists are well documented in the medical literature but whether such waiting list problems are improved or ameliorated by a prognostic model facilitated booking system remain unresolved [73].

8.3 Strengths of the Composite model

The Composite model is an empirically derived model and hence has been derived with a gold standard approach to the development of such prognostic models [59, 95,199]. The Composite model used a variety of self-reported indicators which were statistically associated with clinical judgment of urgency of treatment need, such as psycho-physiological and psycho-social characteristics. This approach to using other indicators representative of need and not just traditional clinical indicators appeared challenging to some SA Dental Service staff involved in the research. However, their use as priority indicators was supported by criteria reported by the population who experience oral conditions, difficulty sleeping at night and being worried about the health and appearance of their teeth. In view of this, the criteria can be said to be indicative of patient experiences of oral health problems.

A strength of the Composite model was that its use created consistency in prioritization across patients, clinics, receptionists and time and that when compared with the traditional method of determining patient need for care, receptionist judgment, the Composite model performed with greater classification accuracy against dentist assessed urgency. Such consistency in application of criteria to allow access to care is a fundamental component of the equity and fairness and capacity for timeliness for care afforded by the application of the Composite model. Such application allowed for transparency and fairness in decision-making within and across clinics and as such, some justice for patients can be said to have been achieved through the minimization of differences and inequalities in the system and by allowing persons of similar urgency to wait a comparable time for care.

It has been shown that the Composite model assisted in bringing about a re-orientation of a system that was previously overwhelmingly trapped in a cycle of providing emergency dental care.

Additionally, the Composite model can be easily implemented as it requires limited staff training to use and can yield clinic workloads that are consistent with resources. By selecting thresholds that produce proportions concordant with dentist assessed urgency, it is readily adaptable to SA Dental Service objectives. Importantly, the Composite model was welcomed by the reception staff that used it despite some reservations about its accuracy. Workplace stress for reception staff reportedly arises from the ambiguity between due process and clinical decision-making. The Composite model lifted some of the individual pressure to make good decisions.

A prognostic model is more likely to be adhered to if it has sufficient user friendliness. If not, it will be undermined by those who are supposed to implement it, particularly when a gatekeeper's ability to practice at least an element of a social model of care is restricted. The fact that reception staff liked the Composite model suggested at least a successful short-term implementation. Longer-term success would depend on whether staff see the Composite model producing outcomes which are reflective of their perceptions of the needs of those seeking dental care. Reception staff were supportive of the Composite model and were satisfied with the increase in people recalled off the waiting lists to receive preventive general dental care. If this trend is maintained and more clients began to experience for themselves the availability of more preventive, general care then attitudes towards the Composite model by the patient population may also shift over time.

The influence of deservedness or assertiveness in decision making was reduced by using the prognostic model. The allocation of care was made using a transparent, consistent and automated process. An opportunity to involve perceptions of deservedness still existed with reception staff able to over-ride the system to appoint for those who they feel more worthy. However, the focus group results showed that reception staff indicated they were relieved to have individual judgement about deservedness removed from their tasks and appreciated the impartiality that the predictive model provided. Additionally, these findings support the argument made by Cameron that the approach to dental care by patients and the responses of staff afforded by chronological queuing approaches to

allocation of care contribute to long waiting lists and consistent and systematic approaches to prioritizing helps ameliorate some of the conditions which lead to them [28].

Having the Composite model in place encouraged people to behave in a more objective way and also deflected responsibility away from individual decision-makers and onto the prognostic model, enabling the discussion about an individual's access to care to be more reasoned [143].

8.4 Implications of study findings

This research has shown that a prognostic model is able to more accurately and consistently predict urgency of treatment need among people seeking same day, priority care better than receptionists' judgement. Area under the curve values for the Composite model reached .70 compared with .50 for reception staff. The proportion of general, preventive dental care provided increased after the implementation of the Composite model and reception staff overall were very happy with the new system for prioritizing people calling for same-day dental care.

Providing priority dental care to those identified as needing it most, in a timely and effective manner, provides for a fairer system of distributing access to care.

Many methods aimed at reducing pressure on public dental systems have been introduced in the past: co-payments; changes to eligibility criteria; changes to services provided to name a few. These methods all place barriers in the pathway to access to care in ways which are founded neither in the principle of justice nor according to need and generally fly in the face of efforts and approaches to *improving* service delivery as the primary means to improving population oral health. The Composite model was built to ensure equity of access to scarce resources between care seeking individuals and to prioritise those individuals according to urgency of treatment need.

The traditional method of using receptionist judgment to determine urgency of treatment need lacks an empirical underpinning and has been shown in this research to be consistently less accurate than any of the Models evaluated. The advantages of the

Composite model are its foundation in patient-reported information and empirically derived models which perform at a higher level of accuracy and more consistently across patients, clinics and time[205]. The Composite model requires minimal staff training for its use. Additionally, and possibly most importantly, the Composite model is adaptable to SA Dental Service objectives by selecting thresholds that are consistent with benchmarked patient populations and which yield clinic workloads consistent with available resources. It appears that by implementing a priority setting which has associated in-built wait times attached to scoring that providing care by appointment functions more akin to a private practice model of care.

The decision to maximise either sensitivity or specificity and hence the predictive accuracies of any prognostic model depends upon the relative cost to a health service of a false positive or false negative test result. Higher false positive results lead to 'unnecessary' and expensive treatment for less urgent patients and higher false negative results deny treatment to people with a real need for care. The SA Dental Service accepted the rate of false positives found with the Composite model, deeming a higher rate of true positives to be the most important measure in the context of provision of 'emergency' dental care. Subsequently the Composite model has been used to prioritize all eligible adult public dental patients seeking access to urgent care in South Australia since 2007.

8.5 Future considerations

As this is a prognostic model which relies on the prevalence of oral health conditions among people seeking urgent dental care to remain unchanged, it is recommended that periodic testing of the sensitivity and specificity and predictive values against the gold standard dentists' assessment of urgency be built into the system. Monitoring and maintaining the accuracy of the prognostic model is imperative for the ability of the SA Dental Service to be responsive to changing community oral health and to continue to deliver oral health care in the most appropriate and just manner.

Additionally, some monitoring of the profile of individual call backs for re-assessment and those denied access to care may be prudent and lead to greater understanding of patient needs and potentially help to increase the sensitivity and specificity of the prognostic model in the future. Holes in the 'safety net' may lead to systemic breakdowns in the acceptability and the usefulness of the prognostic model and serve to foster

potentially costly increases in emergency need, due to the consequences of delayed access to care. Prognostic models like the Composite model are sensitive to changes in disease patterns and changes in demographic characteristics of the people it is intended to service. The system would need to ensure that the Composite model maintained its performance to suit the objectives of the system. As the model has been introduced into clinics to aide decision-making about who receives access to care, the performance of the model needs to be monitored periodically to ensure that the categorisation of urgency remains at suitable thresholds.

Many prognostic models reported in the medical literature also provide for some point-of-call telephone health advice for those denied priority access to care [147, 206, 207]. It may be both financially and ethically prudent to provide some such oral health care advice, options and support for those denied care by the prognostic model.

9 Conclusions

This research involved the development, validation, refinement, and trial implementation of a prognostic model for urgency of dental care amongst people seeking same-day or priority care in South Australian public dental clinics.

1. The two sequential prognostic models developed in the parent study were found to be stable when data were stratified and the models re-specified separately for SA and NSW.
2. The two sequential prognostic models also performed with reasonable accuracy in a new set of data from SA Dental Service clinics. However, a single composite prognostic model was favoured for parsimony and pragmatic reasons supported by the SA Dental Service. The single Composite model performed with similar accuracy, much more accurately than the traditional receptionist judgement. The operation of the Composite model was set to produce proportions of people with urgency that matched dentists assessed urgency.
3. When the Composite model was trialled, people seeking urgent care were similar in socio-demographic characteristics. However, post-implementation there was a shift in dental problems reported with more lost fillings and less 'Other' problems and a higher level of reported oral health impacts.
4. Implementation of the prognostic model led to an increase from 25.5 to 34.4% denial of urgent dental treatment by the SA Dental Service. Among those people prioritized for urgent dental treatment by the SA Dental Service fewer were seen in < 48 hours and 8+ days and more 2-7 days after implementation of the prognostic model.
5. The treatment provided to those SA Dental Service patients was similar pre- and post- implementation, with the exception of less additional courses of care post-implementation.
6. Those treated by the SA Dental Service reported similar percentages pre- and post-implementation whose dental problem was better after treatment.
7. Those denied urgent dental treatment with the SA Dental Service either went without treatment or were deflected into seeking care from a private dentist without

subsidy. There was an increase in the proportion who received their treatment from a private dentist without subsidy.

8. A similar percentage of those deflected into seeking their care from a private dentist reported that their dental problem was better but those receiving care from a private dentist reported higher levels of goal attainment than those treated in the SA Dental Service.
9. Those who went without care had lower reported oral health impacts, lower percentages who reported their dental problem was better and lower levels of dental goal attainment that those who were treated.
10. Denial of treatment operated across most presenting dental problems. A similar proportion of people reporting pain were treated pre- and post- implementation in the SA Dental Service. However, the proportion receiving treatment from the SA Dental Service for a broken tooth, lost filling or 'Other' dental problem decreased. A higher proportion received treatment for these three dental problems from a private dentist. These results reflected the questions and their importance in urgency score within the Composite model.
11. Reception staff whose role as gatekeeper had been largely replaced by the algorithm-based prognostic model, reported favourably on the equity, transparency and consistency of the prognostic model.
12. The reception staff's comfort with the prognostic model was related to reduced stress in decision-making but continued ability to exercise their judgement through an over-ride and to provide a 'safety-net' through advice to call back if a dental problem continued or worsened.
13. Reception staff also supported the potential to shift the system focus of the SA Dental Service away from priority care to preventively-oriented general dental care.
14. The system-level performance in terms of staff time in the clinics participating in the implementation trial showed a substantial shift away from priority care to general dental care.
15. The reorientation of system hours dedicated to the provision of preventive, general dental care represented a significant shift toward providing the public with better oral health outcomes into the future.

10 Appendices

Appendix A: Parent Study Questionnaire

Parent Study Questionnaire Independent variables

1. Socio-demographic variables	– Age group – Sex of patient – Born in Australia – Language mainly spoken at home – Maximum education
2. Oral and facial pain symptoms	In the last week, have you had the following problems? – toothache – pain in teeth with cold food or fluids – pain in teeth with sweet food – pain in jaw while chewing – pain in jaw when opening mouth wide – pain in front of ear – burning sensation in tongue or other parts of mouth – shooting pain in face or cheeks – pain or discomfort from denture *Response format: Yes/No*
3. Other oral symptoms	In the last week, have you had the following problems? – mouth ulcers – cold sores – sore gums – bleeding gums – bad breath – dryness of mouth – unpleasant taste – changes in ability to taste – clicking/grating noise in jaw joint – difficulty opening mouth wide *Response format: Yes/No*
4. Activities of daily living impact scale	During the last week, how often have pain discomfort or other problems with your teeth, mouth or dentures caused you to… – have difficulty sleeping – stay home more than usual – stay in bed more than usual – take time off work – be unable to do household chores

	– avoid usual leisure activities *Response format: all the time, very often, fairly often, sometimes, never*
5. Worry/concern impact scale	During the last week, how often have you worried about… – the appearance of your teeth or mouth – the health of your teeth or mouth *Response format: all the time, very often, fairly often, sometimes, never*
6. Other symptoms	In the last week, have you had the following problems? – pain which is worse in the middle of the day – pain at night – swelling on gums – swelling of your face or neck – a lost filling – a lost crown – a broken filling – a broken crown – a loose tooth – a cracked tooth – high temperature *Response format: Yes/No*
7. Other questions	– do you take any regular medication? – have you experienced pain as a result of problems with your teeth, mouth or dentures? *Response format: Yes/No*
8. Dental Anxiety	– Imagine you had an appointment to go to the dentist tomorrow, how would you feel about it? – Imagine you are waiting in the dentists waiting room for your turn in the chair, how would you feel? – Imagine you are in the chair waiting while the dentist gets the drill ready to begin working on your teeth, how would you feel? – Imagine you are in the dentist's chair to have your teeth cleaned. While you are waiting and the dentist is getting out the instruments to be used to scrape your teeth around the gums, how would you feel? *Response format: responses scored from 1 to 5*

Appendix B: Clinic record form

Appendix C: Ethical approvals

RNI Model Testing

Approval for this Model testing phase was granted by The University of Adelaide Human Research Ethics Committee and the SA Dental Service Board of Directors' Research and Ethics Committee.

Patients who consented to participate in the model testing phase were guaranteed an appointment for dental care irrespective of their oral condition. This process was to ensure that to persons calling for a same day appointment were not pre- screened by reception staff thereby introducing an element of bias. It is believed that such guarantee of an appointment to those calling requesting same day care did not prejudice the ability non-participants to access care they may have needed.

RNI Model Intervention trial

Ethical Approvals

The University of Adelaide's Human Research Ethics Committee approved the distribution of the questionnaire entitled 'Understanding Dental Service Utilisation in South Australia – Dental Beliefs, values and attitudes' among RNI participants.

As the collection of data for this involved accessing clinical records and contact details of participants, the SA Dental Service Board of Directors' Research and Ethics Committee gave approval to access the 'EXACT' management information system (MIS) database to obtain the contact details of RNI participants and to obtain information pertaining to subsequent dental visits and dental services received at those visits for these persons. Information collected from the 'EXACT' MIS was transcribed onto a de-personalised database. Consequently, signed consent was not sought for the collection of anonymous data from clinic records.

However, SA Dental Service Board of Directors' Research and Ethics Committee determined that the CATI questionnaire did not need ethics approval as it would be

delivered under the mantle of SA Dental Service standard procedure and interviews were conducted by SA Dental Service staff, so no ethical approval was gained from the University of Adelaide. However, the University of Adelaide was aware of the conditions under which the research was taking place.

Appendix D - CATI questions

CATI Questions

To be delivered using computer interface.

Opening script

Hello, I'm from the South Australian Dental Service and I'm calling regarding a phone call [Name on sticker] made to one of our clinics. Can I please speak to [name].

I'd like to ask you a few questions about that call you made on [date inserted] as a part of our review on service quality. There are only 8 questions, do you have a couple of minutes to answer these now?

Q1. Do you recall phoning the clinic on [date on sticker and clinic] for an appointment? **If person can't recall making call then prompt with outcome of the call.**	Yes No – Thank person- ☐1 ☐2
Q2. What was the main dental problem that caused you to ask for that appointment? Was it… **Read choices** *(select one response only)*	☐1 Pain ☐2 A broken tooth ☐3 A lost filling ☐4 Other
Q3. Is that problem? **Read choices**	The same Better Worse ☐1 ☐2 ☐3
Q4. Did you see a dentist for that problem?	Yes No ☐1 Go to Q6 ☐2 Go to Q5
Q5a.Did you see any other health provider for that problem?	Yes No ☐1 Go to Q5b ☐2 Go to Q6
Q5b. What kind of health provider did you see? **Read choices** **Tick all that apply**	☐1 Medical Doctor ☐2 Dental technician ☐3 Hospital ☐4 Other (list) ……
Q6a. Where was that dentist? **Read choices** **Tick all that apply**	☐1 The same SADS clinic -go to 7 ☐2 Another SADS clinic -go to 7 ☐3 Private - Go to Q6b ☐4 Other (list) -go to 7 ……
Q6b. Was that private dentist..? **Read choices. Tick one**	☐1 paid for privately ☐2 paid for by SADS
Q7. On a scale of 0 to 10, where 0 is completely *unsatisfied* and 10 is completely *satisfied*, how satisfied are you with the way your dental problem was handled? (***Circle one***)	0 1 2 3 4 5 6 7 8 9 10
Q8. Do you have dental insurance?	Yes No ☐1 ☐2
Thank respondent	

Appendix E: Postal Questionnaire

Government of South Australia
Central Northern Adelaide Health Service

ARCPOH
Australian Research Centre for POPULATION ORAL HEALTH

THE UNIVERSITY OF ADELAIDE AUSTRALIA

SA DENTAL SERVICE
180 Flinders Street
Adelaide SA 5000
Postal: GPO Box 864, Adelaide SA 5001

SA Dental Service Evaluation
INVITATION TO COMMENT

The SA Dental Service is conducting this questionnaire with The Australian Research Centre for Population Oral Health (ARCPOH) at The University of Adelaide. The aim of the survey is to gain your opinions about the way your dental problem was managed. The SA Dental Service aims to continually improve its services. The feedback you give in relation to the service is valuable and will assist in future planning and provision of services. We would be grateful if you would complete this questionnaire. Please be reassured that your comments will be strictly confidential.

This questionnaire asks about your contact with the SA Dental Services clinic at the time of your call to a SA Dental Service clinic as shown on the sticker below. Please answer all questions on the questionnaire according to the main dental problem that prompted you to call for care on the date as shown on this sticker.

How to answer

Most items are answered by ticking one box that best describes your answer *(Example 1)*

	Strongly disagree	Disagree	Neutral	Agree	Strongly disagree
I was satisfied with the dental care I received.	☐ 1	☑	☐ 3	☐ 4	☐ 5

Other items are answered by circling the number which best describes your response *(Example 2)*

I am quick to express an opinion when it comes to my dental health care needs.

Totally unlike me										**Totally like me**
0	1	2	3	4	(5)	6	7	8	9	10

1

A. The following questions ask about your main dental problem, your experience with the South Australian Dental Service and your perceptions of your health.

A1. What was the <u>main</u> dental problem that prompted you to phone on the date as shown on the sticker? **(Tick one box)**	☐1 Pain **(go to A2)** ☐2 A broken tooth ☐3 A lost filling ☐4 Other (*please specify*) **go to A5** ....
A2. Did you experience this pain with hot or cold food/drinks?	Yes ☐1 No ☐2
A3. Did you experience this pain when chewing?	Yes ☐1 No ☐2
A4. Did you experience this pain at night?	Yes ☐1 No ☐2
A5. From the time of my call, I think I could have reasonably managed with my dental problem for …..	☐1 Less than 24 hours ☐2 24 – 48 hours ☐3 2 –7 days ☐4 8 –13 days ☐5 14 days or more

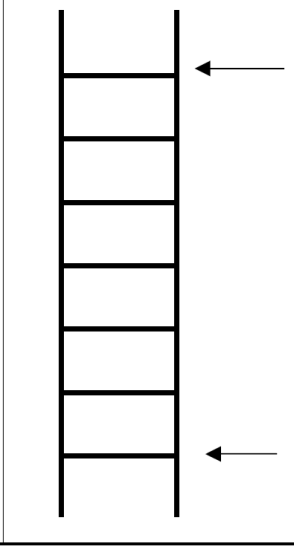
A6. DENTAL GOAL LADDER

Think of this ladder as representing your main goal that you hoped to achieve <u>when you phoned for dental care</u> on the date shown on the sticker on the front page. We want to know where you stand <u>now</u> regarding that goal. At the top of the ladder is the best possible result – your goal has been achieved completely. For example, if your goal was to chew better, the top of the ladder could be 'perfectly able to chew anything'. At the bottom of the ladder is the worst possible result – you have not achieved any part of your goal. For example, if your goal was to chew better, the bottom of the ladder could be 'unable to chew anything'.

The higher up you are on this ladder, the closer you are to achieving your goal. The lower you are on the ladder, the less you have achieved.

Where do you think you stand <u>at the moment</u> with respect to your main dental goal?

Mark the ladder with a large 'X'



Achieved your goal completely

Have not achieved any part of your goal

A7. Were you given an appointment after the phone call you made on... (see sticker on front page of questionnaire)	Yes ☐1 → Go to A8 No ☐2 → Go to A9

A8. The waiting time for an appointment was appropriate for your condition.	Strongly disagree ☐1	Disagree ☐2	Neutral ☐3	Agree ☐4	Strongly agree ☐5

The following questions ask you to compare your experience with SA Dental Service with other service providers you may have encountered recently. If you DO NOT have a doctor or insurance provider please circle the N/A which is located in the box above the scale.

On a scale of 0 to 10 with worse being 0 and 10 being much better, how well were your needs handled by the SA Dental Service compared with…

A9. **…your bank**

SA Dental service was much worse										**SA Dental Service was much better**
0	1	2	3	4	5	6	7	8	9	10

A10. **…your electricity provider**

SA Dental service was much worse										**SA Dental Service was much better**
0	1	2	3	4	5	6	7	8	9	10

A11. **…your doctor**

SA Dental service was much worse				**N/A**						**SA Dental Service was much better**
0	1	2	3	4	5	6	7	8	9	10

A12. **…your insurance company**

SA Dental service was much worse				**N/A**						**SA Dental Service was much better**
0	1	2	3	4	5	6	7	8	9	10

The following questions ask about your perception of your general health and your dental health. Please tick one box that best represents your perception.

A13. How would you rate your **general** health?	Excellent ☐1	Very Good ☐2	Good ☐3	Fair ☐4	Poor ☐5

A14. How would you rate your **dental** health?	Excellent ☐1	Very Good ☐2	Good ☐3	Fair ☐4	Poor ☐5

B. The questions below ask about troubles that people may have in daily life because of dental problems.

Since the date shown on the sticker on the front page, HOW OFTEN …	*Please tick ONE box that best describes your experience*				
B1. … have you had trouble **pronouncing** any **words** because of problems with your teeth, mouth or dentures?	Very Often ☐1	Fairly Often ☐2	Occasionally ☐3	Hardly ever ☐4	Never ☐5
B2. … have you felt that your **sense of taste** has worsened because of problems with your teeth, mouth or dentures?	Very Often ☐1	Fairly Often ☐2	Occasionally ☐3	Hardly ever ☐4	Never ☐5
B3. … have you had **painful aching** in your mouth?	Very Often ☐1	Fairly Often ☐2	Occasionally ☐3	Hardly ever ☐4	Never ☐5
B4. … have you found it **uncomfortable to eat any foods** because of problems with your teeth, mouth or dentures?	Very Often ☐1	Fairly Often ☐2	Occasionally ☐3	Hardly ever ☐4	Never ☐5
B5. … have you been **self conscious** because of problems with your teeth, mouth or dentures?	Very Often ☐1	Fairly Often ☐2	Occasionally ☐3	Hardly ever ☐4	Never ☐5
B6. … have you **felt tense** because of problems with your teeth, mouth or dentures?	Very Often ☐1	Fairly Often ☐2	Occasionally ☐3	Hardly ever ☐4	Never ☐5
B7. … has your **diet been unsatisfactory** because of problems with your teeth, mouth or dentures?	Very Often ☐1	Fairly Often ☐2	Occasionally ☐3	Hardly ever ☐4	Never ☐5
B8. … have you had to **interrupt meals** because of problems with your teeth, mouth or dentures?	Very Often ☐1	Fairly Often ☐2	Occasionally ☐3	Hardly ever ☐4	Never ☐5
B9. … have you found it **difficult to relax** because of problems with your teeth, mouth or dentures?	Very Often ☐1	Fairly Often ☐2	Occasionally ☐3	Hardly ever ☐4	Never ☐5
B10. … have you been a bit **embarrassed** because of problems with your teeth, mouth or dentures?	Very Often ☐1	Fairly Often ☐2	Occasionally ☐3	Hardly ever ☐4	Never ☐5
B11. … have you been a bit **irritable with other people** because of problems with your teeth, mouth or dentures?	Very Often ☐1	Fairly Often ☐2	Occasionally ☐3	Hardly ever ☐4	Never ☐5
B12. … have you had **difficulty doing your usual jobs** because of problems with your teeth, mouth or dentures?	Very Often ☐1	Fairly Often ☐2	Occasionally ☐3	Hardly ever ☐4	Never ☐5
B13. … have you felt that life in general was **less satisfying** because of problems with your teeth, mouth or dentures?	Very Often ☐1	Fairly Often ☐2	Occasionally ☐3	Hardly ever ☐4	Never ☐5
B14. … have you been totally **unable to function** because of problems with your teeth, mouth or dentures?	Very Often ☐1	Fairly Often ☐2	Occasionally ☐3	Hardly ever ☐4	Never ☐5

C. The questions below ask about your last experiences with receiving dental care at either a SA Dental Service clinic or in a private dental practice since the date shown on the sticker on the front page of this questionnaire.

C1. I have received dental treatment for my main dental problem which prompted me to call on [date on sticker]	Yes ☐1 → Go to C2 No ☐2 → Go to Section D				
C2. I was **satisfied** with the dental care I received.	Strongly disagree ☐1	Disagree ☐2	Neutral ☐3	Agree ☐4	Strongly agree ☐5
C3. I would like to have had more **explanation** of my dental treatment **options**.	Strongly disagree ☐1	Disagree ☐2	Neutral ☐3	Agree ☐4	Strongly agree ☐5
C4. The **dental surgery** had everything needed to provide my dental care.	Strongly disagree ☐1	Disagree ☐2	Neutral ☐3	Agree ☐4	Strongly agree ☐5
C5. The dental care I received **did not improve** my dental health.	Strongly disagree ☐1	Disagree ☐2	Neutral ☐3	Agree ☐4	Strongly agree ☐5
C6. I was able to make the dental visit as **promptly** as I felt was necessary.	Strongly disagree ☐1	Disagree ☐2	Neutral ☐3	Agree ☐4	Strongly agree ☐5
C7. The dental professional explained whether there were any patient **costs** and how much before beginning treatment.	Strongly disagree ☐1	Disagree ☐2	Neutral ☐3	Agree ☐4	Strongly agree ☐5
C8. The dental professional I saw explained well what **treatment** was needed.	Strongly disagree ☐1	Disagree ☐2	Neutral ☐3	Agree ☐4	Strongly agree ☐5
C9. I am confident that I received **good dental care** at my last visit.	Strongly disagree ☐1	Disagree ☐2	Neutral ☐3	Agree ☐4	Strongly agree ☐5
C10. There are things about dental care I received that could have been **better**.	Strongly disagree ☐1	Disagree ☐2	Neutral ☐3	Agree ☐4	Strongly agree ☐5

D. The next questions ask about your health behaviours. Please circle a number from 0 to 10 to indicate how well each statement best describes you. Higher numbers indicate a greater level of agreement.

D1. I am quick to express an opinion when it comes to my dental health care needs.

Totally unlike me										**Totally like me**
0	1	2	3	4	5	6	7	8	9	10

D2. I usually think my needs are not as important as other people's needs.

Totally unlike me										**Totally like me**
0	1	2	3	4	5	6	7	8	9	10

D3. If treatment offered is not to my satisfaction, I let the dentist know I am not happy.										
Totally unlike me										**Totally like me**
0	1	2	3	4	5	6	7	8	9	10

D4. If the service received is not to my satisfaction, I complain to dental staff.										
Totally unlike me										**Totally like me**
0	1	2	3	4	5	6	7	8	9	10

E. The next section asks about previous encounters with public dental services. Please indicate your response by placing a tick in the box that corresponds to your answer.

E1.	Prior to the date on the sticker on the front page of this questionnaire, had you ever sought care for a dental problem with the SA Dental Service?	☐1 Yes → **Go to E2** ☐2 No → **Go to Section F**
E2.	Have you previously obtained care for a dental problem at the same clinic as the one shown on the sticker on the front page of the questionnaire?	☐1 Yes → **Go to E3** ☐2 No → **Go to Section F** ☐3 Don't know → **Go to Section F**
E3.	How long have you been attending/using this clinic?	☐1 Less than 1 year ☐2 1 year to less than 5 years ☐3 5 years or more ☐4 Don't know
E4.	Was your most recent encounter with this clinic the same, better or worse than previous encounters?	Same ☐1 Better ☐2 Worse ☐3
E5.	How do you think you were managed this time compared to last time?	Same ☐1 Better ☐2 Worse ☐3

F. The next section asks about your thoughts on appointing visits to public dental services. Please read the statements carefully and indicate your response by circling a number from 0 to 10 to indicate your level of agreement or disagreement. Higher numbers indicate a greater level of agreement.

F1. People who are in the most pain should be given priority access to dental care.										
Totally Disagree										**Totally Agree**
0	1	2	3	4	5	6	7	8	9	10

F2. People who are first to call should be given first access to dental care.										
Totally Disagree										**Totally Agree**
0	1	2	3	4	5	6	7	8	9	10

F3. People who are the most polite should be given priority access to dental care.										
Totally Disagree										**Totally Agree**
0	1	2	3	4	5	6	7	8	9	10

F4. The method used to determine priority for care should be the same at all SA Dental Service clinics.										
Totally Disagree										**Totally Agree**
0	1	2	3	4	5	6	7	8	9	10

F5. Access to dental care shouldn't be easier at some clinics than others.										
Totally Disagree										**Totally Agree**
0	1	2	3	4	5	6	7	8	9	10

F6. A person with dental pain that is affecting their ability to sleep should be given priority.										
Totally Disagree										**Totally Agree**
0	1	2	3	4	5	6	7	8	9	10

F7. A person with dental pain that is affecting their ability to work should be given priority.										
Totally Disagree										**Totally Agree**
0	1	2	3	4	5	6	7	8	9	10

F8. A person with dental pain that is affecting their ability to socialise should be given priority.										
Totally Disagree										**Totally Agree**
0	1	2	3	4	5	6	7	8	9	10

F9. A person with dental pain that is affecting their ability to smile should be given priority.										
Totally Disagree										**Totally Agree**
0	1	2	3	4	5	6	7	8	9	10

F10. A person with dental pain that is affecting their ability to eat should be given priority.										
Totally Disagree										**Totally Agree**
0	1	2	3	4	5	6	7	8	9	10

F11. A person with dental pain that is affecting their ability to talk should be given priority.										
Totally Disagree										**Totally Agree**
0	1	2	3	4	5	6	7	8	9	10

Additional comments would be very welcome. Your co-operation and participation in this survey is greatly appreciated. If you wish to discuss any matter further please contact: Kelly Jones on (08) 8303 4946 or Ali McLean (08) 8303 3291 at the Australian Research Centre for Population Oral Health at The University of Adelaide.

Please feel free to offer additional comments.

Please return this questionnaire in the reply-paid envelope provided to: SA Dental Service Evaluation, Australian Research Centre for Population Oral Health, School of Dentistry, The University of Adelaide, SA 5005.

Office use only: ID:	Date received: / /

Appendix F: Cover letters sent to sample

Initial mailing with questionnaire

Government of South Australia
Central Northern Adelaide Health Service

THE UNIVERSITY OF ADELAIDE AUSTRALIA

SA DENTAL SERVICE
180 Flinders Street
Adelaide SA 5000
Postal: GPO Box 864, Adelaide SA 5001

SA Dental Service Evaluation

We are writing to ask your help with an evaluation of the SA Dental Service. We would like you to complete the enclosed questionnaire that asks about your recent experiences with the Dental Service. The SA Dental Service has engaged researchers at the Australian Research Centre for Population Oral Health at The University of Adelaide to evaluate the results of this study.

We are sending questionnaires to all people who have visited the SA Dental Service in the last 4 weeks in order to understand your experience of the service. The questionnaire is voluntary. However, you can help us very much by taking some time to share your experience. If for some reason you prefer not to respond, please return the blank questionnaire in the enclosed reply-paid envelope. These questionnaires are to be returned directly to the researchers at The University of Adelaide and are confidential. No individual response will be provided to the SA Dental Service. Your response will not affect your future dental care from the SA Dental Service. The results will be released only as summary statistics in which no person can be identified.

The first questions ask about your recent contact with the SA Dental Service. These are followed by questions that ask about how your teeth, mouth or dentures might affect your quality of life. In the middle of the questionnaire we ask people to comment upon their experience of the dental care they received. The last part of the questionnaire asks about your response to dental care, other previous visits to SA Dental Service and your thoughts on public dental care.Thank you very much for helping with this important evaluation. If you have any questions or comments about this questionnaire, please contact Kelly Jones (08) 8303 4946 or Ali McLean (08) 8303 3291 at the Australian Research Centre for Population Oral Health at The University of Adelaide.

Yours faithfully

Ruth Ambler
General Manager, Statewide Dental Services
SA Dental Service

Gary D Slade
Professor of Oral Epidemiology
The University of Adelaide

Reminder card

Government of South Australia
Central Northern Adelaide Health Service

THE UNIVERSITY OF ADELAIDE AUSTRALIA

SA Dental Service Evaluation **A FRIENDLY REMINDER** ...

A short time ago you should have received a questionnaire and a cover letter about a questionnaire asking you to participate in an evaluation of the SA Dental Service. Your participation will make a significant contribution for us to better understand your perceptions of the quality of services and their delivery in public dental clinics in South Australia. This will assist us in finding ways to improve services provided at these clinics.

If you have already returned the questionnaire, please accept our thanks and ignore this notice. If not, please take the time to fill it in and post it back in the reply-paid envelope provided.

If by some chance you did not receive this questionnaire, or it has been misplaced, or you have any questions about the study or the questionnaire, please contact Kelly Jones on (08) 8303 4946 or Ali McLean (08) 8303 3291 at the Australian Research Centre for Population Oral Health at The University of Adelaide.
8303 4946

Ruth Ambler, General Manager
Statewide Dental Services, SA Dental Service

Gary Slade, Professor of Oral Epidemiology
The University of Adelaide

Follow-up letter 1

About four weeks ago we sent an Invitation to Comment questionnaire to you as a part of an evaluation of the South Australian Dental Service. To the best of our knowledge, it has not yet been returned.

The comments of people who have already responded include a wide variety of views. Many have described their experiences, both favourable and unfavourable, and we think the results are going to be very useful to the South Australian Dental Service.

We are writing again because of the importance that your questionnaire has for helping all patients seeking care with the South Australian Dental Service. We are sending questionnaires to all people who have had an encounter with the South Australian Dental Service in the last 4 weeks in order to better understand perceptions of service delivery.
We haven't yet heard from you but we hope to do so as it is only by hearing from everyone that we can be sure that the results are truly representative.

A comment on our survey procedures – an identification number is printed on the sticker on the front of the questionnaire so that we can take your name off the mailing list once the questionnaire is returned. This list of names is then destroyed so that individual names cannot be connected to the results in any way. Protecting the confidentiality of answers is very important to the South Australian Dental Service and to the University.

We hope that you will fill out and return the questionnaire soon, but if for any reason you prefer not to answer it, please let us know by returning a note or the blank questionnaire in the enclosed reply-paid envelope.
Many thanks

Ruth Ambler

General Manager, Statewide Dental Services
SA Dental Service

Gary D Slade

Professor of Oral Epidemiology
The University of Adelaide

Final reminder

Government of South Australia
Central Northern Adelaide Health Service

THE UNIVERSITY OF ADELAIDE AUSTRALIA

SA DENTAL SERVICE
180 Flinders Street
Adelaide SA 5000
Postal: GPO Box 864, Adelaide SA 5001

Final reminder

SA Dental Service Evaluation

Recently we have sent you several mailings asking whether you would be kind enough to complete a questionnaire for the SA Dental Service.

The purpose of the questionnaire is to understand people's experiences regarding their contact with the SA Dental Service.

The study is drawing to a close, and this is the last contact that will be made with people who have approached the SA Dental Service in the last few months. We are sending this final contact letter because of our concern that people who have not responded may have different experiences than those who have. Hearing from everyone that we have approached helps assure us that the survey results are as accurate as possible.

We also want to assure you that your response to this study is voluntary, and if you prefer not to respond, please return the blank questionnaire in the enclosed reply-paid envelope.

If you have any questions or comments about this questionnaire, please contact Kelly Jones (08) 8303 4946 or Ali McLean (08) 8303 3291 at the Australian Research Centre for Population Oral Health at The University of Adelaide.
Yours sincerely

Ruth Ambler

General Manager, Statewide Dental Services
SA Dental Service

Gary D Slade

Professor of Oral Epidemiology
The University of Adelaide

11 References

References are cited using the Vancouver style. Citation of each reference in the text is in the form of a superscripted number that correlates with the source in the reference list. A number is used even if the author(s) is named in the sentence or text. The original number assigned to the reference is reused each time the reference is cited in the text, regardless of its previous position in the text.

When multiple references are cited at a given place in the text, a hyphen joins the first and last numbers that are inclusive.

Citations are according to Vancouver style. Author's surname Initials, Author's surname Initials. Title of article. Title of Journal. [abbreviated] Year of publication Month date; Volume Number (Issue number):page numbers.

Journal titles have been abbreviated in the reference list using PubMed Journals database style.

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