Psychological Determinants of Treatment Adherence in Adults with Cystic Fibrosis

Lisa Kettler
B.A.Hons, M.App.Psych.

Submitted for the award of
Doctor of Philosophy
in the Department of Psychology
University of Adelaide

July 2003

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

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

Dated: 10/7/2003

Abstract

This dissertation demonstrates that adherence to treatment in adults with Cystic Fibrosis (CF) varies significantly between treatments, and is influenced by the beliefs and perceptions that patients hold about both their disease and its treatment.

CF is a genetically inherited, chronic and life-shortening disease, with a complex and demanding daily treatment regimen. Research has demonstrated that many adults with the disease adhere poorly to at least some components of home care and yet the full extent of and theoretical underpinning for poor adherence remain unclear. Difficulties of measurement and definition have hampered research efforts.

In the studies described here, multiple methods of measurement, including electronic monitoring, were used to examine treatment adherence in a group of adults with CF. A new questionnaire measure, the Cystic Fibrosis Perceptions Inventory (CFPI) was developed and used to explore the beliefs and perceptions that adults with CF hold about their disease and its treatment, and the Self-Regulatory Model (SRM; Leventhal, Diefenbach & Leventhal, 1992) was applied to the issue of adherence in this population.

Self-report and electronic monitoring confirmed that some CF treatments that are both complex and time-consuming are managed better than more simple treatments in terms of adherence. Perceptions about the value of treatments and whether the costs of adherence to treatment outweighed the benefits, were significantly associated with self-reported and electronically monitored adherence to several CF treatments. Adherence to less complex treatments was associated with concerns about CF, and heightened attention to the disease and treatment process. The SRM provided a coherent framework for understanding these findings.

Preliminary psychometric data showed the CFPI to be a valid and reliable measure

of health related beliefs and perception about CF, both for adults and a small sample of adolescents with the disease.

These findings contribute to knowledge about the psychological determinants of adherence in adults with CF, and have significant clinical and research implications for the management of CF and other chronic illnesses.

Acknowledgements

I am grateful for the contributions of all of the following people and organisations, towards the successful completion of this research and preparation of this thesis.

My first thanks are to my supervisors Associate Professor Helen Winefield, in the Department of Psychology at the University of Adelaide, and Dr. Hugh Greville, in the Department of Thoracic Medicine at the Royal Adelaide Hospital. Their excellent supervision and assistance in determining the direction and approach adopted for this research have been invaluable. I am grateful in particular for their assistance in the preparation of submissions for grant funding and for reading and editing drafts of this thesis. I am grateful in addition to Dr. Greville for his role in organising practical matters of access to patients through the CF clinic and access to clinical data necessary for this research.

I am grateful for the help and patience of Ms. Rosie Player in the CF clinic at the Royal Adelaide Hospital. Rosie was instrumental in identifying people eligible to participate in this research, booking consultation rooms for me to use for recruitment and ensuring that I could speak with patients without disrupting the smooth running of the CF clinics. Rosie also acted as a reference person in the clinic on occasions when participants needed to return equipment and I was not able to be there.

I would like to thank Associate Professor Susan Sawyer, Deputy Director of the Centre for Adolescent Health at the Royal Children's Hospital in Melbourne, for allowing me to draw on her expertise in this area of research and for her generous informal supervision of the research. I am indebted to Dr. Sawyer for allowing me to use the nebuliser electronic monitoring equipment commissioned by her research team and for negotiating with Dr. Mike Starr on my behalf, for use of the corresponding tablet monitors.

My thanks go to all of the inspirational adults with CF who participated in this

research. My motivation in pursuing this topic of research was an awareness of the extraordinary burden of self-care for people with this illness, and I have been acutely aware of the generosity of those who agreed to participate in this research in addition to their other commitments.

I am very grateful to Roche Products for funding this research and in particular to Ms. Elizabeth Cook, Product Manager for Pulmozyme, for advocating for this research on my behalf and for playing a key role in the facilitation of the collaborative relationship I was able to develop with Associate Professor Sawyer and the Royal Children's Hospital.

I would like to thank Associate Professor John Wilson, and the CF team at the Alfred Hospital for their support of this research. In particular I would like to thank Dennis Leung for all of his recent "on the ground" support, ensuring that the project could go ahead successfully.

I have been fortunate to receive financial support to attend one national and two international CF conferences during my candidature. I am grateful for the support of the University of Adelaide Alumni Association, Mutual Community, the Adelaide Graduate Centre, the Department of Psychology and the North American Cystic Fibrosis Foundation for their financial support to attend the 15th Annual North American Cystic Fibrosis Conference in October 2001. I am also grateful for the support of the Department of Psychology and my supervisor Dr. Hugh Greville for funding assistance to attend the Fourth Australian and New Zealand Conference on Cystic Fibrosis in August 2001. Further, I am grateful to the Faculty of Health Sciences Research Secretariat, the Department of Psychology and Roche Products for financial support to attend the 25th Congress of the European Cystic Fibrosis Society in June 2002.

Attending the international conferences allowed me to discuss my work with two internationally renowned psychologists researching this area; Professor Alexandra Quittner in the USA and Professor Janice Abbott in the UK. I am grateful to them both for their interest in and encouragement for this research and for their hospitality in hosting me in their homes and Universities to learn more about their own research. I would like to thank Professor Quittner for distributing the Cystic Fibrosis Perceptions Inventory, (CFPI, a new questionnaire developed as part of this thesis) to a group of adolescents from Florida.

I am also grateful to Professor Abbott for agreeing to collaborate in follow on research from this thesis by co-ordinating a large UK validation study of the CFPI.

I am deeply indebted to my husband David Kettler for his help in proof reading the text for this thesis, assisting me with data management, preparing the graphs which appear in the text and helping me to format the document. David's personal support and encouragement has been invaluable. Thanks also to both my parents for reading and commenting on aspects of this thesis and for their concern, support and encouragement from the beginning.

Finally, to my children Jennifer and Samuel, for helping me to remember why I started this project in the first place and for their love and patience.

Contents

List of Figures

List of Tables

Chapter 1

Literature Review

1.1 Demographics, aetiology and treatment of Cystic Fibrosis

1.1.1 Incidence

Cystic Fibrosis (CF) is the most common genetically inherited condition among people of North West European descent, affecting approximately one in every 2500 live births in Australia (Sharp, McNeil, Wales, Cooper & Dawson, 1994). One in every 20 to 30 people in this country carries a gene mutation for CF. CF does occur in people from other racial backgrounds, however it is less common, and usually caused by much less frequently observed genetic mutations than those responsible for the condition in people from the most affected racial group (Lewis, 2000).

1.1.2 Physiological process and clinical effects

CF is an autosomal recessive disorder and is due to mutations of the cystic fibrosis transmembrane regulator (CFTR) protein gene (Kerem et al., 1989). Approximately 1000 different mutations of this gene have been identified since the specific genetic mechanism of the disease was first discovered in 1989. The most common mutation of the CFTR protein gene is known as delta F 508, and is the cause of CF in about 70% of cases.

The CFTR protein gene functions mainly as a chloride ion channel in epithelial (lining) cells in the respiratory tract, gastro-intestinal tract and sweat glands. Chloride transport through epithelial cells is essential to their normal function and the mutations of CFTR in CF decrease chloride conductance in the affected epithelia. CFTR also contributes to the regulation of other aspects of cell activity. In CF, the altered CFTR results in both decreased chloride conductance and increased sodium absorption (Davis, 1999).

The abnormal CFTR functioning in the respiratory tract of patients with CF results in the mucus lining the airways becoming thick and viscous. It is then much less readily cleared via the normal mechanisms of cilliary action, or by coughing, the usual mechanical method for clearing excess mucus from the lungs. In time, the abnormal mucus forms plugs that become colonised by bacteria. The usual bacteria most commonly seen in CF respiratory infection are *Staphylococcus aureus* (in early childhood) and *Pseudomonas aeruginosa* (from the second decade onwards). Few people with CF reach adulthood without acquiring *Pseudomonas aeruginosa*, however those who do, often have better lung function measurements (Elborn, 1998). *Pseudomonas* species are present in the environment and may be transmitted from person to person, making it very difficult to avoid infection. *Pseudomonas* can not be eradicated from the airways once it has become established, so treatment is generally directed at minimising the impact of both the bacteria itself and an ineffective immune response of the body.

Regardless of aggressive treatment, infection eventually becomes established, resulting in turn in a chronic inflammatory response from the immune system. The chronic inflammation in turn causes airway damage and a repetitive cycle of fluctuating levels of infection and progressive airway damage ensues (Davis, 1999). Symptomatically, people with CF suffer from a chronic productive cough with large amounts of thick sputum. The mucus plugs can result in partial lung collapse (atelectasis), and infection from blockages in the airways. Rupture of the lung can result in air collecting in the pleural space (pneumothorax) or infection (empyema). Coughing up blood from the lungs (haemoptysis) is not uncommon. With decreasing lung function in the latter stages of the disease, breathlessness and inadequate blood oxygen levels (hypoxaemia) are experienced by many patients. Respiratory failure is responsible for almost all deaths in CF (Phelan, Olinsky &

Robertson, 1994). In addition to the lower respiratory tract problems, upper respiratory inflammation and allergy are often observed in patients with CF.

CF also involves the gastro-intestinal system, where the abnormal function of CFTR results in pancreatic insufficiency. In approximately 85% of people with CF, the flow of pancreatic fluids that contain digestive enzymes is inadequate. The lack of available digestive enzymes leads to malabsorption of proteins, carbohydrates and fats and consequently, the fat soluble vitamins, A, D, E and K. This inadequate digestive process leads to the frequent passage of faecal matter that is greasy, bulky and foul smelling. Inadequate pancreatic function can also lead to bowel obstruction, due to the thick consistency of the bowel contents. This obstruction is known as meconium ileus in infants, and occurs in about 10 to 15% of newborn babies with CF (Phelan et al., 1994). In adults, the bowel obstruction is known as distal intestinal obstruction and is observed in about one fifth of adults with the disease. Many patients with CF also suffer from gastroesophageal reflux. Until the relatively recent development of effective enzyme replacement supplements dramatically improved the ability of people with CF to maintain adequate nutritional status, malnutrition was inevitable in most instances. Difficulties with physical development remain common in CF; specifically, poor weight gain, poor growth and delayed puberty are observed in many individuals.

The abnormal management of salt in the epithelial cells of people with CF results in the loss of excess amounts of salt through sweat and can lead to problems of electrolyte imbalance (Lewis, 2000). The recognition of this excessive loss of salt through sweat lead to the development of the most widely used diagnostic test for CF, the sweat test. Sweat is collected from individuals suspected of having CF and the concentration of sodium and chloride in the sweat is measured against normative data.

Reproductive health is significantly affected in most people with CF. About 98% of men with the disease are infertile due to absence of the vas deferens, while the altered properties of mucus in the reproductive system are implicated in the mildly reduced fertility in women with CF. Fertility can often be further affected in women by poor health overall. With more women living longer into adulthood, more are choosing to have children, however the additional respiratory and nutritional demands of pregnancy can

pose a significant health risk to both the mother and the unborn baby (Sawyer, 2000).

CF can also be complicated by diabetes (Lanng, 2001) and liver disease and there is a growing concern about bone disease associated with prolonged antibiotic use and inadequate levels of calcium and vitamin D, particularly in older patients (Conway et al., 2000).

1.1.3 Psychosocial health

People with CF have relatively good psychosocial health (Shepherd et al., 1990). The incidence of recognisable mental health disorders in those with CF is very similar to the incidence of these disorders in the general population (Blair, Cull & Freeman, 1994). However, high levels of stress and, intermittently, high levels of distress are common and require recognition and attention. Usage of denial and avoidance strategies as coping mechanisms is prevalent among young adults with CF. Moise, Drotar, Doershuk & Stern (1987) noted higher self-esteem, lower levels of psychological distress and better adaptation in those patients using avoidance coping strategies compared with those using more direct and positive coping methods. More recently, Abbott, Dodd & Webb (1995) found that adults with the most serious disease most often reported their health to be better than that of others with CF. As will be discussed later, these findings raise questions about the interactions between treatment adherence and the use of coping strategies which depend on a high level of denial of the disease process and its threats to ongoing health and physical well-being.

1.1.4 Clinical management

Over the past 25 years, significant advances in the management of respiratory infection and pancreatic insufficiency, coupled with better quality of care via specialist multi-disciplinary teams have resulted in a significant improvement in life expectancy for individuals with CF to around 30 years (Elborn, 1998). Many patients with mild disease are now living into their fourth, fifth and sometimes sixth decade. Preventative management and symptomatic treatment is instituted in early childhood for most people diagnosed with CF. As

a consequence, management and treatment routines have been a daily concern over many years for the majority of adult patients.

Better life expectancy has brought with it the challenges of maintaining a complex and time-consuming CF treatment regimen (Quittner, Espelage, Ievers-Landis & Drotar, 2000). For most people with CF, management involves continuous home care with daily prophylactic medications. These may include oral or nebulised antibiotics for infection control, pancreatic enzymes for gastrointestinal and nutritional health, nebulised mucolytic agents to reduce the viscosity of the abnormal mucus, supplementation of fat soluble and other vitamins, as well as daily physiotherapy treatments to assist with airway clearance (Hodson, 1995). Ideal home care also involves optimising dietary choices and eating plans as well as maintaining regular planned exercise routines. Regular (at least once every two to three months) outpatient monitoring is an important review mechanism. From time-to-time, most patients with CF require admission to hospital for intravenous antibiotics and intensive physiotherapy treatment of acute infective exacerbations of their lung disease (Hodson, 1995). Diabetes and liver disease are conditions requiring substantial day-to-day management routines in their own right. End-stage lung disease is addressed in an increasingly large number of patients with bilateral lung transplantation, however transplantation does not reduce the requirement for ongoing self-care and close supervision. Access to psychological support is available in all specialist CF centres in Australia, as is access to social work services to assist in the attainment of educational, financial and independence goals.

In light of the complexity and extent of the treatment requirements for CF and the substantial psychosocial burden of the disease, ongoing adherence to treatments is of significant interest and concern to CF clinicians.

1.2 Adherence to medical regimens

Poor adherence to medical advice and treatment in chronic illness in general is well documented, with reports of patient adherence rarely exceeding 80% and more often falling between 30% and 70% (Meichenbaum & Turk, 1987). The extent to which people ad-

here to recommended treatments appears to depend on the complexity and longevity of both the disease and its treatment. It is common for people to adhere better to treatments in acute illnesses than in chronic illness and further, to adhere better to treatments that are simple and take little time than to treatments which are more complex and time-consuming (Rapoff, 1999). Research results are also influenced by the particular definition of adherent behaviour and the measurement strategies employed (Cluss & Epstein, 1985). In a substantial review of studies on life-threatening disorders (Sackett & Snow, 1979), the mean adherence rate for long-term preventative regimens was found to be only 57% while the mean adherence rate for long term treatments was slightly less again, at 54%.

The consequences of poor adherence, both for individuals and in terms of costs to the health system are significant (Abbott & Gee, 1998). Cluss & Epstein (1985, pg. 404) cited "exacerbation of disability, progression of the disease, more frequent medical emergencies, unnecessary prescriptions of more potent and/or toxic drugs and ultimately, failure of treatment" to be the most important consequences of poor adherence to medical regimens and treatments.

Additional reasons for examining patient adherence include quality assurance and accuracy in clinical trials (Meichenbaum & Turk, 1987) and the collection of accurate data on the efficacy of ongoing treatments. The study of adherence may also allow us to gain a better understanding of patients' health beliefs and behaviour that, hopefully, is a precursor to the design of improved treatment programs and improved relationships between patients and health professionals. This latter goal takes on particular significance in light of the dilemma which exists for health professionals between promoting good psychological health (and perhaps therefore, condoning and accepting denial and avoidance coping strategies) and promoting adherence, which is dependent on attention to and recognition of the disease process and the need to treat it.

1.2.1 Definition of adherence

The terms "compliance" and "adherence" are generally used interchangeably in the literature. However, Meichenbaum & Turk (1987, pg. 20) argue that there is an important

difference between the terms. They refer to the term compliance as "the extent to which patients are obedient and follow the instructions, proscriptions, and prescriptions of health care professionals". In contrast, adherence is defined as an "active, voluntary, collaborative involvement of the patient in a mutually acceptable course of behaviour to produce a desired preventative or therapeutic result" (p. 20). Although this is a useful definition and aids in conceptualising adherence, the definition does not assist in the establishment of criteria used to define adherence behaviours. That is, it does not tell us what someone must do to be considered adherent to a particular therapeutic or preventive regimen. Many studies identify that substantially less than 100% adherence is sufficient to result in desired health changes. Gordis (1976, pg. 52) suggested that a suitable criterion to adopt for adherence behaviours is "the point below which the desired preventative or desired therapeutic result is unlikely to be achieved". Meichenbaum and Turk advocated the need to develop specific criteria based on particular conditions and treatments, rather than adopting general criteria for adherence behaviours. While this appears to be an acceptable criterion, it is only practical for those conditions where it is known how much of any prescribed behaviour is required to produce the desired effect (Meichenbaum & Turk, 1987). The chronic and variable nature of CF with its interdependent components of care and lack of knowledge of 'how much is enough' for most aspects of the CF health care regimen makes the determination of such criterion an ongoing process of adjustment and balance.

Lask (1994) suggested that patients can be described as fully adherent, partially adherent or non-adherent, that is, he differentiated patient adherence using a quantitative approach. He noted that people may be adherent to some components of treatment and not others and cautioned against labelling patients as adherent or non adherent in a global fashion. Koocher, McGrath & Gudas (1990) outlined a different typology of non-adherence, suggesting that non-adherence may be of three types: those who have inadequate knowledge, those who present psychosocial resistance and those who are educatedly non-adherent, that is, have made an informed choice not to adhere. Finally, Lask (1994) suggested that non-adherent patients may be classified on the basis of their behaviour. He described 'refusers', patients who say they don't want or don't need a

particular treatment; 'procrastinators', those who are likely to say they will adhere more in future, but never seem to get around to it and 'deniers', those who will not admit to any non-adherence even when it is known through other means that their adherence is poor.

The descriptive typologies of Koocher et al. (1990) and Lask (1994) have not been subjected to empirical validation and at present represent an anecdotal attempt to recognise quantitative and qualitative differences between patients who do not adhere well to their medical regimens. Further, while highlighting that individual differences in motivation may be present, the typology suggested by Lask could also be interpreted as a "blame the patient" model, as it offers no place for the patient / physician relationship in its view of non-adherence.

Regardless of their limitations, these typologies do highlight the importance of considering various degrees of and motivations for adherence. Unfortunately, much of the experimental literature reports on adherence as a dichotomous construct; one is either adherent or non-adherent. The majority of clinicians may continue to hold a similar view.

What emerges from these considerations is the importance of developing reasonable criteria for adherence which suit the specific context of patients' behaviour.

1.2.2 Measurement of adherence

The measurement of adherence is problematic. The most commonly reported techniques for determining how well people adhere to treatments are:

- to ask the patients directly.
- to ask their physicians.
- to ask patients to keep a diary of their actions.
- to count remaining pills.
- to count the number of filled prescriptions or
- to review the medical record.

All of these methods provide indirect measures of the target behaviour and all are subject to problems of reporting bias, reporting errors, or intentional manipulation on the part of the reporter. In comparison with more direct measurement techniques, all of the techniques described above have been shown to overestimate adherence (Epstein & Cluss, 1982; Cluss & Epstein, 1985). Despite the difficulties and now well recognised limitations associated with these methods, they remain popular, as they are inexpensive, quickly performed, relatively non-invasive for patients and often, provide information that is "good enough". There is also evidence, particularly for the measurement of adherence using patient self-report either by diary methods or questionnaires, that normalisation of non-adherence combined with high levels of specificity in questioning can significantly improve the accuracy of self-report about adherence (Quittner et al., 2000).

Another common approach involves drawing retrospective conclusions about adherence based on the therapeutic response, although this method carries substantial assumptions about the predictability and reliability of treatment responses to particular medications or other forms of treatment (Epstein & Cluss, 1982). When considering a complex disease such as CF, this method also forces assumptions about the interactions between different treatment elements and the stability of treatment effects for treatments other than the one targeted, for example, interactions between antibiotics and physiotherapy in the treatment of respiratory infections.

More direct measurement techniques have also been employed. In particular, blood serum levels or urinary excretion of medications, their metabolites or of a tracer substance have been used with various degrees of success to measure adherence. These methods have their own limitations, particularly the issue of pharmacokinetic variation, which Gordis (1979) described as "differences among individuals in absorption, distribution, metabolism and excretion of drugs" (pg. 27). Of additional concern with laboratory based measurements of adherence is the cost in time, money and intrusiveness to the patient, that is involved in collecting and analysing data of this kind. Further, many blood and urine assays are only able to provide an accurate measure of the amount of medication consumed in the preceding 24 hours (Meyers, Dolan & Mueller, 1975), so that while such a measure may provide information about the patient's adherence on the day

before the test, daily testing would need to be done to truly assess adherence. Clearly this kind of approach is invasive, expensive and impractical for longer term treatment regimens.

Adherence can also be measured by using various electronic recording devices attached to pill bottles, aerosol dispensers (puffers) and nebulisers, which record the date, time and in some cases, the duration of each use of the dispenser (Gong, Simmons, Clark & Tashkin, 1988; Spector et al., 1986; Rand et al., 1992; Starr et al., 1999; Chapman, Walker, Cluley & Fabbri, 2000). This data can be periodically down-loaded for analysis and provides a more dynamic and longitudinal view of adherence than was previously possible. Most researchers in this area report high levels of accuracy and reliability with these devices (e.g., Starr et al., 1999; Chapman et al., 2000) although others have experienced technical difficulties with equipment and data retrieval (Quittner et al., 2000).

This methodology offers some advantages over both direct biological methods and diary report methods. The recording devices are non-invasive, relatively non-intrusive and less dependent on patient co-operation for the collection of data. In addition they allow for the continuous collection of data over a long period of time without the patient having to attend an appointment or clinic. They provide a measure of behaviour, not of belief, memory or drug effect. The main disadvantage of these devices is their high unit cost price. They are however inexpensive to maintain (Starr et al., 1999) and are usually re-usable over a considerable period of time. This technology is presently limited to medications and certain other specific activities (such as physiotherapy using a physiotherapy vest that vibrates the chest) and cannot readily provide information about adherence to treatment regimens such as exercise or diet.

Clearly, this type of monitoring has its own limitations. This data provides information about the use of a medication dispenser, not about whether the patient actually ingested the medication removed from the dispenser. However, it is reasonable to hypothesise that the majority of patients who make the effort to remove medication from the dispenser in the prescribed way (particularly over a long period of time) will also consume the medication. There does remain some risk that patients may turn on a device such as a nebuliser pump and then leave it running for an expected length of time, but not actually

use it for the intended purpose. The motivation for people to appear to be "doing the right thing" could be expected to be relatively low in a research context, where each person is aware that their responses will be considered anonymously and only in the context of a group of participants. Socially desirable patterns of responding to electronic monitoring may be of much higher concern in a clinical context, where patients can expect that their behaviour will be considered on an individual basis or discussed with their health care team.

Researchers using these devices have also questioned whether this form of monitoring actually changes adherence behaviour, that is, whether peoples' knowledge that their medication is being monitored causes them to adhere better to the medication. It has been shown however, that even when the monitoring has been explained to patients, adherence behaviour is not significantly affected by monitoring alone (Gong et al., 1988; Starr et al., 1999) and that if monitoring does change adherence, the effect is very short-lived (Epstein & Cluss, 1982; Rand et al., 1992). Rand and collaborators found that this form of monitoring allowed them to identify instances of medication "dumping" (the repeated use of the medication dispenser, far beyond prescribed levels, shortly prior to medical appointments) which could not be detected from other adherence measures, a finding that is inconsistent with the idea that monitoring itself improves long-term adherence behaviour. In a recent paper by Wagner & Ghosh-Dastidar (2002) the concern about whether electronic monitoring alone changes adherence was addressed directly in a comparison study of adherence under three different conditions; electronic monitoring, detailed diary keeping and no monitoring. After controlling for differences in baseline adherence, no significant differences in adherence between the three groups was found.

These findings may appear to be in contrast to the large body of psychological literature which reports on the effectiveness of self-monitoring techniques in effecting behavioural change (Clark, 1989). The technique of self-monitoring involves patients monitoring and keeping a written record of instances of a particular behaviour or emotion as part of a treatment program; an approach used with many mental health disorders. It is known from this field of work that self-monitoring alone is usually insufficient to bring about desired behaviour change. The technique becomes effective with the addition of

goal directed modifications of cognition and behaviour based on the self-monitoring observations. Of particular interest for the future are the opportunities presented by the merger of medication and health monitoring technologies and the methodology of self-monitoring to assist behavioural change. A case in point is the use of blood-glucose monitors by people with diabetes in assisting dietary management and diabetic control (Bohannon & Jack, 1996; Chmielewski, 1995). If this kind of approach were to be adopted as an aid in the management of treatment in adults with CF, effective communication between the patient and health care provider, including mutual acknowledgement of realistic limits about the degree to which people in general adhere to prescribed treatments would be crucial.

1.3 Adherence considerations in the context of CF

People living with CF often receive little positive reinforcement for their efforts to adhere to treatment (Abbott & Gee, 1998). Furthermore, CF is an inexorable disease and even with complete adherence, the health of an adult with CF will eventually decline. At best, good adherence is thought to reduce the rate of decline in respiratory disease. There is the real risk that adherence may be worse in CF in those with the most severe disease because of the lack of positive reinforcement from any beneficial effect of treatment adherence (Sawyer & Dapiran, 2001).

The treatment demands placed upon adults with CF are extraordinary when compared with most other chronic illnesses, let alone when compared with the healthy population. In addition to the complexity and number of treatments prescribed for adults with CF, adults living with this condition are faced with the challenge of interpreting and understanding the effects and priority of each of these treatments within their own treatment regimen. It is not surprising that patients find this difficult given the lack of consensus among treating physicians and multidisciplinary health care teams about which treatments are most important (Lask, 1997; Quittner et al., 2000).

People with CF often develop strong relationships with their multi-disciplinary health teams. These relationships are usually developed over many years of treatment and link

CF with only a handful of other chronic illnesses in which such long term treatment relationships may be developed. This feature of CF health care must impact (both positively and negatively) on the communication between the health care professional and the patient (Lask, 1997). Such a relationship may enhance the clarity of the communication and may lend an important source of support to the patient. Importantly though, it may also lead to assumptions on the part of both the CF team member and the patient about shared knowledge of the concerns to be dealt with and the treatment program overall. The physician, physiotherapist or dietician may assume, for example, that a patient knows how to manage a particular aspect of treatment if the subject has been discussed in a previous consultation. This assumption may be fair much of the time but there will be occasions on which important information will not be exchanged which may well contribute to adherence difficulties going unrecognised by both the CF team and the patient.

The disruption to longstanding health care relationships when older adolescents transfer their care from a paediatric to an adult facility must be taken into consideration (Sawyer, Blair & Bowes, 1997). The process of transfer can be an unsettling experience for some, while at the same time, it may herald a new sense of belonging or a fresh start. Important changes of this kind can impact on the dynamics of peoples' self-perceptions and perceptions of place and belonging (Landau, 1995). In particular, transfer to an adult unit can signal a different level of parental involvement and supervision of the health care regimen for some young people. Changes in the dynamics of adherence may be predicted as part of this overall change process.

At present there is no information about the relationship between family functioning and either health outcomes or adherence in adults with CF. Unlike their healthy peers, more adults with CF remain within the family home or live alone rather than marrying or sharing accommodation with others (Shepherd et al., 1990). It could be predicted that family functioning may be an important mediating variable for adherence for those adults who continue to live with immediate family and those who marry, but less so for adults with CF living independently. In this group, a broader definition of what constitutes family may be important to consider.

The role of family cohesion, conflict and stress have been linked to longer term trends in

pulmonary functioning and weight gain for children and adolescents with CF (Patterson, Budd, Goetz & Warwick, 1993; Patterson, McCubbin & Warwick, 1990; Quittner et al., 1996). While the mechanisms for these links remain unclear (Quittner et al., 2000), it has been postulated that treatment adherence is the mediator of the effect, with those patients experiencing lower family stress, higher parental availability and positive family coping adhering better to treatments and consequently, enjoying better health.

1.3.1 Studies of adherence in adults with CF

Numerous studies of adherence have been conducted with children and adolescents with CF, so that understanding of the way that families manage the extraordinary demands of CF management is improving rapidly. Very few studies report specifically on adherence in adults with CF and yet the different social, emotional, maturity and lifestyle demands of adult life (notwithstanding the likelihood of ongoing family support), must be considered.

The studies about adherence in adults with CF have been exploratory and have employed self-report questionnaires, physician-report or medical record reviews as their measurement strategy. One study of in-patient adherence made use of behavioural observation to measure adherence. The first three of these measurement strategies are problematic for reasons outlined earlier; particularly physician report, raising some concern about the validity of this information, as it is likely to overestimate the extent of true adherence. The value of self-report in determining relative adherence to treatment has however, been demonstrated (e.g., Morisky, Green & Levine, 1986) and self-report of non-adherence has been found to have good validity (Rand, Nides, Cowles, Wise & Connett, 1995). The generalisability of behaviour observed in a hospital setting, to what people may do in managing treatments at home can only be speculated about and may well be poor.

A further complication in this literature is inconsistency about the age boundaries for people to be included in an "adult" sample. One research group included patients as young as 14 years in a study designed to explore adherence by adults with CF (Conway, Pond, Hamnett & Watson, 1996) and another research group included patients aged 16 years and over (Abbott, Dodd, Bilton & Webb, 1994). In a study aimed at exploring adherence

in adolescents with CF (Czajkowski & Koocher, 1987), almost half of the sample was aged between 20 and 23 years. This inconsistency increases the risks of confounding the behaviour of adults with that of adolescents, by failing to consider factors such as level of responsibility for treatment, level of social responsibility and potential changes in social desirability behaviours. It also fails to take into account issues discussed earlier, regarding the impact of transition from paediatric to adult care.

Czajkowski & Koocher (1987) examined the utility of the Medical Compliance Incomplete Stories Test (M-CIST) and several coping skills in predicting adherence in 40 adolescents and adults with CF aged between 13 and 23 years. The participants were all in-patients admitted to hospital for treatment of exacerbation of their lung disease. Adherence to several different aspects of in-patient CF treatment were considered. Only treatment components that were in some degree within the control of the patient and that could be subject to poor adherence were assessed. Medical and nursing staff recorded participants involvement in treatment for the duration of their admission and this data was later scored according to specific criteria. Each participant was given a total score out of ten for their adherence during the admission. People scoring less than eight out of ten were considered to be non-adherent. In this study, adherence to the different components of treatment was not considered separately.

It was found that a larger percentage of the people aged 20 to 23 years were rated to be non-adherent than younger people with CF and that females were less adherent than males. Those who had been hospitalised more frequently and missed more days of work or school as the result of illness were also less adherent. On the basis of the M-CIST it was found that people with a more optimistic outlook about their future health were more adherent to treatment and that those who believed that their actions would make a difference to their health were also more adherent. The authors noted that in the compliant patients a general viewpoint of "You just do what you have to in order to stay alive" (Czajkowski & Koocher, 1987, pg. 317) was prevalent. Use of adaptive coping skills was also found to discriminate successfully between people who were adherent and those who were not, however the coping skills did not increase the predictive power of the statistical model beyond that found using the M-CIST alone.

Abbott et al. (1994) surveyed 60 people with CF, aged between 16 and 44 years ($M = 20.98$). Degree of disease severity in the sample varied widely. More men participated than women. Participants in this study were interviewed by a psychologist not directly involved with patient management. In the interview they were guided through a questionnaire called the Manchester Cystic Fibrosis Compliance Questionnaire, which contained questions about their adherence to four different aspects of the treatment regimen, perceptions about whether their adherence to the different treatments was adequate, and reasons for poor adherence to different aspects of the regimen. The questions about the way the different treatments were adhered to were different for each treatment and reflected differences in the way each treatment is usually managed in CF. Based on their responses to those questions, participants were rated as compliant, partially compliant or non-compliant with each treatment. Reported compliance differed considerably between the treatments. For enzyme replacement therapy, 83% of participants were considered to be compliant on the basis of their questionnaire responses, while the rates of reported compliance were lower for the other treatments. About 75% of patients were considered compliant with exercise regimens, 53% were compliant with physiotherapy and 46% compliant with vitamin therapy.

Neither demographic differences or differences in disease severity between the patients were associated with adherence. Patients who reported experiencing benefits from their treatments also reported better adherence to those treatments, and the authors hypothesised that patients were using their immediate symptoms (and the symptomatic relief experienced as a result of compliance to some treatment regimens) as "barometers" to guide their treatment choices. Of the many reasons listed in the questionnaire for possible non-compliance, three were endorsed by substantial numbers of the participants. Almost half of the participants believed that they were well without treatment, more than one third perceived their disease to be less serious than others with CF and 20% felt that their exercise regimen could replace traditional physiotherapy for airway clearance.

Conway et al. (1996) surveyed 80 people with CF who were aged between 14 and 40 years, with a median age of 22 years. About half the sample were females. Participants completed a questionnaire about daily adherence with 12 different CF treatments. They

were asked to indicate whether they adhered to the regimen for each treatment "every day or almost every day", rated as good adherence "about 3–5 days a week", rated as moderate adherence "less than 3 days a week" or "never", rated as poor adherence. Respondents were asked to choose any items from a list of nine possible reasons for non-adherence which they felt applied to them. Demographic and disease characteristic data were also collected from each participant. Different members of the health care team were also asked to provide ratings of the adherence of each of the participants and these were then compared against an overall adherence score for the questionnaire completed by participants.

As in the study by (Abbott et al., 1994), self-reported adherence differed considerably between the CF treatments. The percentage of participants reporting good adherence (as defined above) to oral tablet medications such as pancreatic enzymes, antibiotics and vitamin supplements was high (80–85%), while nebulised and inhaled treatments were reported to be adhered to well by between 65 and 78% of participants, depending on the treatment. Good adherence to dietary supplements and physiotherapy was reported by 50 and 41% of participants respectively. Interestingly, the percentages of people reporting good adherence to most of these treatments were considerably higher than previous average percentages found for long term treatments in chronic illness (Sackett & Snow, 1979).

Better adherence seemed to be linked to the ease of treatment delivery method and as in the study by Abbott et al. (1994), to treatments most likely to give direct short-term benefit. Older participants reported themselves to be less adherent overall, however whether this finding would hold true with a group of adults only, rather than a mixed sample of adults and adolescents could not be determined. Other aspects of demographic and disease related differences were not statistically associated with adherence and neither was knowledge about CF. Across treatments, the most common reason given for omitting treatments was forgetfulness, closely followed by concerns about time, effort and commitment. In examining perceptions of disease severity and adherence, it was found that patients rated their disease to be less severe than did their physicians, however physicians and other health carers overestimated adherence to treatment relative to participants own

reports of adherence.

In summary, there were several points of consistency between the studies:

- Reported adherence is different for different treatments.
- People with CF underestimate the severity of their disease.
- People adhere better to treatments from which they experience obvious benefit.

There are significant limitations however, in the adult CF adherence literature. In addition to problematic measurement techniques, studies to date have been cross-sectional in design and have presented a static picture of adherence. There has been no literature examining variability in adherence over time. Equally importantly, studies mainly report treatment factors such as complexity and time along with lack of benefit experienced as explanations for poor adherence. While these factors appear to have some explanatory value, most of the statistical effects are small, leaving significant amounts of the variance in adherence behaviour unaccounted for in the literature.

1.4 Models or theories applied to adherence in CF

1.4.1 Theories previously applied

Efforts to understand adherence behaviours in CF through the application of theoretical models have met with limited success. The Health Belief Model (Rosenstock, 1974), the Health Locus of Control construct (Wallston & Wallston, 1978), and various models of coping (Czajkowski & Koocher, 1987) have been applied. In addition, consideration has been given to the Social Cognitive theory of Bandura (1986) and particularly the concept of self-efficacy (the confidence to perform a particular behaviour).

The theoretical models that have been considered in relation to adherence in CF have their basis in Social Learning Theory. Social Learning Theory (Rotter, 1954) proposes that the likelihood that an individual will engage in a particular behaviour is a function of both the extent to which the person believes that the behaviour will lead to a particular outcome (reinforcement) and, the extent to which the reinforcement is valued. This broad

construct has been examined extensively within the narrower field of health behaviours. The Health Belief Model, for example, posits that adherence to medical regimens will be contingent on a combination of factors. These factors include whether the disease is perceived as serious, the degree to which a person feels vulnerable to a particular illness, and his or her evaluation of the perceived costs and benefits of a prescribed course of treatment. Some support has been found also, for individual differences in the degree to which people perceive themselves to be in control of personal health outcomes, or, Health Locus of Control (Wallston & Wallston, 1978). People who believe themselves to be in control of their own health are considered to have an Internal locus of control, and those who believe that more powerful others such as physicians have control of their health, are described as having an External locus of control. Within health research, some support has been found for the hypothesis that people with an internal locus of control are more likely to engage in health promoting behaviours (Wallston & Wallston, 1978).

Other models draw on the idea that individuals differ in terms of their learned practical and cognitive coping resources and motivation, and that these differences can lead to important differences in health related behaviours. These models, which have their origins in Social Learning Theory but add a cognitive component, include Social Cognitive theory (Bandura, 1986) and the Theory of Reasoned Action (Azjen, 1988). Central to Social Cognitive theory is the idea that people are more likely to perform health protective and health management behaviours if they believe both that the proposed action will be efficacious and if they feel confident that they have the ability to perform the required behaviour.

The Theory of Reasoned Action (TRA) proposes specifically that the majority of actions in a social context (including a health context) are under volitional control and that therefore, whether a person intends to perform a particular behaviour or not will be an immediate predictor of that person's action. While the TRA has not been investigated in relation to adherence in CF and may have some explanatory value in understanding decision making about treatment, it seems unlikely, given the complexity of the treatment decisions to be made, that intention alone will be sufficient to predict behaviour. Further, even if intention was identified as a predictor for adherence behaviour, the social, cul-

tural and cognitive influences on the formation of an intention to act seem intuitively, to represent the more interesting explanatory component of this decision making sequence.

Abbott, Dodd & Webb (1996) found little support for the Health Belief Model as a predictor of adherence in adults with CF. They were unable to discriminate between adherent and non-adherent patients on the basis of their health beliefs, with the exception of finding that those patients who worried more about their illness reported better adherence to most of their treatments. Consideration of Health Locus of Control was more fruitful. Patients who believed that "chance factors" or "powerful others" controlled their health reported better adherence to physiotherapy regimens, enzymes and vitamin supplements, while there was better adherence to exercise regimens reported among those who believed they were in control of their own health.

These findings warrant further investigation. Self-report of adherence behaviour was used in this study as the basis of testing the two theoretical models. It may be that a study using more objective measures of adherence or at least multiple measures of adherence will further clarify the contribution of these theoretical models to the issue of adherence. It certainly seems reasonable to predict that patients who perceive their illness as serious, believe that treatment is beneficial and are motivated or concerned for their health (as described in the Health Belief Model), would adhere better to prescribed treatment programs. It seems likely however, that this model will not provide a sufficient explanation for adherence behaviours.

Czajkowski & Koocher (1987) explored the predictive value of six coping behaviours in distinguishing between adherent and non-adherent adolescents with CF. Coping behaviours were described as "understanding the severity of the illness, taking responsibility for medications at home, seeking information about the illness, future goal orientation, involvement in school or work and openness with peers about illness" (p. 316). Adolescents' reports of whether they used these coping behaviours reportedly discriminated between adherent and non-adherent young people. Those using the coping behaviours also demonstrated better adherence.

Parcel et al. (1994) evaluated the importance of various skills in maintaining adherence to the CF treatment program. Skills included confidence in managing various aspects of

medical treatment, symptom and behaviour monitoring, communication and adjustment. They found that self-efficacy was the most important factor predicting whether patients and their care-givers effectively monitored health and treated respiratory problems.

1.4.2 New theoretical directions

The research literature (e.g., Sackett & Snow, 1979) suggests that the difficulties with adherence to medical treatment are universal. Wright (1993, pg. 909) goes so far as to quote Hippocrates, who said "keep watch also on the faults of the patients, which often make them lie about the taking of things prescribed". In fact, in a review just of interventions to improve adherence, Haynes, McKibbon & Kanani (1996) screened 1553 citations and abstracts from the medical literature. Articles about other aspects of adherence continue to proliferate as well. It is appropriate therefore to investigate models applied to other diseases and in other disciplines to assist us in understanding this complex problem in adults with CF.

New models in health psychology offer as yet unexplored possibilities for understanding the mechanisms which influence adherence to treatment among adults with CF. In particular, the Self-Regulatory Model (SRM; Leventhal, Nerenz & Steele, 1984) has led to developments in the understanding and measurement of health behaviours, particularly adherence to treatment. This model places elements of "common sense" findings about adherence in the literature, such as findings that people adhere better to regimens that they perceive to be of immediate benefit to them, into a cohesive framework. The SRM suggests that health related behaviours such as adherence are influenced by the beliefs or cognitive schema (labelled "illness representations") which the patient holds about the illness (Leventhal et al., 1992). It then offers a way of integrating various social and contextual factors with aspects of individual cognition and feelings (the illness representations). In effect it builds on the consistent findings about adherence and describes a consistent way of making sense of apparently disparate aspects of the findings.

In this model, it is said that people structure their beliefs around five separate components or themes relating to the illness. The themes are described as "Identity", "Time-

line", "Cause", "Consequences" and "Cure/Control" (Leventhal et al., 1992). These representations then form the basis from which people make decisions about the way they will "cope" with the illness. This model places particular emphasis on the way that a person's symptoms influence other representations about, for example, the time frame and consequences of the disease and takes into account the parallel emotional processing of that information. The decision to adhere to a particular course of treatment is seen as one of a large range of possible "coping" responses. The model proposes that the greater the level of cohesion between a person's representation of the illness and the apparent fit of the proposed or trialled treatment, the more likely that adherence to a particular treatment will be maintained. The appraisal process is seen to be dynamic, such that a change in the perception of the illness based on one or more of the five themes or a change in the perception of the fit between those appraisals and the chosen coping mechanism, can influence health decisions and behaviour.

A questionnaire measure was developed by Weinman, Petrie, Moss-Morris & Horne (1996) to measure peoples' perceptions of their illness across these themes. Responses on this measure predicted patients' attendance for rehabilitation and their return to work following a myocardial infarction (Petrie & Weinman, 1997), suggesting a link between illness perceptions and adherence behaviours. The measurement of illness representations in adults with CF may assist us to predict the way in which adults with CF will adhere to their treatment and therefore to plan ways of managing the effects of illness representations on adherence.

Consistent with the concept of illness representations but targeting treatments rather than the illness itself, is recent work examining beliefs about medicines or *treatment representations* (Horne, 2000). Horne proposes that people not only form cognitive schemas about their illness, but also form such schemas about the medicines prescribed to treat their illness. He suggests that these schemas are formed around two independent themes: the beliefs that patients hold about the necessity of medications prescribed for them as well as specific concerns about potentially adverse effects of their medications. Horne argues that treatment representations may play a significant role in the choices people make about how to adhere to prescribed medicines.

On examination in a large sample of people with chronic illness, it was found that treatment representations explained a significant amount of the variance (15–20%) in reported adherence to prescribed medications, independent of representations about illness (Horne, 2000). Across more than 7 illness groups, it was found that patients with a stronger belief about the necessity of their medication were more adherent, while those with stronger concerns were less adherent. Patients who reported both a strong belief in the necessity of their medication as well as reporting a high level of concern about adverse effects of the medication were less adherent. It was hypothesised that such patients perform a 'cost/benefit analysis' of the pros and cons of taking medication, trying to minimise the perceived risks of the medication by taking less than the prescribed dose.

Further support for this extended SRM was provided in an additional study examining links between treatment adherence among 100 people with asthma and the representations they held about both their illness and its treatment (Horne & Weinman, 2002). In that study, of the variables examined, (including disease parameters and socio-demographic data), treatment perceptions were found to be the best predictors of reported adherence to preventer medications.

This model of illness and treatment perceptions seems to fit well with previous findings about adherence in adults with CF. In particular, findings that greater worry about the disease predicts better adherence, that adherence varies between treatments as much or more than between people, and that people adhere better to treatments which they perceive to be of immediate benefit to them.

Specific knowledge about one's prescribed treatment may also influence the cost/benefit analyses performed by patients. It has been found, for example, that although knowledge about CF in general has a very limited relationship with treatment adherence, there are strong relationships between accurate knowledge of a specific treatment regimen and better adherence to the regimen, at least among adolescents with CF (Henley & Hill, 1990; Ievers et al., 1999).

Overall, it seems that the combination of better measurement techniques and appropriate theoretical models to guide research questions may make us better able to predict (and test) more accurately the way that adults with CF adhere to their treatments.

1.5 Summary and aims for this research

At present, adherence behaviour in adults with CF remains poorly understood and has not been sufficiently explained in the scientific literature. While some individual factors influencing adherence have been identified, most of which are consistent with the broader literature describing issues of adherence in chronic illness, the findings have not been adequately explained by theoretical models applied to the problem.

Difficulties in developing a clearer understanding of adherence in this population appear to be related to several factors:

- Inconsistency in the definition of adherence and the closely related issue of the determination of what constitutes adherence to different treatments.
- Difficulties associated with meaningful measurement of adherence.
- Cross-sectional study designs only.
- Lack of a cohesive explanatory model for the factors found to be associated with adherence in adults with CF.

While this list of issues is by no means comprehensive, it is likely that research in which these concerns are addressed would have the potential to make a substantial impact on the level of current understanding of this phenomenon.

If we are to develop our understanding of and ability to predict adherence to treatments in people with CF (with the end goal of improving adherence) longitudinal studies of adherence behaviours are indicated, using effective measurement tools. This is necessary as the current literature does not provide any understanding of the changing nature of adherence over even short periods of time, and researchers have been reliant on measurement tools or strategies which are known to have significant biases. Investigation of links between adherence and patient beliefs and perceptions of their disease and it's treatment also promises to be fruitful, if findings from other areas of chronic illness can be considered indicative.

Currently, the few adherence interventions that have been tested in people with CF have targeted children and adolescents. No research evaluating adherence interventions

for adult patients has been published. I believe however, that it is only with greater understanding of the complex issue of adherence in people with CF (and other chronic conditions) that we will be able to design and test interventions that aim to improve and maintain adherence in adults with CF in order to improve health and wellbeing.

The research described in the following chapters was conducted with the overall aim of increasing understanding about the nature of and mechanisms underpinning adherence to treatment in adults with CF.

Specifically, the aims for this research were:

1. To investigate rates and patterns of adherence to treatment in Australian adults with CF.

2. To consider the role of demographic and disease characteristics on treatment adherence in adults with CF.

3. To explore the beliefs and perceptions of adults with CF in relation to a variety of CF treatments.

4. To investigate the role of family environment in adherence to treatment by adults with CF.

5. To conduct a longitudinal examination of adherence to concurrent treatments in CF.

6. To investigate the associations between illness and treatment perceptions and adherence to CF treatments, using multiple methods of measurement.

7. To apply the SRM to a consideration of adherence to treatment in adults with CF.

1.6 Overview of the present program of research

In order to accomplish these aims, three studies were conducted, involving a total of 74 adults with CF. Three different study designs were employed. In the first study, described in Chapter 2, a semi-structured interview was used to investigate the opinions of adults

with CF about the factors that may influence their motivation to adhere to treatment and that might interfere with their adherence.

In the second study a new measure of beliefs and perceptions was developed and trialled to investigate links between adherence to treatment and the perceptions held by adults with CF about both their illness and its treatment. The development and validation of the measure are described in Chapter 3. This study also incorporated an examination of the role of demographic and disease characteristics on adherence and an investigation into the role of family environment on adherence. A questionnaire based, cross-sectional, repeated measures study design was used. The findings from all elements of the study except the questionnaire validation, are described in Chapter 4.

The third study (described in Chapter 5), was a longitudinal study extending the investigation of relationships between adherence and patient perceptions of illness and treatment. Two concurrent CF treatments were electronically monitored over three months. Additional measurement of adherence was achieved with self-reports using the new measure from Study 2 at baseline and three months. Outpatient clinic attendance records and pill counts were also employed. This study provided a significant opportunity to explore the role that the SRM might play in understanding adherence to treatment in adults with CF.

Technical and practical matters that influenced the outcomes of this program of research are discussed in Chapter 6, along with a presentation of the limitations of the research. Chapter 7 presents an overview and synthesis of the whole program of research, with reference to the aims described above in section 1.5, and incorporates a discussion of clinical applications and broader implications for the findings of the research.

It is hoped that the development of a better understanding of treatment adherence in adults with CF will lead to improvements in CF treatments, improved health outcomes, and improved patient quality of life.

Chapter 2

Study 1: Pilot study

2.1 Introduction

Adherence to treatment by adults with CF has not been studied previously in Australia, despite growing concern about the issue within the community of CF health carers. This concern was plainly in evidence at the two most recent national CF conferences, held in 1999 and 2001, with invited international speakers making keynote presentations on adherence issues at both of those meetings. It seems reasonable to expect that findings about adherence in other Western nations (where CF is most prevalent), ought also to apply in the Australian context. There are differences however, in the approach to CF care and in the cultural context of medical care which are important and may influence behaviours such as adherence. Also clear from both the published literature and rich discussions at recent national and international CF conferences, is the fact that regardless of culture and geography, adherence in adults with CF is understood in only a limited way. More studies are needed to elucidate both the extent of poor adherence, factors associated with good adherence and any potential clinical responses to the issue.

As described in Chapter 1, there is a developing understanding of some of the specific reasons for non-adherence among adults with CF, however none of the theoretical frameworks applied to this issue have been well supported by the research to date. An aim for this program of research was to explore whether the theoretical framework of the self-regulatory model (SRM; Leventhal et al., 1992) would add to current understanding

about adherence to treatment in adults with CF. It was considered premature however, to begin that phase of the research without first conducting a preliminary investigation to explore reported adherence among Australian adults with CF. Such an investigation was considered important in part to examine whether reports of adherence were likely to be similar or different to those of adults with CF elsewhere in the world, but also as a means of gathering additional information from patients about what they believed to be important factors in their management of home-care treatments.

Previous research with adolescents with CF has found that specific knowledge about treatment regimens is associated with better treatment adherence (Ievers et al., 1999), however this aspect of the adherence picture has not been examined in adults with CF. Given the differences in the level of responsibility taken for treatment management by adolescents compared with adults, and the absence of specific studies about this issue in adults, it would be unjustified to extrapolate from these findings and assume that the relationship would hold true for adults. It does however, highlight the importance of making sure that there is a common understanding between the patient and the treatment team about what any treatment regimen being measured for adherence actually involves.

The main aim of this pilot study then, was to gather information from local adults with CF about:

- their perceptions of their disease and its treatment
- their recollection of their own treatment regimen
- their perception of how much of their CF treatment they adhered to
- both motivating and inhibiting factors in their management of treatments at home.

It was anticipated that talking with Australian adults with CF about their disease and about adherence, would help to clarify both the questions which should be asked in the next phase of the research and how best to measure the answers.

A semi-structured interview was chosen as the measurement approach for the first part of this study. It was considered important that no prior assumptions be made about the way people managed their treatment or what may influence their treatment

decisions. An open question format was considered likely therefore, to assist in generating novel information about both helpful and unhelpful factors associated with treatment management for this sample of people with CF.

A further aim of this study was to trial the Manchester Cystic Fibrosis Compliance Questionnaire (MCFC) with a sample of Australian adults with CF. The MCFC (Abbott et al., 1994) is a disease specific self-report questionnaire designed to evaluate the adherence of adults with CF to four commonly prescribed CF treatments and to explore reasons for poor adherence. This measure was developed in the early 1990's in Britain and was used in several of the studies about adherence in adults with CF conducted there in the 1990's. At the time when this research was being planned, the MCFC was the only CF specific questionnaire measure of adherence that had been published. The MCFC has undoubtedly assisted in the understanding of non-adherence in adults with CF, and findings from it have helped to highlight that reported adherence varies depending on the specific treatment involved (Abbott et al., 1994).

Despite its research value, no reliability or validity data have been published for the MCFC and so it was considered important to trial the measure in a local sample of adults with CF to determine at least its face validity and acceptability to patients, before making any decisions about whether to use it in future aspects of this program of research.

2.2 Methods

2.2.1 Setting

This study was carried out within the Cystic Fibrosis Unit at the Royal Adelaide Hospital (RAH), a large teaching hospital in South Australia. Within the hospital, the Department of Respiratory Medicine runs the only specialist Adult Cystic Fibrosis Unit for both South Australia and the Northern Territory. Those states cover a large geographical area and have a total population of about 1.7 million people. A small minority of people with CF choose a physician in private practice to manage their CF care, but the majority of adults with CF use the specialist clinic. While the population of people using the specialist CF

clinic is dynamic rather than static, numbers have increased slowly and relatively steadily since the clinic's inception and at the time of the study there were just over 80 people with CF listed as current patients of the clinic.

The CF Unit was established in 1989 and is physically located within a larger Chest Clinic at the RAH . The CF Unit is directed by a Respiratory Physician and staffed by a full-time Clinical Nurse and Social Worker, a senior respiratory Registrar and part-time Physiotherapist, Dietician, Gastro-enterologist and Psychologist. The unit is also served by a technician (who manages regular pulmonary function testing), a regular outpatient pharmacy service timed to coincide with outpatient clinics, and various other laboratory units within the hospital as required.

This unit operates in a formal partnership with the Department of Respiratory Medicine at the Women's and Children's Hospital in South Australia, which has the only CF unit responsible for the medical care of infants, children and adolescents with CF in South Australia. Through a formal transition process, older adolescents transfer their CF care from the Women's and Children's Hospital to the Royal Adelaide Hospital (RAH) at a negotiated time in the year subsequent to their 18th Birthday.

In the adult CF unit, outpatient clinics are held on one afternoon each week and most patients attend once every 2-3 months. A few patients attend more frequently and others may attend only once or twice per year. At each visit appointments are scheduled with the respiratory physician or senior registrar and with at least some of the allied health staff. Up to 15 patients may be booked into the clinic on any day, which can result in lengthy waiting times for patients between appointments. The frequency with which patients attend the clinic and the fact that they usually have considerable portions of waiting time between appointments, provides a valuable opportunity to recruit participants to research. At this time they are thinking about their CF and have time to be involved, without the need for additional research related appointments.

CF care in Australia, operating on the model of separate, dedicated units for children and adults, with a multi-disciplinary health care team along with access to the best quality treatments, is among the best in the world.

2.2.2 Participants

The participants for this study were 10 adult volunteers (5 men) with Cystic Fibrosis who attended the RAH CF outpatient clinic for a routine visit during December 1999. All clinic patients with a confirmed diagnosis of CF, who were competent speakers of English were considered eligible to participate in this study. In all, thirteen patients were approached in the clinic waiting area and informed about the opportunity to participate in a research interview about managing their CF, and 10 agreed to participate. Of the three who declined to participate, two were unwell on the day and were later admitted to hospital and the third had previously demonstrated a preference not to participate in CF research. Details of the recruitment process are discussed below in section 2.2.4.

2.2.3 Measures

As outlined above, two tools were used to gather the information in this study. Participants were involved in a semi-structured interview, during which they were asked a series of open-ended questions about themselves and their CF. Participants were asked for demographic data including their age, gender, living situation (who with, country versus metropolitan), marital and employment status. They were asked to recall and describe their CF treatment program in detail. Then they were asked about factors that motivate them to adhere to treatment or that interfere with their adherence to treatment and were asked to what treatments they found it the most difficult to adhere. Finally, they were asked to give ratings about the importance of each treatment to their health on a 4 point scale where 1 = *Essential*, 2 = *Important*, 3 = *Helpful* and 4 = *Not Helpful.* A copy of the interview questions is provided in Appendix A.

The Manchester Cystic Fibrosis Compliance Questionnaire (MCFC) was also administered (Abbott et al., 1994). This questionnaire contains questions for sufferers of CF about their compliance with four elements of CF treatment; pancreatic enzymes, physiotherapy, vitamins, and exercise. For each of these treatments participants are asked to indicate their degree of compliance from a set of responses on a four to six point scale. These responses are then coded into categories of *Compliant*, *Partially compliant* and

Non-compliant in the manner described by Abbott et al. (1994). Respondents are then asked to choose any applicable items from lists of possible reasons for non-compliance with each treatment. There are between 13 and 18 reasons listed for each of the four treatments examined by the measure. Some of the reasons are presented separately for all four treatments, while others are unique to a treatment. A copy of the MCFC is presented in Appendix B.

A medical record review was conducted for each patient to cross-check patients' recall of their treatment regimen.

Ethics approval for this study was obtained from the Human Research Ethics Committees of both the University of Adelaide and the Royal Adelaide Hospital.

2.2.4 Procedure

Recruitment took place over a period of two weeks at successive outpatient clinics, continuing until the required number of participants had been recruited. Clinic attendees were approached while waiting for medical and allied health consultations and invited to take part in an interview about their CF management. All participants gave written consent for their involvement and were assured of the confidentiality of their responses. The decision about which patients to approach was based on the logistics of their place in the "queue" to see the clinic staff. Patients identified by the nursing staff as having at least 1/2 an hour to wait before their next health consultation were approached and if they agreed to participate, the interview took place immediately. The next participant was recruited after the conclusion of each interview. This recruitment approach resulted in a sample of convenience, recruited on the basis of random issues of timing.

Subjects participated in the semi-structured interview with the investigator, who is a registered psychologist. Interviews took place in a consulting room within the clinic. At the conclusion of the interview the items of the MCFC were read out to the participants, and the responses were recorded and later categorised by theme. Subjects were also asked to give their opinion of the interview questions and of the questionnaire they had completed. The whole process took between 25 and 30 minutes for each participant.

The medical record of participants was examined in order to determine their current prescribed treatment regimen.

2.3 Results

As this was a pilot study and only 10 patients were involved, it was inappropriate to conduct any formal statistical analysis with this data. Frequency and descriptive data are reported and the arithmetic calculations were made using a calculator and cross checked by another independent person.

2.3.1 Sample characteristics

The average age of the study participants was 24.6 years (range = 18–36yrs), nine were single and eight were living at home with their parents. Six participants lived in the metropolitan area and the remaining four lived in country towns. Of the 10 participants, three were in full-time employment and one in part-time employment, three were studying, one was seeking employment and the remaining two considered themselves unable to work.

2.3.2 Adherence rates

Interview data showed that nine of the participants described themselves to be 75% adherent or more to their overall treatment program for CF, while one participant reported 100% adherence to her treatment program.

Adherence rates reported in the MCFC Questionnaire can be seen in Table 2.1. For consistency, the degree of compliance was determined using the same criteria as in previously published studies using this measure (e.g., Abbott et al., 1994, 1996).

2.3.3 Treatment prescribed and treatment recalled

Concordance between the patients' reports of treatment for their CF and that described in the medical record was examined. Patients listed their treatments and then the details they provided about the frequency and manner in which the treatment was to be

	% compliant	% part-compliant	% non-compliant
Physiotherapy	55	11	33
Exercise	90	10	0
Vitamins	70	10	20
Pancreatic Enzymes	80	20	0

Table 2.1: Adherence rates as reported on the MCFC.

performed were compared with a similar list extracted from each patient's medical case notes. Where the two lists agreed on a treatment and the way it was to be managed, this was considered to be an instance of concordance between the two. Where there was an additional treatment on either list, or disagreement between the two lists about the management of a particular treatment, these events were considered to be instances of non-concordance. The proportion of concordant events was then determined for each patient.

The proportion of treatments for which there was concordance varied between a low of 41% for one patient and a high of 85% for another patient, with an average across patients of 64%. It was more frequent for the patient to list additional treatment components to those recorded in the case-notes than to find that the patient had forgotten or inaccurately recalled some recorded components of the treatment. In this small sample there was no clear relationship between treatment adherence and the degree of concordance between patient and medical record reports of treatment.

2.3.4 Perceptions of treatment importance

Participants were asked to ascribe an importance rating to each of their main prescribed treatments (see Figure 2.1. Not all participants were prescribed all treatments. Participants were unanimous in rating pancreatic enzymes as essential to both their short and long term health. That was also the treatment element to which the most patients reported good adherence on the MCFC. In contrast, patients varied considerably in their reports of the importance to their health of physiotherapy and vitamin replacement therapy. For both of these treatments there was also a lower rate of reported adherence on the MCFC.

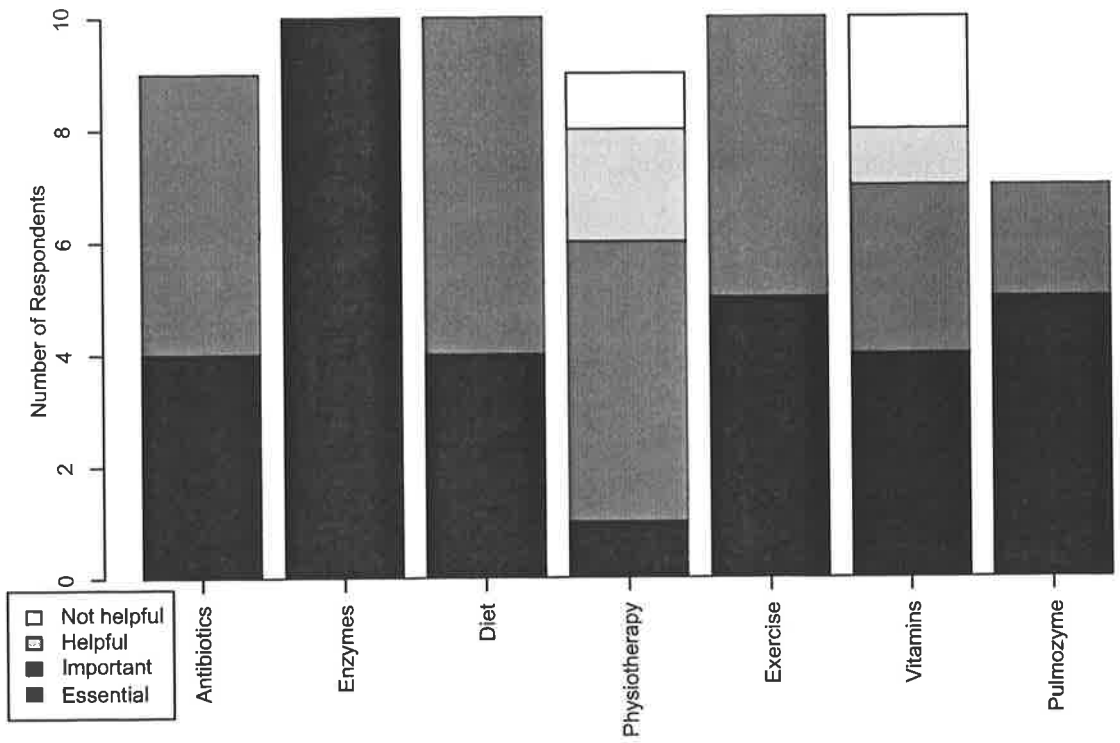

Figure 2.1: Importance ratings given by participants to the different CF treatments. Participants were asked to rate only the treatments prescribed for them.

2.3.5 Factors affecting adherence

From the MCFC questionnaire, a pattern emerged that people reporting greater adherence tended to endorse few of the reasons listed for possible non-adherence. The six patients who reported themselves to be adherent to all four treatments endorsed an average of 2.8 reasons for failing to adhere from time to time to their treatment as prescribed. Of those reasons, 'simply forget' was the most frequently endorsed reason for non-adherence to most treatments, along with a belief that sufficient exercise could replace their daily physiotherapy program. The four patients who reported themselves to be non-adherent endorsed an average of 10.75 reasons for failing to adhere to their treatment program, and the reasons were very varied. During the completion of the MCFC, several of the participants expressed irritation over the repetitiveness of the items and most commented that they thought a number of the possible reasons listed for non-adherence were foolish and not at all relevant to them.

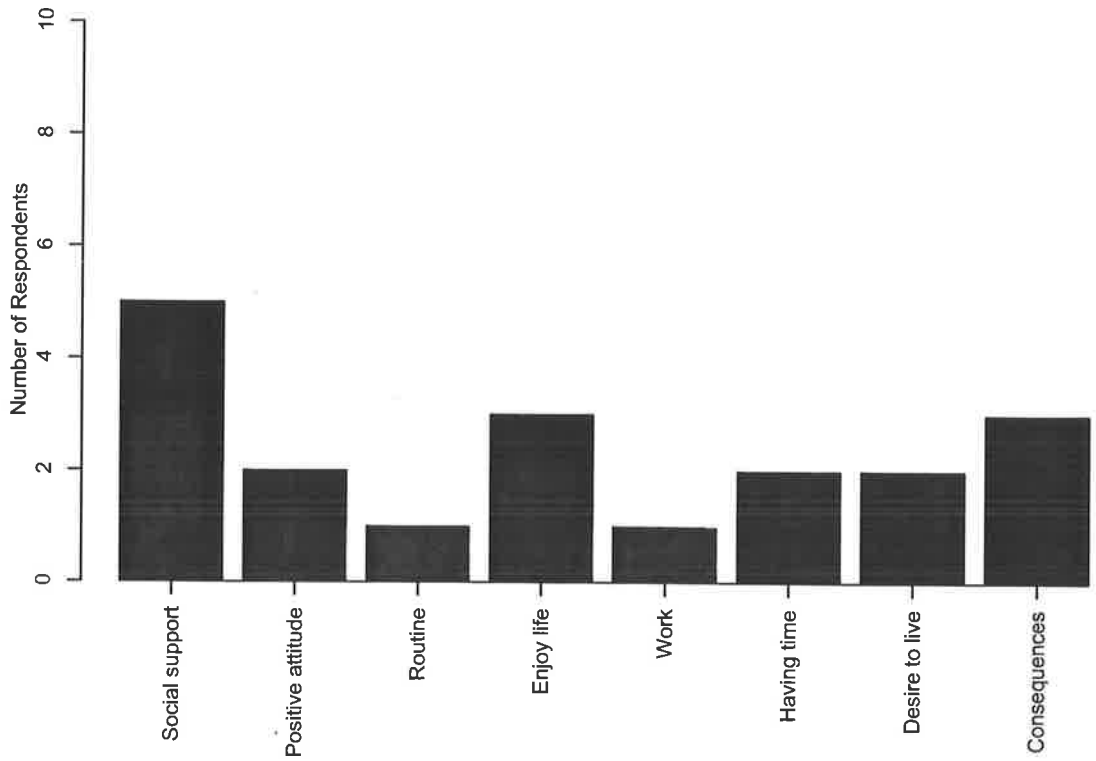

Figure 2.2: Themes which emerged when participants were asked what motivates them to adhere to treatments.

Half of the interviewees reported that social support was a significant motivating factor for their adherence to treatment, while 30% reported a desire to be well enough to enjoy life as their primary motivation to adhere to treatment. An additional 30% reported a dislike of the consequences of non-adherence (such as more symptoms or less energy for activities) as a significant motivating factor (See Figure 2.2).

When asked about factors which interfered with their adherence to CF treatments, 50% of respondents indicated that their non-adherence was a cost/benefit choice; that is, at times the social, emotional or energy related costs of adhering to treatments outweighed the perceived or actual benefits to them. Other important factors were tiredness, lack of time and being out of routine, factors endorsed by 40, 30 and 30% of respondents respectively (see Figure 2.3).

Participants were asked to say to what treatment component they found it most difficult to adhere. Physiotherapy and exercise were the most difficult treatments to adhere to for 30% each of the participants, while 10% each of patients reported tablets in general,

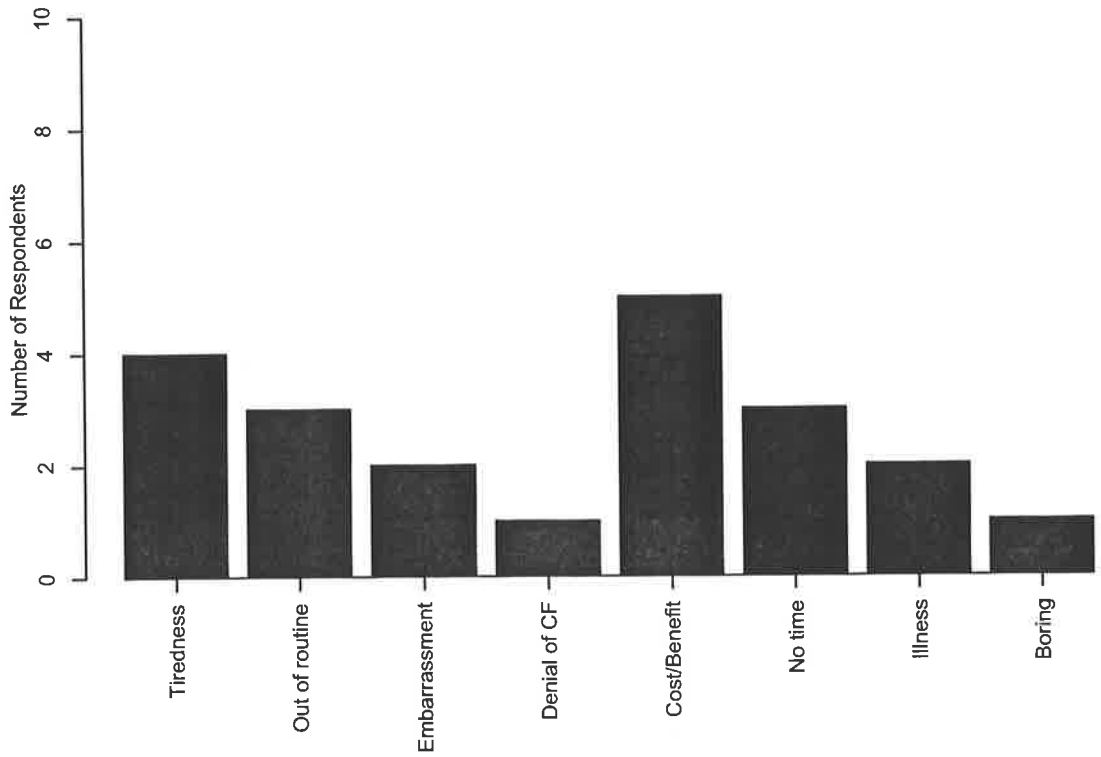

Figure 2.3: Themes which emerged when participants were asked what interferes with their adherence to treatments.

nebulised treatments or dietary considerations to be the most difficult elements of treatment. Respondents tended to group medications by delivery method rather than action. Two reported that none of the treatments were difficult to adhere to and commented that adherence was a matter of attitude and necessity, not whether the treatment was difficult.

2.4 Discussion

In this pilot study the aim was to develop a preliminary understanding of adherence to treatment in an Australian sample of adults with CF. Participants were interviewed about factors which motivated them to adhere to treatment or interfered with their adherence to treatment and were asked to report on their adherence to treatment. Further, they were asked to complete and also comment on the MCFC, to assist in an evaluation of its appropriateness with Australian CF patients.

Patients' reports of their overall adherence to the treatment program proved to be

too general and of limited value in understanding adherence behaviour. In contrast, the treatment specific questions about adherence in the MCFC allowed participants to provide much more detailed responses about their treatment behaviours. However, an important limitation of the MCFC is that it samples only some of the main treatments prescribed in CF. Given the discrepancy in adherence between treatments, even at the self-report level, it seems important for a balanced view that participants are given the opportunity to report on their adherence to all of their main treatments.

In this sample, self-reported adherence to treatments on the MCFC was rated very similarly to that recorded by the Questionnaire authors in their sample of British adults with CF (Abbott et al., 1994), using the same criteria for degree of adherence. As in the British group, adherence varied considerably with the different elements of CF treatment. However, the MCFC was not well received by participants, who found it repetitive and therefore tedious to complete. Most respondents found some of the listed reasons for non-compliance to be irrelevant and this perception seemed to have the effect of reducing the credibility of the measure for the participants. The MCFC is also subject to significant limitations in the way it can be analysed. The format of the questionnaire and the response system limit this questionnaire to descriptive or categorical analysis or to use as a clinical tool to assist in identifying patterns of adherence and possible reasons for poor adherence in individuals with CF.

In the interviews, in response to an open question about what motivated them to adhere, most participants gave responses expressing either the importance of having a positive attitude towards the future or the importance of social supports such as family and friends. In contrast, inhibitors to adherence were largely reported to be situational or related to negative perceptions of the relative value of the treatment in comparison with its demands. While time and health issues emerged also, concerns about aversive aspects of treatments were noticeably absent from participants' comments. Interestingly, inconveniences or aversive aspects of treatments, such as not liking the taste of the treatment, or having difficulty swallowing tablets, were among the reasons for non-adherence listed on the MCFC that people in this small sample considered to be foolish or petty. Items such as these seemed to contribute to the unfavourable opinion which participants

expressed about the MCFC.

In seeking to establish the concordance between participants' recall of treatment and the treatment recorded in their medical record, it was discovered that a complete, written, up-to-date description of the current treatment regimen for each person was not present in one place in their medical record but had to be pieced together in a potentially unreliable fashion. Eventually, it became necessary to meet with the Head of the CF Unit to review the current treatment plan for each participant to confirm whether it was accurate. For some patients consultation with the physiotherapist or dietician was also required, as a recent plan was not noted in the main medical record. It emerged that at times in CF medical consultations in this particular clinic, a written treatment plan was not available at all, and staff from time to time relied on the patient's understanding of the current plan to assist in decision making about renewing prescriptions and instigating new treatments. At the time this study was taking place, a new computer system was being installed in the clinic and it was anticipated that this would assist the physician at least to have ready access to the patient's prescription history. Copies of this history would also be inserted into the medical case notes at regular intervals. Patients at the RAH CF clinic are not routinely given a written copy of their current treatment plan.

It is hypothesised that the limitations in the process of medical record keeping and information sharing in the this CF clinic, may be a relatively widespread problem in Australian CF clinics. This situation could in fact contribute to difficulties with adherence in CF. Without the clear understanding of all parties of what the treatment regimen actually is, it is very difficult to know whether a person is adhering to the treatment or not. It may also make it very difficult for a person who is prescribed treatment to plan the way in which he or she manages treatments and on occasion, prioritises one treatment over another. From a research perspective, in the absence of a clear and specific prescription for treatment it is difficult to either define or measure how well a person has adhered to a treatment program.

This limitation in the information sharing process has been observed as a widespread issue in medical practice, particularly in chronic illness, according to Swinburne (1993). In her letter to the editor of the *Lancet*, she described the problem of patients who

experience medical emergencies as a result of continuing to use a particular product or health management approach over many years that is no longer appropriate for them. Often their physician does not know they are still using the treatment, and the patient does not realise that the treatment may be problematic, as neither party thought to discuss the matter in the medical consultation.

This observation, coupled with the finding of less than optimal concordance about the treatment program from even this small sample, seems to highlight the importance of patients being able to make rational and informed decisions about their own health management. Particularly in a complex illness with a complex routine of home-care, collaboration about the treatment regimen, and formal, written copies of the current treatment plan at medical consultations may prove to be a critical factor in optimising adherence.

These findings then return attention to the question of the cognitive appraisals involved in treatment management by adults with CF. In this study, some participants specifically described a process of weighing up the costs associated with the treatments against the health or lifestyle benefits anticipated as a result of adhering to the treatment. Others reported a more general belief in maintaining a positive attitude to management of the disease and consequently, to prescribed treatments. These outcomes in particular were considered to be key concepts in need of further examination in the main studies for this program of research.

Chapter 3

The Cystic Fibrosis Perceptions Inventory (CFPI)

3.1 Introduction

The main aim of this program of research, outlined in Chapter 1, was to examine the psychological and practical determinants of adherence to treatment among adults with Cystic Fibrosis: in particular, links between disease and treatment perceptions and adherence. This chapter describes the development and validation of a CF specific questionnaire to measure cognitive perceptions and appraisals of both the disease and treatment process as well as self-reported adherence to the main prescribed treatments in CF. The measure has been named the Cystic Fibrosis Perceptions Inventory (CFPI). The rationale for the decision to develop and test a new measure is presented, along with a discussion about the item development and the results of studies conducted to examine construct validity, internal and test re-test reliability and the value of the measure in improving understanding of treatment adherence in adults with CF.

In psychological research many factors can drive the decision to produce a new measure for research rather than using one previously developed. Often there is no suitable measure available and therefore no doubt that a new measure is required. At other times, there may be measures which will address part of the research question and in combination with one another, can be used to collect the required information. In this case, there were three

measures which addressed elements of the questions to be answered by this research: the Manchester Cystic Fibrosis Compliance Questionnaire (MCFC; Abbott et al., 1994), the Illness Perceptions Questionnaire (Weinman et al., 1996) and the Beliefs about Medicines Questionnaire (Horne, Weinman & Hankins, 1998). There were concerns however, about the relevance of aspects of each of the measures to the specific context of this research and there were overlaps in the concepts addressed by the measures. Further, there were additional concepts that have been identified as associated with adherence in CF, such as elements of health locus of control and health beliefs (Abbott et al., 1996) which were not represented in any of these existing measures and which warranted inclusion in this research.

The pilot study described in Chapter 2 provided an opportunity to trial the MCFC with a sample of Australian adults with CF and revealed some important limitations with the measure. It was not generally well received by participants, being perceived as repetitive; was limited to an examination of only four regular CF treatments, and provided limited options for data analysis. A dilemma in considering whether to use this measure in spite of the limitations and its apparent lack of popularity with participants was the recognition that while it is repetitive, there are sound reasons for that. Previous research into adherence among adults with CF has begun to demonstrate that people with CF adhere differently to the different treatments (Abbott et al., 1994; Conway et al., 1996). The obvious logical extension to this, in terms of the hypothesis that beliefs and perceptions influence adherence, is that people will have different opinions and beliefs relevant to their adherence to particular treatments. The approach used in the MCFC for the self-report measurement of adherence was considered to be informative, and a good model for further development. Further, some items in the measure relating to reasons for non-adherence were endorsed by a majority of participants in the pilot study and were therefore considered important concepts to include in future studies. Overall however, the relatively small number of reasons for non-adherence endorsed by the pilot study participants, from among the many reasons listed, and the limited number of treatments covered by the measure, were crucial factors in the decision not to depend upon this measure.

The Illness Perceptions Questionnaire (IPQ) was also considered for this study. It is directed specifically at individuals' appraisals of their illness in terms of the five themes of illness perception described in the Self-Regulatory Model (SRM) and detailed in Chapter 1, and has been found to be a valuable tool in predicting adherence to treatment in some chronic illnesses (Petrie & Weinman, 1997). On close consideration, it was considered likely that only those items relating to *consequences* of the illness or to *cure/control* would be likely to discriminate meaningfully between adults with CF. For example, CF is an hereditary illness, which is life-long and life-shortening. These characteristics are understood by all but a very small number of adult patients (Conway, Pond, Watson & Hamnett, 1996) and it was anticipated therefore, that the IPQ items related to *time-line* and *cause* of the disease were likely to elicit the same responses from most patients with CF. These responses would thus be unhelpful in discriminating between patients on the basis of adherence. Similarly, previous research has demonstrated that disease severity (and by association, symptom severity) does not predict adherence in CF (Conway et al., 1996; Abbott & Gee, 1998), so it was deemed unlikely that items related to symptoms experienced (*identity*) would predict adherence in this population. Given that only some parts of the measure were expected to be useful in the context of CF, and that the IPQ authors had cautioned against relying on the psychometric stability of the particular subset of items from the measure (Weinman et al., 1996), a decision was made that the relevant themes of the IPQ would be important to represent in the final measure to be used for this study, but that the IPQ itself would not be used. At the time this report was being written, the Revised IPQ had been validated and was available, however it had not been published at the time the research was being planned and could not therefore be examined for its suitability for use for this research.

The last of the measures considered for use in this research was the Beliefs about Medicines Questionnaire (BMQ). This is a 10 item questionnaire, designed to extend the scope of the SRM to include cognitive representations about medicines prescribed to treat illness (Horne, 1997; Horne et al., 1998). As with the IPQ and (to a lesser extent), the MCFC, the BMQ has been well validated both conceptually and psychometrically. Scores on the measure have been found to have small to moderate and statistically significant

correlations with self-reported adherence to treatment for people with chronic illness in several large samples and across seven chronic illness groups (Horne et al., 1998; Horne & Weinman, 1999). The majority of the items in this measure were conceptually close to issues to be addressed with this research. There were two important limitations to the measure however, which were important in the CF context. The first was that the measure was concerned only with prescribed medicines and not with other prescribed non-drug treatments which are central to CF care. The second was that the items were generalised to all medicines for an illness, rather than differentiating between medicines for that illness. As described above, this was of concern given the possibility that at least some beliefs about treatment may be limited to some treatments but not others.

Thus, as with both of the other measures, it was decided not to use the BMQ, but to incorporate the concepts of beliefs about medicines into a new, CF specific measure of beliefs and perceptions about both the illness and its treatment and including self-reported adherence to seven of the most commonly prescribed CF treatments.

The development and preliminary validation of this new measure has taken place as part of the two main studies conducted for this doctoral research project. Those studies are described in Chapters 4 and 5. The initial item development and preparation of the structure of the measure was conducted after and partly as a result of the outcomes of Study 1, and was first used in the cross-sectional study described in Chapter 4. In that study, the face validity, preliminary test-retest reliability (over two weeks), and internal reliability of the measure were examined for the first time. The construct validity was considered through the findings reported from that study.

Based on the outcomes of those evaluations, some changes were made to both the item content of the measure and its structure. Further evaluation of the measure has been and is continuing to be conducted in four different studies. Study 3, the longitudinal electronic monitoring study described in Chapter 5, provided an opportunity to test the construct validity of the measure further, in particular in relation to the BMQ. It was possible to compare the self-reported adherence to two CF treatments with electronically monitored adherence to the same treatments over three months. That study also provided test-retest information about the measure over three months.

In the planning for Study 3, it was recognised that although that extra data would add to an understanding of the validity of the measure, the sample size would be too small to conduct factor analyses in order to better understand the internal properties of the measure, and further, would only provide data about the way the measure was used by a relatively small group of people. In response to the need for a stronger test of the the value and reliability of the measure, three new, collaborative studies were planned. The first of these studies involved a small sample of adolescents from Florida, USA, and is completed and reported below. Another study involves a sample of 150 adults with CF from Leeds in the United Kingdom, and the third, a sample of 100 adults with CF from Victoria, Australia. The last two studies have required very lengthy processes of negotiation, communication, planning and ethics approval in order to begin, and, at the time of preparation of this dissertation, are not complete. Regrettably, the data for those two major studies are still being collected and are not available to be included in this thesis.

3.2 Aims

The following aims were generated for the production of this new measure:

- to develop the Cystic Fibrosis Perceptions Inventory (CFPI), a disease specific measure of treatment and illness beliefs, with a focus on treatment adherence, for adults with Cystic Fibrosis.
- to explore the internal structure and reliability of the CFPI.
- to examine the test-retest reliability of the CFPI over two weeks and over three months.
- to examine the construct, concurrent and discriminant validity of the CFPI as a disease specific measure of treatment and illness beliefs.

3.3 Item development

Once the decision had been made to develop a new, CF specific measure of beliefs and perceptions, combined with a self-report of adherence, the categories of items were chosen and item development began. The measure was separated into three parts: a section for self-reported adherence to treatments in CF, a section for a rating of importance for each of the treatments, and a section with a number of statements of perceptions, opinions or beliefs about the disease and its treatment that may be important to adherence.

3.3.1 Self-reported adherence

Development of the self-reported adherence section of the measure was done first. An important issue to be resolved for this self-report scale was whether it was going to be designed to represent a "true" measure of adherence or whether it was to represent patients' estimates of their relative adherence to the different treatments. As discussed in Chapter 1, there are difficulties with response biases and inaccurate recall in self-report, that result in self-report underestimating the extent of non-adherence by about 20% (Haynes et al., 1980). At the same time, specificity of questions, and recall over a short period of time have both been found to improve the accuracy and predictive value of self-report (Quittner et al., 2000). As observed directly in the pilot study reported in Chapter 2, and as noted in the literature (Oppenheim, 1992), self-report of adherence is more likely to yield accurate results if measured on a continuous scale rather than a dichotomous scale that uses *adherent* versus *non-adherent* categories.

As one of the most significant aims of this research was to explore the differential adherence of people with CF to different treatments, it was decided that it would be more important to aim for respondents to provide a global estimate about their relative adherence to the different treatments, rather than to provide accurate detail about the extent of their adherence to each treatment. This approach was also adopted by Horne et al. (1998) in their paper addressing the relationship between adherence to treatment and beliefs about medicines for four chronic illness groups.

Keeping in mind all the factors associated with more accurate self-report, the format

adopted for measuring adherence in this study was based on the structure used specifically for enzyme and vitamin use in the MCFC, the only self-report measure previously developed to examine adherence in adults with CF. In that measure, patients are asked to rate their use of those medicines as *Never*, *Occasionally*, *Usually* or *Always*, yielding a four point ordinal scale. Additional information is requested also, about the way that the medicines are used, to check for correctness of the regimen. Although there are advantages to having this extra information, it also makes the measure more complex for people to complete and adds to the difficulty of comparing perceived adherence between treatments. As it was desirable for the purposes of this research that the scores for each treatment be comparable, and it was people's perceptions of their relative adherence to treatments that were of interest, it was decided to use a variation of the four point scale used in the MCFC, without the additional treatment information. In the pilot study described above, some participants had commented that they did some of their treatment only when they were sick, so it was decided to include this condition in the scale of choices for reported adherence. The choices on the Likert type scale were therefore drafted as *Never*, *Only when sick*, *Occasionally*, *Usually* and *Always*; corresponding to scores of "1", "2", "3", "4" or "5" respectively.

This draft scale wording was shown at random (as a part of the first draft of the whole measure), to a small number of adults with CF attending the RAH outpatient CF clinic for medical consultations. All the patients who were asked to comment on the scale agreed that it was understandable, but noted that the choice of words was formal and a little off-putting. Suggestions were made that the word "usually" be replaced with "mostly" and the word "occasionally" be replaced with "sometimes". These suggestions were adopted. Also, at the suggestion of patients, the order of presentation of the options was reversed, so that "Always" appeared first and "Never", last.

The treatments chosen for representation in the measure were drawn from two sources: a discussion with the head of the CF Unit at the RAH about the most frequently prescribed or "standard" treatments in CF, and from the treatments in common, reported by participants in the pilot study to be part of their regular treatment regimen. From these two sources, the following list of treatments was derived:

- Antibiotics
- Pancreatic Enzymes
- Physiotherapy for airway clearance
- Vitamin replacement therapy
- Exercise
- Dietary management
- rhDNase

After this list had been made, the wording of the items and the period of time on which people were to base their self-report estimates of adherence were considered. Discussions were held with members of the treatment team at the RAH to determine whether the names given to the treatments in the list above would be readily understood by patients. The descriptions above were considered acceptable for all but the last treatment. For the last treatment, it was recommended by the team that the brand name Pulmozyme be used as this is the only brand of rhDNase available in Australia, and would be much more readily understood by patients than the generic name. In these same consultations, the people approached recommended unanimously, that "pancreatic enzymes" be shortened to "enzymes", "physiotherapy for airway clearance" be shortened to "physiotherapy" and that "vitamin replacement therapy" be shortened to "vitamins". Agreement about these changes was unanimous in this small group and it was decided that it was unnecessary to consult more widely with a larger group of adults with CF. The adult volunteers also recommended that the wording be changed for "dietary management", but did not concur about the alternative wording in that case. When these changes were taken back to the CF team, all team members approached agreed that the new descriptors for the treatments could be expected to be understood by adults with CF generally and, just as importantly, not confused with other treatments. A suggestion was made that "dietary management" be changed to "eaten in the way recommended to me", and this was considered acceptable by another two patients approached in the waiting area for their opinion.

The period of time over which patients were asked to report their use of the chosen treatments was set at one month. Given the limited specificity requested of patients about their adherence to each treatment, one month was considered (short of the patient experiencing extraordinary circumstances), to be an adequate length of time for patients' to be able to represent their typical adherence. While people could be expected to be more accurate about their adherence over a shorter period of time like one week, one or two weeks was considered too short a time to establish a sense of their usual pattern of behaviour rather than just a moment in time. A longer period of time than one month was considered to present a higher risk of receiving a "guesstimate" rather than a considered response from participants.

A critical decision to be made about this measure, was the way that the concept of "adherence" was to be worded. Adherence is a fairly formal and somewhat jargonistic term, which it was decided, would be best avoided in the measure if possible. Two alternative phrases were generated; "stick to my CF treatments" and "keep up with my CF treatments", as being conceptually close to the term "adherence". These were presented to the adults with CF who were consulted about other aspects of wording, for their opinion about what the two phrases meant, so that a choice could be made between them for the measure. The descriptions given by people about the phrase "keep up with my CF treatment" accurately reflected the concept of adherence as presented earlier, in Chapter 1, and that phrase was therefore adopted for use throughout the measure.

3.3.2 Perceived importance

The perceived importance of treatments to adults with CF was a central concept to be addressed by this measure. Further, it was important that the measure be structured so that this concept could be compared with reported adherence for each treatment. The same treatments as described above, were thus represented in this section of the measure with the addition of an "Other" category, to allow patients to report on the importance of any additional medications or treatments for their CF which were not represented explicitly on the scale. While a five point scale was chosen for the self-report of adherence,

a four point scale was chosen for reporting on treatment importance. Further breakdown of the degree of importance was considered unlikely to add appreciably to the value of the information sought from the scale. As there were no previously published measures of perceived importance on which to base the scale points for this measure, the points were chosen to try to represent graded levels of importance, from extremely important through to treatments which were perceived to have no importance. The descriptors were chosen so that each point could be represented by a minimal number of words. The descriptors chosen were *Essential*, *Important*, *Helpful* and *Not Helpful*. When presented for consideration to the random sample of adults with CF, this wording was judged by them to be acceptable and understandable, and was retained. For analysis purposes, these descriptors were assigned number values of "1" for *Essential*, "2" for *Important*, "3" for *Helpful* and "4" for *Not Helpful*.

In CF, some treatments provide acute symptomatic relief or immediate benefit, while others have a delayed or preventive benefit. It was predicted because of this, that people may perceive the importance of the treatments relative to their short or long-term health differently. To cater for this possible difference, the perceived importance scale was presented twice in the measure, once with reference to perceptions of importance to short-term health and again with reference to long-term health.

3.3.3 Beliefs about CF and CF treatment

The third major section was to measure the beliefs and perceptions held by adults with CF about their disease and its treatment (other than the degree of perceived importance treatments have for them). The format for this section of the measure was chosen to match that of the BMQ (see Appendix B), with a series of statements, each rated in terms of the amount to which the respondent agrees or disagrees with the statement. As for the BMQ, a five-point scale was chosen, with responses being *Strongly Disagree*, *Disagree*, *Neither Agree nor Disagree*, *Agree* and *Strongly Agree*. In the BMQ, the middle response on the scale is *Uncertain*, however this was changed to *Neither Agree nor Disagree* for this scale, as it was intended to provide a choice for those people who felt they did not

have an opinion about the statement rather than being uncertain about an opinion. For the purpose of analysis, these scale points were given numeric values of "1" for *Strongly Disagree* through to "5" for *Strongly Agree.*

There was a dilemma to be resolved about the degree of repetition to use in this measure to differentiate between beliefs applicable to some treatments but not others. Excessive repetition was considered likely to result in a measure which was too long and that patients would be unwilling to complete. However, treatment characteristics were considered important for some beliefs or perceptions. A compromise was made, where items which were about CF generally were not made referent to specific treatments, but others, which were deemed most likely to be affected differently by different treatments, were formulated more specifically for those treatments.

There were a number of different conceptual ideas which were considered important to represent in the measure, drawn from previous findings about adherence by adults with CF, from the SRM put forward by Leventhal and colleagues and described in Chapter 1 and from the practical expressions of that model, including illness perceptions and beliefs about treatment. Previous adherence research with adults with CF (Abbott et al., 1996) showed that worry about the disease was associated with better adherence to treatment and that adults cited forgetfulness as a significant reason for non-adherence(Abbott et al., 1994). Further, adults who perceived significant others to be in control of their health (i.e., doctors) reported adhering better to treatments (Abbott et al., 1996). These findings appeared to apply to CF treatments in general and items generated to reflect these ideas were therefore worded about CF and its treatment generally. In that same paper, other aspects of health locus of control were not found to be associated with adherence to treatment, however, in the absence of replications for those findings, it was considered worthwhile to include other aspects of responsibility about decision making for CF treatment in this measure. The following items were generated about these issues:

- I worry about the future.
- When I feel worried about my CF I keep up with more of my CF treatment.
- At times, I genuinely forget to do some of my treatment.

- I am the best judge of the treatment I need.
- My doctors are the best judges of the treatment I need.
- Decisions about my treatment must be made jointly by me and my doctors.

Although the *Importance* scale described above was designed to assess the relative value that people perceive the different CF treatments to have for their health, it was also considered important to ask for information about treatment value more generally, as previous findings using the BMQ indicated that in general the concept of the necessity of medicines was associated with better adherence (Horne et al., 1998). In particular, the value of the process of medication management was considered to be an important and separate consideration from the value of the treatment itself. Conceptually, it makes sense to consider beliefs about the value or effectiveness of treatments alongside beliefs about the possibility of cure or control of the disease. Together, the following items were constructed to address these concepts:

- When I do it properly, I believe that my CF treatment works well overall.
- Keeping exactly to my prescribed treatments is very important.
- When I am in a good routine, I keep up with more of my CF treatment.
- I will beat CF
- When I start a new treatment I keep up with more of my usual CF treatment.

In contrast to these concepts of value, the issue of concerns about treatment was important to address and this was a situation in which it was considered likely that some concepts would be treatment specific while others might be more general. A blend of general and treatment specific items was generated to reflect concerns identified previously in research using the MCFC, in the pilot study reported earlier and in research addressing beliefs about medicines. This was also considered to be an opportunity for patients to report on their beliefs about the acceptability or otherwise of managing their treatments differently to the way they were prescribed. The items were:

- I am prescribed too much medication.
- My treatment is too demanding on my time.
- My treatment costs too much money.
- I need "time-out" from my CF treatment routine from time-to-time.
- Sometimes, the hassles involved with my CF treatment (e.g., effort/time/expense) outweigh the benefits.
- When I don't feel any better after my treatment I keep up with less of my CF treatment.
- Missing some doses of medication won't do me any harm.
- Taking my medication at the wrong time of day won't do me any harm.
- Missing my exercise or physio sometimes won't do me any harm.
- It is okay for me to vary my treatments depending on how well I feel each day.

In Study 1, several factors were reported as being related to better motivation to adhere to treatments and it was considered important to represent these ideas in this measure. Some of these factors also fit quite well with the concept of perceived threat of the illness as discussed in the SRM. The factors reported by the patients in the pilot study were social or family support, better health, "reminders" to adhere such as outpatient clinic appointments or, less positively, increases in the perceived threat of the illness such as feeling unwell, admission to hospital for treatment of CF exacerbations, and drops in lung function. The following items were developed to address these concepts. Some of the items were deliberately worded in the opposite direction to the expected responses, to help guard against the risk of people responding automatically in the same way to each item, without really thinking about their response to it.

- When I feel supported or encouraged by people around me I keep up with more of my CF treatment.

- When I feel well I keep up with more of my CF treatment.
- After a regular clinic visit I keep up with more of my CF treatment.
- When I have a clinic visit coming up I keep up with less of my CF treatment.
- When I get home after a hospital admission I keep up with more of my normal CF treatment.
- When my lung function drops I keep up with more of my CF treatment.
- When I get feedback (e.g., PFT, blood test) that a treatment is working I keep up with the treatment more.
- When I am unwell I keep up with less of my CF treatment.

Responses from the pilot study also highlighted that there may be important emotional or energy related distractions or significant competing activities which may influence adherence to treatment. These were represented in this measure by the following items:

- When I am on holidays I keep up with less of my CF treatment.
- When I feel down or depressed I keep up with less of my CF treatment.
- When I am pressured with work I keep up with less of my CF treatment.
- When I am tired I keep up with less of my CF treatment.
- When I have problems or hassles in my family I keep up with less of my CF treatment.
- When I am busy in my social life I keep up with less of my CF treatment.

In light of the finding from the pilot study that there was limited concordance between what patients reported their treatment regimen to be, and what the treatment regimen was reported to be in the medical notes, issues associated with communication about the health care regimen were considered likely to be associated with adherence in adults with CF. The following items were included to examine this.

- I always have a clear understanding of what I am supposed to do with my medications and other treatments.
- I would feel comfortable about telling my doctor if I was having trouble keeping up with all my treatments.

As discussed earlier, with reference to perceived importance of treatments, it was anticipated that patients would perceive short and long-term importance of treatments differently, and it was hypothesised that differences in short or long-term focus in general may be linked with adherence as well. These hypotheses arose in response to thinking about the *time-line* aspect of illness perceptions. While, as noted above in the introductory remarks for this chapter, it was considered likely that people with CF would think similarly to one another about the time-line of the disease, the concept of a more generalised "now" versus "future" focus was one more likely to differentiate between people with CF and may in its own right, influence decisions about treatment. The following items were developed to reflect beliefs associated with this.

- I focus on the future more than what is happening right now.
- I focus on today and let the future take care of itself.
- When I have a goal to work towards, I keep up with more of my CF treatment.
- When I feel positive about the future I keep up with more of my CF treatment.

Finally, in the pilot study, one participant particularly commented about being "in denial" about her disease and the severity of it and described this as something which interfered with her adherence to treatment. Also, one of the consistent findings from research about adherence in adults with CF is that people underestimate the severity of their disease. This, combined with the fact that some people with CF are affected only mildly by symptoms from their disease, aroused my curiosity about whether other adults with CF experienced a similar emotional reaction and further, whether it was associated with adherence for them. In order to examine this possibility, the following two items were added to the measure.

- I find it hard to believe that I have CF.
- At times I try to forget that I have CF.

Once these items had been chosen, their order of appearance in the measure was decided, and the measure was completed. The whole measure was presented to both the CF health care team at the RAH and the small group of adults with CF mentioned above, and with the support from both of these groups, for the clarity and face validity of the measure, the cross-sectional study described in Chapter 4 was undertaken, using the measure in this form. Changes made to the measure as a result of that study are reported below.

3.4 Psychometric properties of the CFPI

All statistical analyses were conducted using the statistics software package SPSS for Windows, version 10. Consideration was given to the appropriate statistical approach to examining the data generated by this measure. While the data were, strictly speaking, ordinal, analysis of the distribution of responses for each item revealed sufficient variability in responses to most items to engender confidence that this data could be treated as interval level data and thus, parametric analyses would yield meaningful and valid results. Where the responses to particular items fell in a particularly restricted range, reducing the validity of the analyses, this is discussed at the appropriate place in the text below. The main statistical tools used to examine the psychometric properties of this measure therefore, were Pearson's Product Moment Correlation Coefficients, to examine the strength of association between items, and Cronbach's Alpha to examine the internal reliability of sub-scales derived from this measure.

Several types of reliability and validity were examined for this measure, although it was beyond the scope of this investigation to examine all the relevant aspects of validity. The types of reliability and validity addressed, were drawn from those identified by Nunally & Bernstein (1994). These guidelines have been used recently in the validation of the Cystic Fibrosis Questionnaire, a health related Quality of Life measure designed primarily for

children and adolescents with Cystic Fibrosis (Quittner, Buu, Watrous & Davis, 2000) and offer a useful framework for considering the properties of a questionnaire.

As described in the previous section, content validity was a high priority and was given significant consideration in the development of the items for the measure. The construct validity of the CFPI was considered mostly when the measure was used in the studies described in Chapters 4 and 5 and is only discussed briefly below, in the context of the determination of the subscales of the *beliefs* section of the measure. A part of that validation process was the examination of the way in which the items in the scale were associated with one another, and whether these associations met with prior expectations about constructs the measure was designed to represent and capture. The internal reliability of the emerging constructs was then examined, as was the item internal consistency (i.e., the strength of association between an item and the sum of the items in that scale).

Test-retest reliability analysis of all aspects of the measure was conducted, both in the short-term (two weeks) and over a longer period of time (three months). Concurrent and convergent validity of the measure was examined through the electronic monitoring study, where aspects of the CFPI were compared with the BMQ. As this is a new measure, and its properties were being considered for the first time, the measurement of discriminant validity (i.e., correlations between measures that are *not* expected to relate to each other) was not attempted, although item-level discriminant validity was examined. The predictive validity of the measure was not examined here either, largely because the sample sizes of the studies reported were not large enough to attempt predictive modelling.

3.5 Internal structure and reliability

3.5.1 Determination of subscales for the CFPI

The internal structure of the CFPI was first examined through the cross-sectional study described in Chapter 4, and the internal reliability results for that study are described here.

The *beliefs* section of the CFPI was designed to measure a number of different aspects of illness and treatment perception in adults with CF. As an examination of illness and treatment perceptions in CF was a novel process, it was decided that, rather than attempting to fit the items into the pre-determined categories from which they were drawn, a valuable first process would be to examine the inter-relationships between items "blindly", with only number identification, in order to see whether there was a conceptual fit between items which correlated well with one another. Another goal for this first consideration of the data was to identify any items which did not relate well to others in the scale or did not appear to add a novel contribution to any emerging scales. This scale was quite long in its first form, and it was considered desirable to reduce the number of items in the scale if any were found to be redundant.

Pearson's correlations were performed therefore, to examine the relationships between each of the items in this section of the scale with all the other items in the section. A combination of several criteria were used to determine whether an item should be dropped from the measure. If the item had only one or two statistically significant correlations with any other item in the section, and it was not independently associated with reported adherence to any of the CF treatments, it was dropped from the measure. If one item appeared to duplicate the role and associations of another item, the item out of the two with the largest correlations was retained and the weaker item was dropped from the measure. If an item had a number of statistically significant correlations with others, but did not appear to fit better with any particular cluster of items compared with others, it was flagged for closer consideration in terms of content. If it did not have a good conceptual fit with any particular emergent subscale, it was dropped. Finally, if an item did not discriminate between respondents because everyone answered it in the same way, it was considered unlikely that the item would be helpful to the examination of factors which differentiate between people in terms of adherence to treatment, and the item was dropped, regardless of whether the finding was of interest in its own right.

On examination, eight items were found to meet at least one of the redundancy criteria above, and were dropped from the measure. No further analysis was conducted with items dropped from the measure at this stage. Items dropped from the analysis after the

questionnaire had been used for the first time, in the cross-sectional study described in Chapter 4 were:

C2 My doctors are the best judges of the treatment I need.

C8 I find it hard to believe I have CF.

C18 I focus on today and let the future take care of itself.

C19 I worry about the future.

C24 When I get feedback (e.g., PFT, blood test) that a treatment is working I keep up with the treatment more.

C28 When I feel well I keep up with more of my CF treatment.

C34 When I have a clinic visit coming up I keep up with less of my CF treatment.

C38 When I am unwell I keep up with less of my CF treatment.

A further two items also failed to fit well into any of the emerging scales, however it was decided to retain the items for the next study. Both of these items were associated conceptually with the idea of an internal locus of control and had associations with numerous other items in the scale. It was decided that it would be premature to remove them at this stage of the validation of the measure. No attempt was made to place them into a subscale although their test-retest reliability is examined with the other items later. The two items retained but not used in the analysis were:

C1 I am the best judge of the treatment I need.

C4 It is okay for me to vary my treatments depending on how well I feel each day.

Due to the small sample size for this study, it was not possible to use conventional principal components analysis to explore the item relationships in this measure. This process was therefore done by hand, with an examination of the intercorrelations between the different items, based on the McQuitty process of cluster analysis (McQuitty, 1961). This analysis makes use of the highest correlations held by each variable with any other.

The basis of each cluster is a pair of variables whose highest correlation is with the other variable of the pair. The cluster is then built around this pair and includes all other variables that have their highest correlation with any other variable in the cluster. In this context, where some association between constructs could be expected and there was not a prediction of fully orthogonal subscales, it was considered that this process was potentially too inclusive. In order to be retained in the cluster then, each variable needed to have a positive statistical relationship with the other variables in the cluster, and to be statistically significantly associated with more than one variable in the cluster.

At the end of this process, five clusters, that will be referred to as subscales, emerged. While they were all somewhat different from the specific constructs used in the item development phase, each did appear to be a conceptually linked group of items, perhaps representing slightly different constructs than first anticipated. The internal reliability of these subscales was examined using Cronbach's Alpha. Four of the scales were found to have good internal reliability (an α of 0.80 or higher), while the fifth scale, although it appeared to make sense conceptually, had a lower α of just under 0.60. As this was a new measure and tested on a small sample, this lower α was considered to be acceptable at this stage. Based on the concepts which these five subscales appeared to represent, they were given the following names: Treatment Value, Cost versus Benefit, Denial, Concerns/Attention and Lifestyle/Energy.

The Treatment Value scale ($\alpha = 0.82$) appeared to reflect two main concepts; an overall belief in the value or effectiveness of the treatment program and a motivation to do it well. In contrast, the Cost versus Benefit scale ($\alpha = 0.85$) appeared to reflect a belief in the acceptability of modifying treatment plans, combined with concerns that treatment was too costly in terms of effort, time or money compared with the benefits to be experienced as a result of the treatment. The third scale, labelled Denial ($\alpha = 0.58$), had only three items. It seemed to reflect either one of two possibilities: that the person was, at some level, in denial about the seriousness of their illness, or that they were extremely optimistic and focussed on a positive future. Given the current reality of the nature of CF as a life-shortening illness, for the purposes of this research the cluster of items was described as Denial rather than optimism about an achievable future. This

position also fits with the findings from examinations of coping behaviour in CF, that denial of the illness process is a common and in some cases, quite effective psychological coping process for people with CF.

The fourth scale, Concerns/Attention ($\alpha = 0.83$), included items about responsiveness to situations of heightened attention to the disease process in CF, or that might increase the perceptions of illness threat in CF, such as clinic and hospital attendance, changes in treatment routine or health status and a tendency to think about the future in terms of the disease. The final subscale, Lifestyle/Energy ($\alpha = 0.88$), appeared to reflect issues related to lifestyle choices or pressures and to emotional or energy drains which might impinge on the self-regulatory process of decision making about treatment.

The CFPI items are presented in their subscales in Table 3.1. The detailed internal reliability information, for each subscale, including item level statistical properties, is presented in Appendix C.

Table 3.1: Internal subscale structure of the CFPI.

Item	Content
	Treatment Value
C3	Decisions about my treatment must be made jointly by me and my doctors.
C5	When I do it properly, I believe that my treatment works well overall.
C6	Keeping exactly to my prescribed treatment is very important.
C7	I always have a clear understanding of what I am supposed to do with my medication and other treatments.
C27	When I have a goal to work towards I keep up with more of my CF treatment.
C37	When I feel supported or encouraged by people around me I keep up with more of my CF treatment.
C39	When I am in a good routine I keep up with more of my CF treatment.

Table 3.1: (continued)

Item	Content
	Cost vs Benefit
C9	I am prescribed too much medication.
C10	My treatment is too demanding on my time.
C11	Missing some doses of medication won't do me any harm.
C12	Taking my medication at the wrong time of day won't do me any harm.
C13	Missing my exercise or physio sometimes won't do me any harm.
C20	At times I genuinely forget to do some of my treatment.
C21	I need "time-out" from my CF treatment routine from time-to-time.
C23	Sometimes, the hassles involved with my treatment (e.g., effort/time/expense) outweigh the benefits.
	Denial
C14	I will beat CF.
C17	My treatment costs too much money.
C22	At times I try to forget that I have CF.
	Concern/Attention
C15	I would feel comfortable about telling my doctor if I was having trouble keeping up with all my treatments.
C16	I focus on the future more than what is happening right now.
C29	When I get home after a hospital admission I keep up with more of my normal CF treatment.
C30	When my lung function drops I keep up with more of my CF treatment.
C31	After a regular clinic visit I keep up with more of my CF treatment.

Table 3.1: (continued)

Item	Content
C32	When I feel worried about my CF I keep up with more of my CF treatment.
C33	When I feel positive about the future I keep up with more of my CF treatment.
C36	When I start a new treatment I keep up with more of my usual CF treatment.
	Lifestyle/Energy
C25	When I am on holidays I keep up with less of my CF treatment.
C26	When I feel down or depressed I keep up with less of my CF treatment.
C35	When I am pressured with work I keep up with less of my CF treatment.
C40	When I am tired I keep up with less of my CF treatment.
C41	When I don't feel any better after my treatment I keep up with less of my CF treatment.
C42	When I have problems or hassles in my family I keep up with less of my CF treatment.
C43	When I am busy in my social life I keep up with less of my CF treatment.

For each of these scales, a summary score was calculated by taking the mean of all the item scores in the scale for each person. To account for missing data, a mean scale score was produced if there were scores for at least four out of the total number of items for the scale. For the Denial scale, which had only three items, at least two scores needed to be present before a scale score was calculated. Once these subscale scores had been calculated, it was possible to examine the relationship between each item and both the overall scale it was supposed to be contained within, as well as its association with any other scales. Ideally, item-to-scale correlations should be 0.40 or greater (Campbell & Fiske, 1959; Quittner et al., 2000). This analysis also allows for an examination of item-

level discriminant validity, that is, whether the item is correlated more strongly with its intended scale or another scale. The results of this analysis are presented in Table 3.2 and it can be seen that all of the item-to-scale correlations met the criteria of being 0.40 or higher. Further, with the exception of item C39, which correlated more highly with the Concerns/Attention scale than with Treatment Value, its intended scale, all of the items did demonstrate item-level discriminant validity, being more highly correlated with their intended scale than any other. It was clear however, that there was a significant correlation between the Treatment Value scale and the Concerns/Attention scale.

Item	Treatment Value	Cost vs Benefit	Denial	Concern/ Attention	Lifestyle/ Energy
C3	.774**	.058	.106	.467**	.412*
C5	.748**	.024	.257	.531**	.262
C6	.670**	−.283	−.008	.547**	−.007
C7	.766**	.173	.325*	.479**	.242
C27	.681**	.348*	.541**	.519**	.404*
C37	.640**	.459**	.290	.454**	.607**
C39	.563**	.234	.223	.726**	.284
C9	−.072	.654**	.121	−.031	.370*
C10	−.019	.559**	.265	−.105	.407*
C11	.038	.672**	.363*	−.010	.295
C12	.294	.705**	.515**	.330*	.387*
C13	.127	.764**	.429**	.019	.249
C20	.212	.804**	.423**	.150	.648**
C21	.342*	.746**	.646**	.325*	.499**
C23	.206	.728**	.338*	.112	.529**
C14	.381*	.175	.737**	.373*	.129
C17	.288	.652**	.723**	.225	.273
C22	.096	.529**	.779**	.058	.258
C15	.379*	.074	.348*	.425**	.006
C16	.320*	.229	.417**	.480**	.098
C29	.523**	.250	.351*	.730**	.156
C30	.522**	−.001	.046	.772**	.115
C31	.501**	−.080	.197	.846**	−.043
C32	.723**	.061	.185	.818**	.359*
C33	.736**	.063	.237	.868**	.277
C36	.487**	.109	−.046	.596**	.340*
C25	.313	.422**	.202	.108	.755**
C26	.438**	.471**	.192	.254	.819**
C35	.473**	.411*	.314	.326*	.691**
C40	.262	.449**	.155	.245	.724**
C41	.246	.631**	.251	.074	.787**
C42	.369*	.450**	.205	.101	.774**
C43	.359*	.444**	.208	.073	.823**

* Correlation is significant at the .05 level (2-tailed).

** Correlation is significant at the .01 level (2-tailed).

Table 3.2: Item to scale correlations for each cluster of the CFPI, for the first CFPI study ($N = 39$), described in Chapter 4. For item content, please refer to Table 3.1.

3.5.2 Electronic monitoring study

The CFPI was used again in the longitudinal study described in Chapter 5 and its reliability and validity were considered further in the context of that study. In particular, further examination was made of the internal reliability, item-level internal consistency and item-level discriminant validity of the subscales derived from the measure in the first study.

When the two items retained from the first use of the measure but not used, were examined in this study, they were found to be poorly correlated with other items in the measure and were again, left out of the analysis. Other validation studies of this measure were commenced before the findings from the electronic monitoring study were known, so these items are also being examined in those studies. It seems likely however, that these items will be dropped from any future versions of the measure.

In this electronic monitoring study, an examination was also made of the relationship between the subscales of the BMQ and the subscales of the CFPI, to test for concurrent and discriminant validity of the CFPI.

Appendix D lists the items in each scale and a copy of the final version of the measure is presented in Appendix B. While the content of the items in each scale remained the same as for the cross-sectional study, the item numbers changed when the eight redundant items were dropped from the scale, which is important when examining the way the items intercorrelated with each scale. The full internal reliability information for each of these subscales is presented in Appendix E. In this smaller sample ($N = 25$), the internal reliability of the Concerns/Attention scale, the Lifestyle/Energy scale and the Denial scale was good, with α greater than 0.80, while it was a little lower for the Cost versus Benefit scale, with an α of 0.70 (largely due to the effect of item C16), and slightly lower again ($\alpha = 0.58$) for the Treatment Value scale. While this lower reliability for the two scales was disappointing, it was offset by the fact that the item-discriminant validity remained high for almost all items and the item-internal consistency was acceptable for all but two items in the Cost versus Benefit scale (see Table 3.3).

Item	Treatment Value	Cost vs Benefit	Denial	Concern/ Attention	Lifestyle/ Energy
C2	.666**	.024	.027	.253	−.241
C4	.464*	.029	−.309	.062	−.209
C5	.405	−.594**	.010	.164	−.395
C6	.537**	−.002	−.332	−.063	−.134
C22	.506*	.040	−.163	.404	.303
C30	.487*	−.352	.225	.626**	−.108
C31	.660**	−.118	−.020	.456*	−.099
C7	−.145	.502*	−.303	−.270	.114
C8	−.294	.848**	.294	−.243	.503*
C9	−.176	.693**	.011	−.398	.050
C10	−.202	.811**	.099	−.144	.360
C11	−.374	.808**	.259	−.336	.396
C16	.121	−.333	.050	.387	.166
C17	−.090	.332	.085	−.247	.259
C19	−.346	.644**	.214	−.147	.026
C12	.029	.155	.865**	.171	−.057
C15	−.157	.187	.828**	.028	.045
C18	−.221	.094	.878**	.299	.194
C13	.236	−.692**	−.129	.627**	−.097
C14	.479*	−.402	.187	.773**	.017
C23	.532*	−.099	.138	.820**	−.045
C24	.470*	−.179	−.077	.458*	−.195
C25	.024	−.063	.463*	.637**	−.168
C26	.256	.027	.303	.689**	−.050
C27	.323	−.337	.141	.673**	.232
C29	.471*	−.206	.171	.932**	.133
C20	−.292	.446*	−.053	−.253	.774**
C21	−.090	.090	−.004	.243	.847**
C28	−.433	.741**	.340	−.325	.811**
C32	−.144	.466*	.018	−.063	.738**
C33	−.034	.052	.052	.365	.704**
C34	−.114	.438*	.028	.048	.689**
C35	−.133	.203	−.041	−.215	.828**

* Correlation is significant at the .05 level (2-tailed).

** Correlation is significant at the .01 level (2-tailed).

Table 3.3: Item to scale correlations for each cluster of the CFPI, for the electronic monitoring study ($N = 25$), described in Chapter 5. For item content please see Appendix D.

Item	Original Item	U.S.A. Teen Item
C11	Missing my exercise or physio won't do me any harm.	Missing my exercise or chest physio won't do me any harm.
C23	When I get home after a hospital admission I keep up with more of my normal CF treatment.	When I get home after a stay in hospital I keep up with more of my normal CF treatment.
C28	When I am pressured with work I keep up with less of my CF treatment.	When I am pressured with school I keep up with less of my CF treatment.
C35	When I am busy in my social life I keep up with less of my CF treatments.	When I am busy with my friends I keep up with less of my CF treatment.

Table 3.4: Item wording changes for the U.S.A. adolescent version of the CFPI

3.5.3 U.S.A. teen study

As mentioned in the introductory remarks for this chapter, data was collected from a small sample ($N = 15$) of adolescents with CF (aged 14 to 19 years) from Florida in the United States of America. The aim for this mini study was to conduct a preliminary validation of the measure in a sample that was different, both in country of residence and in age. Given that the sample size was so small, the findings obtained are considered to be very much preliminary and to provide an indication only, of the way the concepts in the measure may be understood with reference to a different population. The measure was completed only once by each adolescent and the group of adolescents who completed the measure were participants in another study on adherence to treatment at the time. The impact this involvement may have had on their responses is not known, and no individual demographic data is available for the participants in this sample.

Some minor changes were made to the wording of some items of the measure to account for the younger sample and to ensure that the terminology used was culturally appropriate to the U.S.A. setting. Changed items are listed in Table 3.4, with the original adult version and the version included in the teen measure presented side by side. In the self-reported adherence and perceived importance sections of the measure, the treatment "physiotherapy" was changed to "chest physiotherapy".

For each subscale, the Cronbach's Alpha is presented in Table 3.5. As this was pre-

Subscale	α
Treatment Value	.7748
Cost vs Benefit	.7803
Denial	.0223
Concern/Attention	.6073
Lifestyle/Energy	.7013

Table 3.5: Internal reliability of CFPI subscales for 15 adolescents from the U.S.A.

liminary data it was not considered worthwhile to include the full item-total statistics of the measure for this sample. It can be seen however, that four of the five scales had internal reliability scores which are considered acceptable as defined above. The Denial scale showed no internal consistency at all. Despite this, two of the three items in the scale did have their highest correlation with the Denial scale rather than any other, as shown in Table 3.6, where the item to scale correlations are shown for the five subscales and their constituent items. Also in Table 3.6, it can be seen that the Concern/Attention scale for this sample was significantly compromised, with many of its hypothesised items correlating more highly with other scales in the measure. Item numbers for the adolescent version of the measure used in this study are the same as for the electronic monitoring study.

Item	Treatment Value	Cost vs Benefit	Denial	Concern/ Attention	Lifestyle/ Energy
C2	.426	.481	.237	.235	−.330
C4	.811*	−.160	−.283	.542*	−.289
C5	.763	−.241	.283	.491	−.535*
C6	.580*	.255	.073	.011	.095
C22	.839*	−.260	−.233	.822*	−.651*
C30	.615*	−.312	−.143	.437	−.428
C31	.580*	−.255	−.110	.390	−.208
C7	.210	.715*	.305	.175	−.124
C8	−.102	.596*	.468	−.137	.154
C9	−.335	.645*	.485	−.188	.351
C10	−.124	.798*	.569*	.084	.115
C11	−.411	.677*	.712*	−.103	.378
C16	−.267	.134	.000	−.511	.500
C17	.262	.369	.146	.071	.417
C19	.053	.829*	.490	.028	.107
C12	.049	.224	.661*	.523*	−.355
C15	−.278	.470	.729*	.099	.006
C18	−.015	.400	.346	−.321	.433
C13	−.026	.080	−.006	.072	.112
C14	−.053	−.028	.227	.535*	.034
C23	.587*	−.267	.000	.851*	−.682*
C24	.855*	.115	−.149	.454*	−.458
C25	.587*	−.267	.000	.851*	−.682*
C26	.383	.461	.485	.458	−.543
C27	.507	−.285	.035	.669*	−.683*
C29	.232	−.053	.356	.501	−.369
C20	−.295	.642*	.411	−.020	.325
C21	−.326	.146	−.105	−.632*	.784*
C28	−.169	−.092	−.279	−.227	.602*
C32	−.330	.120	.110	−.542	.740*
C33	−.370	.075	−.033	−.556*	.630*
C34	−.433	.352	.102	−.441	.715*
C35	−.226	.192	.048	−.484	.472*

* Correlation is significant at the .05 level (2-tailed).

Table 3.6: Item to scale correlations for each cluster of the CFPI, for the Florida adolescents.

3.6 Test-retest reliability

3.6.1 Self-reported adherence

Test-retest reliability is an important feature for understanding whether a measure is measuring something which is stable or reliable over time. A major consideration which affected the interpretation of test-retest analyses of self-reported adherence, conducted with the CFPI, was the expectation that adherence is a variable behaviour. Anticipating that this would be the case necessitated some expectation of difference in reported adherence between time one and time two, even though the self-reported adherence scale was designed to access "typical" adherence. Further, it was expected that the differences observed would be larger in the study described in Chapter 5, where the interval between tests was three months, than in the study described in Chapter 4, where the interval between tests was two weeks.

The reliability of self-reported adherence over two weeks was examined with the subset of 25 people who completed all aspects of both the first and second administration of the CFPI in the study described in Chapter 4. Pearson's r was calculated to examine the correlation between each item on the self-reported adherence scale for time one and time two. Adherence was coded on the five point scale described earlier, such that a score of "1" indicated most adherence, while a score of "5" indicated least adherence. The correlations for six of the treatments between time one and time two were moderate to high and statistically significant, while the correlations found for antibiotics and enzymes were low and not statistically significant. In the case of enzymes, this poor correlation appeared to be the result of a restricted response range, with 95% of respondents reporting their adherence to this treatment to be in the "Always" or "Mostly" categories at both time one and time two, so that a shift from "Always" to "Mostly" from time one to time two had a very significant effect on the statistic, which did not really reflect a big change in reported adherence. The small correlation for antibiotics did seem to reflect a genuine difference in reported adherence for that treatment between time one and time two. Table 3.7 shows the different treatments, the mean adherence score (between 1 and

Treatment	Time 1	Time 2	r	p
Antibiotics	2.24 (1.18)	1.76 (0.89)	.34	.13
Enzymes	1.24 (0.54)	1.29 (0.56)	.26	.26
Physiotherapy	2.40 (1.22)	2.36 (1.19)	.93	$< .001$
Vitamins	1.39 (0.66)	1.43 (0.66)	.64	.001
Exercise	2.13 (1.15)	2.21 (0.93)	.74	$< .001$
Diet	1.96 (0.95)	1.92 (0.97)	.84	$< .001$
Puffers	1.94 (1.09)	1.82 (0.88)	.90	$< .001$
rhDNase	1.63 (1.02)	1.75 (1.18)	.74	.001

Table 3.7: Mean and (standard deviation) for self-reported adherence scores at Time 1 and Time 2, two weeks later, and test-retest correlations for different CF treatments ($N = 25$).

5 for each treatment on each occasion) and standard deviation, the correlation between the means for time one and time two and the significance (p) of the correlation.

Test re-test reliability of self-reported adherence was also calculated over a period of three months, on a smaller sample ($N = 18$) of adults with CF who completed the measure at both the beginning and end of the electronic monitoring study reported in Chapter 5. The scale for self-reported adherence was changed for this study, to represent number of days per week on which the treatment was taken or done, rather than the more general conceptual estimate used in the first study conducted with the measure. While it was still considered desirable for people to represent their recent typical adherence, and a high level of accuracy was not expected, one of the aims for the electronic monitoring study was to compare self-reported adherence with electronically monitored adherence. In order to do that, it was decided that it would be more helpful to have participants report their estimate of the number of days per week on which they adhered to their treatments, to match with the measure of adherence that would be obtained from the monitors, than for them to report their adherence on the scale as it was first derived. Adherence was reported on a four point scale representing "7 or 6", "5 or 4", "3 or 2" or "1 or 0" days of the week. These scale points were scored with numbers from one, indicating "7 or 6" days, to four, indicating "1 or 0" days of the week.

Pearson's r was calculated to examine the strength of association between self-reported

Treatment	Time 1	Time 2	r	p
Antibiotics	1.31 (0.87)	1.06 (0.25)	-.10	.73
Enzymes	1.06 (0.24)	1.29 (0.85)	.52	.03
Physiotherapy	2.29 (0.99)	2.53 (1.13)	.70	.002
Vitamins	1.39 (0.61)	1.72 (1.07)	.18	.49
Exercise	1.94 (0.87)	2.06 (0.87)	.16	.53
Diet	1.22 (0.43)	1.44 (0.78)	.04	.88
rhDNase	1.22 (0.73)	1.50 (1.04)	.54	.02

Table 3.8: Mean and (standard deviation) for self-reported adherence scores at Time 1 and Time 2, three months later, and test-retest correlations for different CF treatments ($N = 17$).

adherence at time one and time two for the different CF treatments. As with the examination of self-report stability over two weeks, there were difficulties with restricted range for self-reported adherence, but this time for several of the treatments, reducing the validity of the correlation coefficient calculated and reducing the meaning of the mean adherence score calculated. As a result of these difficulties, the statistics are reported here (see Table 3.8), but the reader must be aware that they have limited validity. To balance this, a comparison is presented of the percentage of participants reporting adherence in each of the categories at time one and time two for each treatment (see Table 3.9). From this comparison, it can be seen that for all treatments, reports of adherence on 7 or 6 days per week varied little between time one and time two (no more than 5% difference from time one to time two for any treatment). It can also be seen that for antibiotics, enzymes and rhDNase, reports of adherence on 7 or 6 days per week accounted for at least 77% of responses. Greater variability in both adherence and reporting between time one and time two is evident for the other treatments. Issues related to the way participants used this scale and the meaning that this has for the findings of the study are described in detail in Chapter 5.

3.6.2 Perceived importance

Similar analyses were conducted to examine the test-retest reliability of perceived importance of the CF treatments, over two weeks in the cross-sectional study described in

Treatment	% reporting 7 or 6 days	% reporting 5 or 4 days	% reporting 3 or 2 days	% reporting 1 or 0 days
Antibiotics T1	89.5	0	5.3	5.3
Antibiotics T2	94.1	5.9	0	0
Enzymes T1	86.4	13.6	0	0
Enzymes T2	88.2	0	5.9	5.9
Physiotherapy T1	22.7	36.4	31.8	9.1
Physiotherapy T2	23.5	23.5	29.4	23.5
Vitamins T1	60.9	34.8	4.3	0
Vitamins T2	61.1	16.7	11.1	11.1
Exercise T1	30.4	47.8	13	8.7
Exercise T2	27.8	44.4	22.2	5.6
Diet T1	63.6	31.8	4.5	0
Diet T2	66.7	27.8	0	5.6
rhDNase T1	82.6	13.0	0	4.3
rhDNase T2	77.8	5.6	5.6	11.1

Table 3.9: Percentage of participants reporting adherence in each of the four categories at time one and at time two three months later (N for T1 is 24, N for T2 is 18)

Chapter 4, and over three months in the electronic monitoring study described in Chapter 5. For the first study using this measure (test-retest over two weeks), as for test-retest of self-reported adherence, there was a sample of 25 people who completed the measure at both time one and time two. Again, the distributions of responses for the different treatments were examined and it was determined that with the exceptions described below, there was sufficient variability in the response sets to justify the use of parametric statistics to examine the relationships for each treatment between the two occasions. Pearson's correlations were conducted to examine the strength of the relationships between time one and time two. Importance over the short term was examined first, however, for perceived importance of Enzymes, the problem of a very restricted range of responses invalidated the correlation coefficient for both short and long-term adherence. In that case, the mean importance score and standard deviation for time one was identical to that for time two, both for short and long-term importance, with almost all participants reporting the treat-

Treatment	Time 1	Time 2	r	p
Antibiotics	1.77 (0.81)	1.55 (0.74)	.45	.03
Enzymes	1.05 (0.22)	1.05 (0.22)	-.05	.83
Diet	1.63 (0.77)	1.54 (0.66)	.42	.04
Physiotherapy	1.92 (0.97)	1.75 (0.90)	.92	$< .001$
Exercise	1.68 (0.99)	1.64 (0.76)	.84	$< .001$
Vitamins	1.43 (0.59)	1.74 (0.86)	.77	$< .001$
rhDNase	1.43 (0.65)	1.50 (0.65)	.73	.003

Table 3.10: Mean and (standard deviation) scores for perceived short-term importance at Time 1 and Time 2, two weeks later, and test-retest correlations for different CF treatments ($N = 25$).

ment to be *essential* to their health. Also, there were no matched pairs for the "Other" category on which analyses could be performed. Otherwise, over two weeks, patients reported similar levels of perceived importance for all of their treatments, with moderate to strong and statistically significant correlations as shown in Table 3.10.

Restricted response ranges also caused difficulties for the test-retest comparison of the perceived importance of antibiotics when long-term importance was examined. For antibiotics, 94% of participants reported the treatment to be either *Essential* to *Important* to them at time one, compared with 88% at time two. Perceived importance of diet to long-term health appeared to change from time one to time two, with a low and non-significant correlation emerging, however the apparent difference is not as significant as it appears from the correlation. Again, participants' limited use of the range of the scale for perceived importance of the scale led to an inflated significant for the difference in reports for time one to time two. For the remaining treatments, test-retest correlations of perceived importance of the treatments between time one and time two did appear to be valid, and were moderate to large and statistically significant. The means and standard deviations, along with the Pearson's correlation coefficient and the significance of the correlations are shown in Table 3.11.

The test-retest reliability of perceived importance over three months was considered through the electronic monitoring study. As described in Chapter 4, there was a comparatively smaller degree of association found between reported adherence and ratings of

Treatment	Time 1	Time 2	r	p
Antibiotics	1.35 (0.81)	1.45 (0.89)	.35	.13
Enzymes	1.05 (0.22)	1.05 (0.22)	-.05	.83
Diet	1.50 (0.80)	1.27 (0.46)	.26	.24
Physiotherapy	1.61 (0.84)	1.61 (0.72)	.79	$< .001$
Exercise	1.46 (0.88)	1.50 (0.66)	.78	$< .001$
Vitamins	1.39 (0.66)	1.65 (0.78)	.55	.007
rhDNase	1.40 (0.74)	1.53 (0.74)	.63	.01

Table 3.11: Mean and (standard deviation) scores for perceived long-term importance at Time 1 and Time 2, two weeks later, and test-retest correlations for different CF treatments ($N = 25$)

the long-term importance of treatments than between perceived importance to short-term health and adherence. A decision was made on the basis of this finding, to drop the importance to long-term treatments scale from the measure. The importance scale is thus presented only once in the revised version of the CFPI, with the term "ongoing" replacing "short-term" importance. In the electronic monitoring study, the distribution of scores on the importance scale for each treatment at both time one and time two allowed for a valid parametric statistical comparison to be conducted. Pearson's r was used again as the measure of comparison between time one and time two. It was found that there was a significant test-retest reliability in the perceived importance of all the different treatments from time one to time two, suggesting that perceived importance of treatments is a relatively robust concept, that does not change dramatically, at least over three months. The means and correlations for perceived importance at time one compared with time two are presented in Table 3.12.

3.6.3 Disease and treatment beliefs

The test-retest reliability of the items in the third section of the CFPI was considered in the same way as for the other aspects of the measure. First, an examination of the distribution of the data was made to ensure that it was suitable for parametric analysis. As with the previous elements of the scale, there were some items which had a very

Treatment	Time 1	Time 2	r	p
Antibiotics	1.31 (0.60)	1.38 (0.62)	.92	$< .001$
Enzymes	1.12 (0.33)	1.06 (0.24)	.69	.002
Physiotherapy	1.83 (1.04)	1.83 (1.10)	.90	$< .001$
Vitamins	1.83 (0.71)	2.00 (0.84)	.79	$< .001$
Exercise	1.33 (0.59)	1.61 (0.85)	.74	$< .001$
Diet	1.61 (0.70)	1.61 (0.79)	.79	$< .001$
rhDNase	1.39 (0.61)	1.56 (0.98)	.80	$< .001$

Table 3.12: Mean and (standard deviation) scores for perceived importance to ongoing health at Time 1 and Time 2, three months later, and test-retest correlations for different CF treatments ($N = 18$)

limited distribution, or which had one or two outlier scores which significantly affected the correlation between the item at time one and time two. Overall however, the items were suitable for parametric analysis. Pearson's product-moment correlations were conducted to examine item stability over two weeks (see Table 3.13), and, with the shortened version of the measure used in the electronic monitoring study, over three months (see Table 3.14).

Some degree of item stability over time was anticipated for this section, however the SRM describes illness (and treatment) perceptions as dynamic and therefore to be expected to change over time as a result of feedback about disease and treatment outcomes and so on. Item correlations from time one to time two, over two weeks and over three months, revealed moderate or high and statistically significant correlations for most items. This finding was consistent with the SRM idea of a dynamic process but also seemed to indicate that some of the concepts were quite stable over time. Items which were most stable over two weeks were:

- I find it hard to believe that I have CF.
- Taking my medication at the wrong time of day won't do me any harm.
- I focus on the future more than what is happening right now.
- I need "time-out" from my CF treatment routine from time-to-time.

Items which were most stable over three months were:

- Keeping exactly to my prescribed treatment is very important.
- My treatment costs too much money.
- At times I try to forget that I have CF.

Table 3.13: Mean score and (standard deviation) for each item, with test-retest correlations of beliefs about CF and its treatment over two weeks ($N = 25$).

Item	Time 1	Time 2	r	p
I am the best judge of the treatment I need.	3.92 (0.81)	3.48 (0.71)	.64	.001
My doctors are the best judges of the treatment I need.	3.72 (0.89)	3.72 (0.68)	.42	.04
Decisions about my treatment must be made jointly by me and my doctors.	4.32 (0.85)	4.36 (0.70)	.36	.08
It is okay for me to vary my treatments depending on how well I feel each day.	3.25 (1.07)	3.13 (1.03)	.68	$< .001$
When I do it properly, I believe that my CF treatment works well overall.	4.20 (0.65)	4.20 (0.65)	.30	.15
Keeping exactly to my prescribed treatment is very important.	3.88 (1.01)	3.84 (0.80)	.49	.01
I always have a clear understanding of what I am supposed to do with my medications and other treatments.	4.44 (0.51)	4.28 (0.54)	.44	.03
I find it hard to believe that I have CF.	2.20 (1.22)	2.12 1.05)	.88	$< .001$
I am prescribed too much medication.	2.52 (0.82)	2.60 (0.82)	.51	.009
My treatment is too demanding on my time.	2.92 (1.15)	3.16 (0.99)	.53	.007
Missing some doses of medication won't do me any harm.	2.60 (1.08)	2.72 (0.98)	.68	$< .001$
Taking my medication at the wrong time of day won't do me any harm.	2.76 (0.83)	2.80 (0.82)	.79	$< .001$

Table 3.13: (continued)

Item	Time 1	Time 2	r	p
Missing my exercise or physio sometimes won't do me any harm.	2.80 (1.19)	2.80 (0.91)	.50	.01
I will beat CF.	3.60 (1.38)	3.32 (1.18)	.75	$< .001$
I would feel comfortable about telling my doctor if I was having trouble keeping up with all my treatments.	3.84 (0.90)	3.72 (0.79)	.52	.008
I focus on the future more than what is happening right now.	3.38 (1.17)	2.83 (0.96)	.79	$< .001$
My treatment costs too much money.	3.04 (1.16)	3.13 (0.99)	.60	.002
I focus on today and let the future take care of itself.	3.39 (0.89)	3.52 (0.73)	.30	.16
I worry about the future.	3.27 (1.12)	3.36 (0.79)	.64	.001
At times I genuinely forget to do some of my treatment.	3.00 (1.41)	3.43 (1.16)	.72	$< .001$
I need "time-out" from my CF treatment routine from time-to-time.	3.42 (1.10)	3.21 (1.10)	.79	$< .001$
At times I try to forget that I have CF.	2.65 (1.15)	2.91 (1.16)	.76	$< .001$
Sometimes, the hassles involved with my CF treatment (e.g., effort/time/expense) outweigh the benefits.	2.78 (1.38)	2.74 (1.14)	.74	$< .001$
When I get feedback (e.g., PFT, blood test) that a treatment is working I keep up with the treatment more.	3.63 (0.92)	3.67 (0.70)	.60	.002
When I am on holidays I keep up with less of my CF treatment.	2.87 (1.06)	3.43 (0.84)	.37	.08
When I feel down or depressed I keep up with less of my CF treatment.	2.79 (1.02)	3.04 (0.91)	.48	.02

Table 3.13: (continued)

Item	Time 1	Time 2	r	p
When I have a goal to work towards I keep up with more of my CF treatment.	3.71 (0.75)	3.83 (0.70)	-.01	.95
When I feel well I keep up with more of my CF treatment.	3.29 (1.04)	3.25 (0.85)	.06	.78
When I get home after a hospital admission I keep up with more of my normal CF treatment.	3.59 (0.80)	3.45 (0.74)	.57	.005
When my lung function drops I keep up with more of my CF treatment.	3.79 (0.72)	3.63 (0.71)	.52	.009
After a regular clinic visit I keep up with more of my CF treatment.	3.25 (0.79)	3.46 (0.72)	.63	.001
When I feel worried about my CF I keep up with more of my CF treatment.	3.68 (0.69)	3.56 (0.71)	.38	.06
When I feel positive about the future I keep up with more of my CF treatment.	3.56 (0.65)	3.64 (0.57)	.57	.003
When I have a clinic visit coming up I keep up with less of my CF treatment.	2.38 (0.82)	2.29 (0.69)	.49	.02
When I am pressured with work I keep up with less of my CF treatment.	2.83 (1.03)	2.87 (0.87)	.58	.003
When I start a new treatment I keep up with more of my usual CF treatment.	3.42 (0.93)	3.63 (0.58)	.55	.005
When I feel supported or encouraged by people around me I keep up with more of my CF treatment.	3.38 (0.92)	3.63 (0.65)	.10	.64
When I am unwell I keep up with less of my CF treatment.	2.52 (0.95)	2.70 (0.88)	.31	.15
When I am in a good routine I keep up with more of my CF treatment.	3.71 (0.69)	3.92 (0.50)	.68	$< .001$

Table 3.13: (continued)

Item	Time 1	Time 2	r	p
When I am tired I keep up with less of my CF treatment.	3.09 (0.95)	3.39 (0.99)	.74	$< .001$
When I don't feel any better after my treatment I keep up with less of my CF treatment.	2.54 (0.83)	2.88 (0.99)	.56	.005
When I have problems or hassles in my family I keep up with less of my CF treatments.	2.70 (0.88)	2.96 (0.98)	.62	.002
When I am busy in my social life I keep up with less of my CF treatments.	3.04 (1.02)	3.48 (1.08)	.35	.10

Table 3.14: Mean score and (standard deviation) for each item, with test-retest correlations of beliefs about CF and its treatment over three months ($N = 18$).

Item	Time 1	Time 2	r	p
I am the best judge of the treatment I need.	3.00 (0.69)	2.72 (0.67)	.26	.31
Decisions about my treatment must be made jointly by me and my doctors.	3.39 (0.85)	3.39 (0.61)	.15	.56
It is okay for me to vary my treatments depending on how well I feel each day.	2.28 (0.58)	2.33 (0.67)	.50	.04
When I do it properly, I believe that my CF treatment works well overall.	3.33 (0.49)	3.22 (0.55)	.37	.13
Keeping exactly to my prescribed treatment is very important.	3.11 (0.68)	3.00 (0.69)	.76	$< .001$
I always have a clear understanding of what I am supposed to do with my medications and other treatments.	3.39 (0.61)	3.28 (0.58)	.68	.002
I am prescribed too much medication.	2.11 (0.76)	2.00 (0.91)	.43	.08

Table 3.14: (continued)

Item	Time 1	Time 2	r	p
My treatment is too demanding on my time.	2.56 (0.71)	2.39 (0.85)	.60	.008
Missing some doses of medication won't do me any harm.	2.44 (0.71)	2.22 (0.65)	.55	.02
Taking my medication at the wrong time of day won't do me any harm.	2.67 (0.77)	2.33 (0.59)	.65	.004
Missing my exercise or physio sometimes won't do me any harm.	2.61 (0.85)	2.50 (0.71)	.73	.001
I will beat CF.	2.67 (0.91)	2.44 (1.04)	.73	.001
I would feel comfortable about telling my doctor if I was having trouble keeping up with all my treatments.	3.06 (0.80)	3.00 (0.77)	.38	.12
I focus on the future more than what is happening right now.	2.44 (0.71)	2.28 (0.58)	.55	.02
My treatment costs too much money.	2.28 (0.90)	2.22 (1.00)	.85	$< .001$
At times I genuinely forget to do some of my treatment.	2.72 (0.83)	2.78 (0.81)	.70	.001
I need "time-out" from my CF treatment routine from time-to-time.	2.61 (0.79)	2.28 (0.83)	.54	.02
At times I try to forget that I have CF.	2.33 (0.97)	2.22 (0.88)	.81	$< .001$
Sometimes, the hassles involved with my CF treatment (e.g., effort/time/expense) outweigh the benefits.	2.22 (0.73)	1.83 (0.62)	.22	.39
When I am on holidays I keep up with less of my CF treatment.	2.72 (0.83)	2.61 (0.70)	.21	.40
When I feel down or depressed I keep up with less of my CF treatment.	2.41 (0.80)	2.41 (0.62)	.65	.005

Table 3.14: (continued)

Item	Time 1	Time 2	r	p
When I have a goal to work towards I keep up with more of my CF treatment.	2.88 (0.70)	2.65 (0.70)	.42	.09
When I get home after a hospital admission I keep up with more of my normal CF treatment.	2.67 (0.59)	2.50 (0.71)	.56	.02
When my lung function drops I keep up with more of my CF treatment.	3.00 (0.59)	2.89 (0.76)	.52	.03
After a regular clinic visit I keep up with more of my CF treatment.	2.50 (0.62)	2.50 (0.62)	.08	.76
When I feel worried about my CF I keep up with more of my CF treatment.	2.82 (0.64)	2.76 (0.56)	.40	.11
When I feel positive about the future I keep up with more of my CF treatment.	2.61 (0.78)	2.89 (0.58)	.68	.002
When I am pressured with work I keep up with less of my CF treatment.	2.69 (0.70)	2.38 (0.50)	.54	.03
When I start a new treatment I keep up with more of my usual CF treatment.	2.82 (0.64)	2.88 (0.70)	.52	.04
When I feel supported or encouraged by people around me I keep up with more of my CF treatment.	2.72 (0.58)	2.83 (0.62)	.69	.002
When I am in a good routine I keep up with more of my CF treatment.	3.06 (0.64)	3.06 (0.64)	.42	.08
When I am tired I keep up with less of my CF treatment.	2.72 (0.58)	2.61 (0.50)	.22	.39
When I don't feel any better after my treatment I keep up with less of my CF treatment.	2.39 (0.61)	2.22 (0.65)	.67	.003
When I have problems or hassles in my family I keep up with less of my CF treatments.	2.29 (0.59)	2.41 (0.62)	.51	.04

Table 3.14: (continued)

Item	Time 1	Time 2	r	p
When I am busy in my social life I keep up with less of my CF treatments.	2.61 (0.70)	2.56 (0.71)	.70	.001

The final element of test-retest reliability considered for this measure was the stability of the CFPI subscales derived from the items described above. The subscale scores at time one were correlated against the score for the same subscale at time two, to determine their stability over two weeks or three months. As can be seen from Table 3.15, test-retest reliability was high for the clusters *Cost/Benefit*, *Concern/Attention* and *Denial* over two weeks and moderate for the other two subscales. Over three months, test-retest reliability was highest for *Concern/Attention*, *Denial* and *Lifestyle/Energy* and lower for *Cost/Benefit* and *Treatment Value* (see Table 3.16).

Treatment	Time 1	Time 2	r	p
Treatment Value	3.95 (0.41)	4.02 (0.42)	.44	.03
Cost vs Benefit	2.86 (0.78)	2.92 (0.66)	.81	$< .001$
Denial	3.13 (0.84)	3.17 (0.88)	.82	$< .001$
Concern/Attention	3.56 (0.49)	3.50 (0.44)	.80	$< .001$
Lifestyle/Energy	2.83 (0.71)	3.17 (0.71)	.62	.001

Table 3.15: Mean and (standard deviation) and test-retest correlations of CFPI subscales over two weeks.

Treatment	Time 1	Time 2	r	p
Treatment Value	3.12 (0.34)	3.10 (0.32)	.56	.02
Cost vs Benefit	2.64 (0.46)	2.22 (0.56)	.45	.06
Denial	2.43 (0.81)	2.30 (0.84)	.90	$< .001$
Concern/Attention	2.75 (0.48)	2.71 (0.45)	.73	.001
Lifestyle/Energy	2.55 (0.52)	2.46 (0.46)	.88	$< .001$

Table 3.16: Mean and (standard deviation) and test-retest correlations of CFPI subscales over three months.

Item (scale)	BS1	BS3	BS4	BS7	BS10
C5 (Treatment Value)		.61		.58	.52
C8 (Cost v Benefit)		-.63		-.51	
C9 (Cost v Benefit)				-.47	
C10 (Cost v Benefit)				-.46	
C11 (Cost v Benefit)				-.55	
C13 (Concern/Attention)	.49				
C14 (Concern/Attention)			.44		
C17 (Cost v Benefit)	-.47				
C19 (Cost v Benefit)				-.44	
C20 (Lifestyle/ Energy)		-.43			
C21 (Lifestyle/ Energy)		-.60		-.46	-.45
C28 (Lifestyle/ Energy)	-.68	-.59		-.61	
C32 (Lifestyle/ Energy)		-.59			
C33 (Lifestyle/ Energy)		-.49			
C34 (Lifestyle/ Energy)		-.58		-.48	
C35 (Lifestyle/ Energy)	-.52	-.52	-.51		

Table 3.17: Item level relationships between items from the BMQ *Necessity* scale (horizontal axis) and items from the CFPI beliefs section (vertical axis)

3.7 Concurrent and discriminant validity

As mentioned above, concurrent and discriminant validity for the CFPI were examined in the electronic monitoring study, by comparing data from the subscales of the CFPI with the scales of the BMQ, completed on the same day. Item level relationships were also examined, to determine which specific BMQ items were associated with specific items from the CFPI. The statistically significant correlations ($p < .05$) between items on the BMQ *Necessity* scale and items from subscales of the CFPI, are presented in Table 3.17. It can be seen that there were a substantial number of item level correlations of moderate effect size, and in relationships in the expected direction between specific items from the CFPI scales and the BMQ *Necessity* scale.

A similar process of comparison was conducted for the items of the BMQ *Concerns* scale and the items from the beliefs section of the CFPI (see Table 3.18). Results were consistent with those reported in Table 3.17, showing that the elements of the CFPI which might be expected to be measuring similar constructs to those of the BMQ are in fact doing

Item (scale)	BS2	BS5	BS6	BS8	BS9
C4 (Treatment Value)		-.51		-.45	-.46
C5 (Treatment Value)	-.53	-.51		-.48	
C6 (Treatment Value)			-.50		-.46
C7 (Cost v Benefit)		.55			
C8 (Cost v Benefit)	.45			.89	
C10 (Cost v Benefit)			.44		
C13 (Concern/Attention)					-.43
C18 (Denial)			.50		
C19 (Cost v Benefit)			.46		
C28 (Lifestyle/ Energy)				.71	
C32 (Lifestyle/ Energy)				.43	
C34 (Lifestyle/ Energy)	.49			.66	

Table 3.18: Item level relationships between items from the BMQ *Concerns* scale and items from the CFPI beliefs section

so, and that elements of the CFPI that would be expected to have negative relationships with the BMQ are also doing so. Of importance also, was the finding that items which would be expected to have no relationship with the specific necessity of treatments or concerns about treatments, such as beliefs about who should be in charge of treatment planning, and responses to treatment related events, were, as might be expected, not associated with items in the BMQ.

A further exploration of the relationship between the BMQ and the CFPI was conducted by examining the inter-correlations of the CFPI subscales and the BMQ subscales. Table 3.19 shows the result of this analysis. It can be seen that greater belief in the necessity of medicines was significantly associated with less belief that the costs of treatment outweigh the benefits, while a higher level of concern about medicines was related positively to a belief that the costs of treatment outweigh the benefits and negatively to a belief in the overall value of treatments. Similarly, the differential score between necessity and concerns on the BMQ (indicating higher necessity scores than concerns scores), was positively associated with Treatment Value and negatively associated with Cost versus Benefit on the CFPI.

A final examination of the concurrent validity of the CFPI with the BMQ was con-

CFPI Subscale	Necessity	Concerns	Necessity/ Concerns
Treatment Value	.18	−.47*	.47*
Cost/Benefit	−.54**	.52**	−.65**
Denial	−.11	.24	−.23
Concerns/Attention	.14	−.08	.13
Lifestyle/Energy	−.64**	.33	−.57**

* Correlation is significant at the .05 level (2-tailed).
** Correlation is significant at the .01 level (2-tailed).

Table 3.19: Pearson's correlations between scales from the BMQ and scales from the CFPI beliefs section

ducted by investigating the relationship between items from the perceived importance scale of the CFPI with the subscales and differential Necessity/Concerns score of the BMQ. It was found that the perceived importance of physiotherapy and exercise was related to lower levels of concerns about medicines ($r = -.48$ and $r = -.58$ respectively, $p < .05$), and at the same time, related to a larger differential score indicating higher belief in the necessity of medicines than concerns (for physiotherapy, $r = .57$, for exercise, $r = .48$, $p < .05$).

3.8 Discussion

This chapter described the development and validation of the Cystic Fibrosis Perceptions Inventory. Its internal structure, test-retest reliability and both concurrent and discriminant validity have been examined in three studies to date and these properties as they are understood so far, are described in detail. The value of the measure in developing a better understanding of adherence to treatment in adults with CF will be examined in the following two chapters of this dissertation. Two further validation studies with larger numbers of participants are being conducted with this measure, to provide greater statistical power and thus higher levels of confidence in the outcomes. Unfortunately the data from these studies was not available to be included in this discussion.

The CFPI was developed to meet the need for a disease specific measure of beliefs

about illness and treatment, combined with self-reported adherence to all the main CF treatments. Although other measures were available which addressed aspects of the aims of this research, their limitations with respect to CF and the overlap between the measures prompted the development of this new measure. Aspects of the design and conceptual content of all three of the measures considered were included in the final measure. Additional concepts were included on the basis of the pilot study described in Chapter 2 and on the basis of previous findings in the international literature on adherence to treatment in adults with CF.

3.8.1 Subscale structure

A modified McQuitty style cluster analysis was conducted with the data obtained from the first study that used the CFPI. This process yielded a conceptually coherent group of five subscales for the *beliefs* section of the measure. Cronbach's alpha scores were above 0.80 for four out of five of these scales and, overall, the items were significantly associated with their hypothesised scale and more closely associated with it than with any other scale, indicating item-discriminant validity. Eight items were dropped from the measure as they either did not relate well to other items, or did not make a unique contribution to any of the derived scales. A further two items were not included in any scale, but were retained after this first analysis as it was considered possible that they may yet prove to have important links with treatment adherence. The subscale structure of the CFPI was examined again in the electronic monitoring study and then in the study of adolescents from the United States and found to have acceptable levels of internal reliability, except for the Denial scale, which demonstrated poor reliability in the adolescent sample. The two items retained from the first study, but not used in any of the subscales were not found to associate well with other items in the measure in these latter two studies and it is expected that they will be dropped from the final version.

The internal structure and reliability findings for the CFPI are encouraging. The fact that the same structure was essentially supported in three small and largely independent samples indicates the likelihood that this internal structure is a valid and meaningful

one conceptually. As will be discussed in the next two chapters, it also appears likely that these subscales reflect beliefs and perceptions which are linked in different ways with adherence to CF treatments.

3.8.2 Test-retest reliability

An examination of the test-retest reliability of all aspects of the measure was conducted over two weeks in the first study and over three months in the electronic monitoring study. On the basis of the SRM, in which illness and treatment beliefs are thought to be dynamic over time, and based on the hypothesis examined elsewhere in this thesis, that adherence varies over time, the expectations of test-retest reliability were that there would be some association between a patient's beliefs and adherence at one time, with those at another, but that this association would not necessarily be large.

Difficulties arose with some aspects of these analyses, due to restricted response ranges for some items in each section of the scale. At the level of individual items, these threatened the validity of some of the analyses, in particular, yielding spuriously low correlations between some items. On the whole though, the item response distributions were adequate for the analyses conducted and it could be seen that the test-retest reliability for most aspects of the measure was moderate and for some aspects, was high.

Self-reported estimates of adherence were generally quite stable over two weeks, but the picture was less clear over three months. It seemed that over three months, very similar proportions of participants reported their adherence to be on 7 or 6 days per week at both time one and time two, but there were changes in the distribution of responses for people reporting their use of the treatments to be in the other categories. What is not clear from these results is whether the difference in findings for self-reported adherence over two weeks, compared with three months, is due to a real effect of time, a different sample of respondents, or the fact that the scale was changed from a more general estimate to one indicating days of the week.

Test-retest reliability of the perceived importance of the different CF treatments to short term or ongoing health was demonstrated to be quite stable as evident from both the

similar mean scores and standard deviations at time one and time two, and also from the high correlations. Perceptions of the long term importance of treatments did not appear to have very reliable stability over two weeks and further, was less strongly associated with adherence (as will be discussed in Chapter 4), and this combination of outcomes resulted in the decision to drop the scale from the measure.

For the CFPI subscales, test-retest reliability was higher over two weeks than over three months, which fits with the SRM model of dynamic appraisals well. It seems far more likely that appraisals based on health and health care would change more over three months than they might be expected to do over two weeks, unless there were extraordinary circumstances. The fact that there were some beliefs and perceptions which changed very little from time one to time two across the sample, suggests on the other hand that not all appraisals are as subject to influence by experience as others, and that in fact some of the beliefs examined in these studies may be quite stable.

3.8.3 Concurrent and discriminant validity

Concurrent and discriminant validity were both considered in the electronic monitoring study, by comparing the responses on the CFPI with responses on the BMQ. In all of the examinations of the relationships between these two measures (e.g., items in conceptually similar scales, intercorrelation of all subscales), there were moderate levels of correlation in the expected directions for instances where relationships would be expected, and poor or no correlations between items and subscales where no relationship would be anticipated. Given the extensive validation of the BMQ, in a variety of chronic illness groups, the fact that the CFPI was associated with it in the way it was hypothesised to be, is most encouraging. It implies construct validity for the related constructs that the CFPI is designed to measure but also suggests (due to moderate rather than strong correlations between the measures) that the CFPI is measuring something that is different from the BMQ. Overall, the findings from this examination of the relationship between the BMQ and the CFPI lead to the conclusion that the CFPI does demonstrate adequate concurrent and discriminant validity.

3.8.4 Remaining issues

No formal attempt was made to examine the predictive validity of this measure, largely due to the small sample sizes for these studies. It was felt that predictive modelling would be unlikely to return valid findings and may prejudice opinion about the potential value of this new measure. Clearly it would be valuable to examine the predictive validity of the CFPI with reference to treatment adherence in CF, if this measure is to be useful in the clinical context or for future research addressing interventions for adherence in CF.

As discussed above, two further studies with much larger sample sizes, using the CFPI, are ongoing and should add considerably to understanding about the properties of the measure, not only in the Australian context, but in the British context as well.

Overall, this examination of the properties of the CFPI indicates that it has significant potential as a reliable and valid tool for the investigation of beliefs, perceptions and adherence in adults with CF.

Chapter 4

Study 2: Cross-sectional questionnaire study

4.1 Introduction

With the initial development of the Cystic Fibrosis Perceptions Inventory complete, it was necessary to trial the measure. This was important so that investigation of its psychometric properties (as described in Chapter 3) could take place, and decisions could be made about whether the measure would be useful for future studies. Within this context the study was conducted to investigate the role that illness perceptions and treatment perceptions might play in adherence to treatment among adults with Cystic Fibrosis.

Several key components make up the CFPI. A detailed exploration of beliefs and perceptions about both CF and its treatment is followed by a section for self-report of participant's relative adherence to the seven most common aspects of a comprehensive CF treatment regimen. The third key component of the CFPI is a section for participants to rate the importance of each of these treatment components to their health. This third component is considered to be crucial as it provides patients with an opportunity to rate the *relative* importance of the different aspects of the treatment regimen. This provides an implicit acknowledgement of the notion that treatments will be perceived differently and that their value is not a fixed or absolute quality.

Placing this construct of importance within the framework of the SRM, importance

may be related to both the themes of *Consequences* and *Cure/Control* that is, a treatment may be perceived as important if it impacts on the perceived consequences of an illness or contributes to perceptions of better control over the disease process. Both of these perceptions have been associated with better adherence to medical recommendations (Leventhal et al., 1992), hence the potential link between adherence and importance to be examined in this study.

This study also provided an opportunity to examine the role of family functioning on the way that adults with CF manage their treatments. Previous research (e.g., Patterson et al., 1993) found that several aspects of family environment impacted on adherence to treatments and consequently, pulmonary health trends over a considerable length of time in children with CF. As noted in Chapter 1, the impact of family interactions on adherence has not been studied before with adults who have CF, even though many young adults continue to live with their immediate family and others continue to receive more family support (especially health support) after they leave home, than is usual in the general community (Blair et al., 1994; Shepherd et al., 1990). It might be expected that under these conditions family interactions would continue to play a role in decision making and behavioural choices for many adults with CF.

For consistency with previous studies examining links between family functioning and adherence in CF, the Moos Family Environment Scale (FES) was adopted as the measure of family factors for this study. This measure has an extensive history of use as a well validated research tool in the broader context of psychological research as well as having been used specifically in previous CF research. The FES was first developed in the early 1970's to provide a method of comparing the psychosocial styles and assets of different families. The third edition of the FES (Moos & Moos, 1994) was used in this study. The measure contains sub-scales designed to assess the following constructs that are considered by the authors to be integral aspects of family functioning; cohesiveness, expressiveness, independence, recreational orientation, moral-religious orientation, organisation, conflict, achievement orientation, and control.

4.1.1 Aims

There were four aims for this study.

1. To explore the self-reported adherence of adults with CF and the beliefs and perceptions that they hold about their disease and its treatment.
2. To investigate links between reported adherence and both beliefs and perceptions.
3. To conduct a preliminary examination of the validity and reliability of the CFPI.
4. To examine the role of family functioning on adherence among adults with CF.

4.1.2 Hypotheses

Based on these aims, and in light of findings from the pilot study described in Chapter 2 as well as previous findings in the literature about adherence to CF and the literature about the SRM, the hypotheses for this study were as follows:

1. **Reported adherence will vary between CF treatments.**

   Previous self-report research conducted with adults with CF (Abbott et al., 1994; Conway et al., 1996) as well as the small pilot study described in Chapter 2 has shown variations in adherence for different CF treatments and it is therefore anticipated that participants in this sample will adhere differently to different treatments.

2. **Demographic and disease characteristics will have differential relationships with reported adherence to different CF treatments.**

   If hypothesis 1 is true, then it seems possible that demographic and disease characteristics will be associated differently with adherence to different treatments. The findings regarding relationships between demographic factors and adherence in CF have, however, been equivocal (Abbott & Gee, 1998), and in adults, generally poor (Abbott et al., 1994), so no particular associations are hypothesised.

3. **Reported adherence will be higher for those treatments rated as having higher importance.**

Importance is represented as a general perception of value and therefore, high ratings of importance are expected to represent high perceived value of a particular treatment.

4. **Higher levels of cohesiveness and expressiveness in families will be correlated with higher levels of adherence to all CF treatments.**

   This hypothesis is based on the previous CF research which has found this link for children and adolescents.

5. **Higher levels of conflict in families will be correlated with lower levels of adherence to CF treatments.**

   As for hypothesis 4, this hypothesis is based on a similar finding in children and adolescents with CF.

4.2 Methods

4.2.1 Participants

Participants for this study were 39 adult volunteers (21 men) who attended the Royal Adelaide Hospital CF outpatient clinic for a routine visit between September 2000 and January 2001. To be eligible to participate in this study, patients were required to have a confirmed diagnosis of CF, be competent speakers of English and be aged 18 years or over. In addition, participants were required to be able to read and write in English. All clinic patients who met these criteria were approached and invited to participate. In all, about 45% of the total clinic population participated in this study, representing 85% of the people who attended the clinic during the data collection period. Fifteen percent of those approached and invited to participate either declined to be involved, or completed only the first part of the study. Of the 39 participants in this study, 7 had participated in the pilot study conducted 9 to 12 months earlier.

Consideration was given to recruiting more participants for this study to improve its statistical power, however there were two concerns that prompted the decision not to

continue recruitment. Firstly, there was a concern about the extra time this would take. Secondly, it was anticipated that another study would be conducted within the same clinic to further develop this research. As this is a relatively small clinic there was a concern that the patients may be overburdened by research demands if asked to take part in more than one aspect of this study. It was hoped that by recruiting fewer than half of the clinic population, there would be less risk of the same people being asked to participate in the next phase of the research. While randomisation of subject selection for this study was not attempted, the final sample proved to be broadly representative of the total clinic population in terms of disease parameters and demographic variables.

4.2.2 Measures

Demographics and disease status

The following information was collected from each participant to provide a descriptive profile of the sample and to allow for an examination of any associations between socio-demographic data and self-reported adherence. Participants were asked to provide their age (in years), gender, employment status (from 6 categories), marital status (from 5 categories), living arrangements (who with) and living location (country or metropolitan).

In addition, participants were asked to give their height, their weight and their Forced Expiratory Volume in one second, expressed as a percentage of predicted forced expiratory volume based on their age, height and gender (FEV1%). In most cases, pulmonary function tests take place at each routine outpatient CF clinic appointment, and many patients are familiar with their FEV1%. Some patients though, did not remember that information or did not know it and for those patients, the information was obtained from their medical record. Together, height, weight and FEV1% enable a simple examination of relative disease severity. The first two pieces of information can be used to determine the person's current Body Mass Index, a common measure of nutritional status in CF, while the FEV1% is a very useful, safe and relatively sensitive indicator of functional pulmonary status in CF.

Beliefs and perceptions

The Cystic Fibrosis Perceptions Inventory (CFPI), the new questionnaire measure described in detail in Chapter 3 was the main measure used in this study.

Family functioning

In order to examine family functioning, three sub-scales of the Moos Family Environment Scale were completed. The sub-scales *Cohesiveness*, *Expressiveness* and *Conflict* were chosen for this study as they have been linked with treatment adherence in studies in children and adolescents with CF (Patterson, 1985; McCubbin et al., 1983) and in children with other chronic illnesses including diabetes (McKelvey et al., 1989) and phenylketonuria (Fehrenbach & Peterson, 1989). "Cohesiveness" refers to the degree to which a family 'sticks together' or supports one another as a cohesive unit, "Expressiveness" refers to the degree to which family members communicate openly with one another, and "Conflict" refers to the degree to which the family style is characterised by fights and conflict. Together these three sub-scales comprise 27 items, each of which must be rated as 'True' or 'False'. Each sub-scale is scored from 0 to 9, with higher scores representing higher levels of the attribute within the family.

4.2.3 Procedure

Participants were recruited at weekly CF outpatient clinics over a period of three months. All patients who attended the clinic during this three month period were approached during waiting time in the clinic and invited to participate in the study. All participants were assured of the confidentiality of their personal responses and all gave written consent for their involvement in this study. Examples of the information sheet and consent form approved by the RAH ethics committee can be seen in Appendix F. Each participant answered the demographic questions, then completed the CFPI and the Cohesiveness, Expressiveness and Conflict sub-scales of the FES. Most people completed the measures while waiting for their scheduled appointments. A small number of participants who did not have time to finish the questionnaires at the clinic completed them at home and

returned them in a reply-paid envelope. Participants were also given a second copy of the CFPI and asked to fill it in two weeks after their clinic visit. They were given a reply paid envelope in which to return the questionnaires at the conclusion of the study.

4.2.4 Analysis

The Statistical Package for the Social Sciences (SPSS) version 10 for Windows was used for the data management and analyses in this study. With an $N = 39$ and using $p = 0.05$ as the accepted minimum level of statistical significance, this study has a statistical power level of 0.80 for correlation effect sizes of 0.40 or greater. It is much less likely that statistical significance can be demonstrated for smaller effect sizes than 0.40 with this sample size. Clearly this limits the possibility of this study elucidating more subtle relationships between disease or treatment beliefs and adherence.

Frequencies analyses were conducted to explore the demographic data, adherence rates and ratings of importance for different treatments. A frequencies analysis was also performed on all of the items from the first section of the CFPI, to explore the distribution of responses and to determine whether the data would be suitable for parametric statistical analysis. Except where some specific items were affected by difficulties of restricted range, as discussed in detail in Chapter 3, this data was found to be suitable for parametric statistical analysis. Parametric techniques were then used for all subsequent analyses. Relationships between demographics and disease parameters and reported treatment adherence were examined using independent samples t-tests and one-way analysis of variance where there were three or more categories. Relationships between reported adherence and reported importance of treatments were examined using Pearson's product-moment correlations. Relationships between reported adherence and the derived subscales of the CFPI were also examined using Pearson's correlations.

4.3 Results

4.3.1 Sample characteristics

The mean age of the study participants was 25 years (range 18–47yrs). The average FEV1% was 60.35% with a range of 26–99%. These values represent almost the full spectrum of respiratory disease severity in CF. The majority of participants (74.4%) were single, 46% were living at home with their parents and a further 25.6% were living with a spouse or partner. In this sample 61.5% were in full or part-time employment and 12.8% were studying. The remainder reported that they were not employed and the majority of the people not working were receiving a disability pension.

4.3.2 Hypothesis 1: Adherence Rates

It was hypothesised that reported adherence to the various CF treatments would differ between treatments. Participants were asked to rate whether they were *always*, *mostly*, *sometimes* or *never* adherent to eight common components of CF treatment. Figure 4.1 shows that overall, participants reported adhering most to enzyme replacement therapy, with more than 74% reporting that they always took their enzymes. Participants reported adhering least to physical airway clearance, with only 18% reporting that they always did their physiotherapy. For most treatments, the majority of participants reported that they *mostly* or *sometimes* adhered to the treatment.

4.3.3 Hypothesis 2: Relationship between demographic and disease characteristics and reported adherence

No specific relationships were hypothesised between demographic or disease characteristics and self-reported adherence, however it was expected that any relationships which did emerge would be treatment specific rather than global. Pearson's correlations were calculated to examine the association between reported adherence to each of the treatments and participants' Body Mass Index (BMI) and FEV1%. There were no significant associations between self-reported adherence and BMI, but a moderate association was found

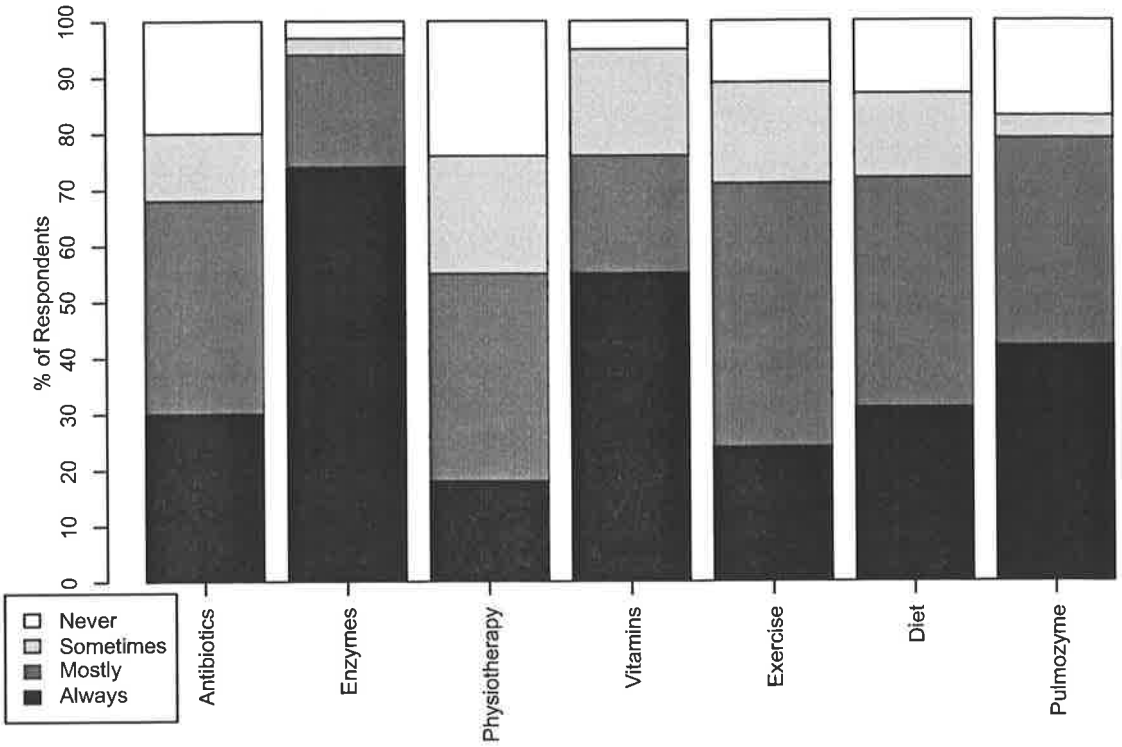

Figure 4.1: Degree of adherence reported by the respondents for 7 CF treatments.

between higher FEV1% and higher reported adherence to pancreatic enzymes ($r = 0.59$, $p < 0.001$). FEV1% was not associated with reported adherence to any of the other treatments.

Possible differences in reported adherence as a result of age, gender, marital status, employment status, location and who the person was living with were explored using independent samples t-tests (for age, gender and location) or one way analysis of variance.

In order to examine the role of age on adherence, the sample was divided into two groups, based on the median age (24 yrs) of the participants. People aged 18 to 24 years were considered *younger* and people aged 25 to 47 years were considered to be *older* for the purposes of this analysis. Similarly, participants were divided into three groups in order to further examine the variability in adherence as a result of different levels of respiratory disease severity. People with a FEV1 of 40% or less of predicted values were classified as *severe*; those between 41 and 70% were classified as *moderate* and those with a FEV1 of 71% of more were classified as having *mild* disease. Of all the analyses conducted only

three statistically significant findings emerged. Women reported themselves to be less adherent to antibiotics than men ($t = 2.41$, df=32, $p = 0.02$) and people with the most severe disease reported themselves to be less adherent to enzyme replacement therapy ($F(2, 32) = 6.77$, $p = .004$). This latter finding was consistent with the direction of the correlation between FEV1% and adherence to pancreatic enzymes. The other statistically significant finding was that people who lived in the country reported themselves to be less adherent to recommended exercise regimens than people who lived in the metropolitan area ($t = 2.40$, df=36, $p = 0.02$).

4.3.4 Importance ratings of CF treatments.

Participants' ratings of the importance of various CF treatments to their short-term health were very variable (see Figure 4.2). Ratings for long-term importance are discussed below. While almost 86% of participants believed that their enzyme replacement therapy was essential to their short-term health, only 38% believed that their physiotherapy treatment was essential. It is noteworthy however, that for each treatment there was a small group of participants who reported the treatment to be unhelpful to them.

4.3.5 Hypothesis 3: Relationship between reported adherence and importance ratings.

It was hypothesised that reported adherence would be correlated with the perceived importance participants ascribed to the different CF treatments. Table 4.1 shows the correlation between short-term importance and the reported adherence to each of the CF treatments. All of these relationships were found to be statistically significant but the effect size varied considerably. The strongest effects were found for physiotherapy, rhDNase (Pulmozyme), and pancreatic enzymes, where participants' responses varied in both the proportion who claimed to adhere to the treatment and the importance rating given to the treatment.

There were generally strong relationships between the perceived importance of treatments in the short term compared with the importance of the same treatments over

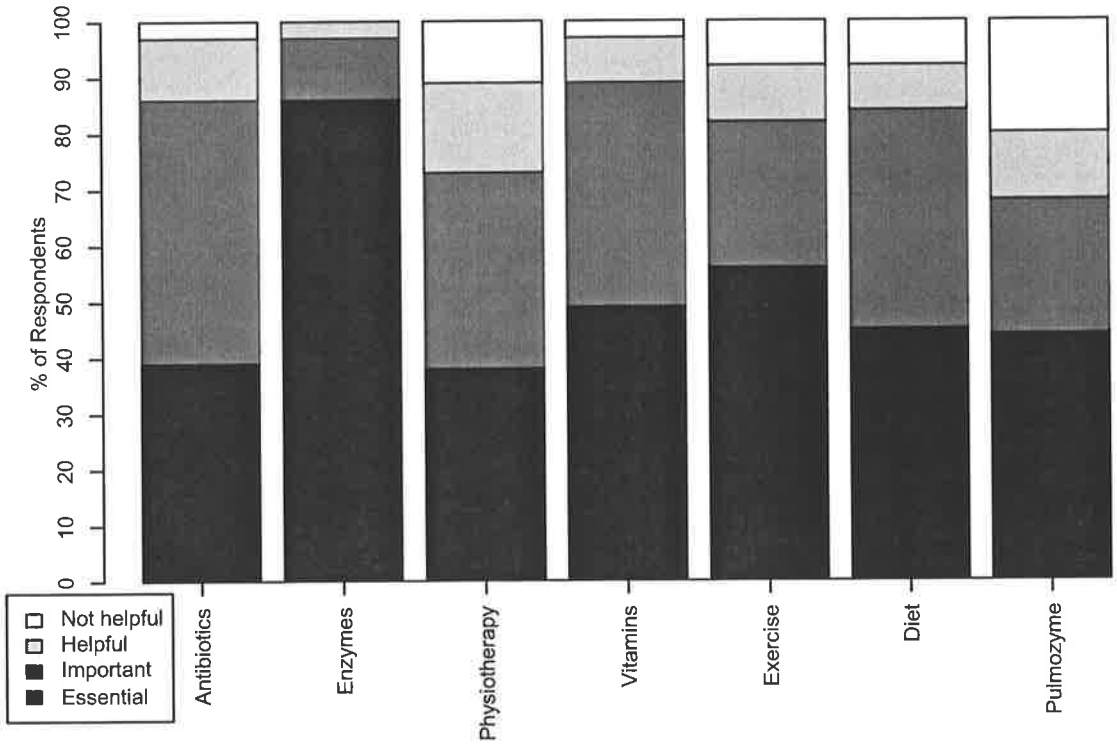

Figure 4.2: Importance ratings given by the participants for the 7 CF treatments.

Medication	r	p
Antibiotics	0.35	0.04
Enzymes	0.76	< 0.001
Physiotherapy	0.86	< 0.001
Vitamins	0.62	< 0.001
Exercise	0.71	< 0.001
Diet	0.43	0.01
rhDNase	0.77	< 0.001

Table 4.1: Correlation between reported adherence and short-term importance ratings for each treatment.

Treatment	Short term	Long Term
Antibiotics	0.35*	0.30
Enzymes	0.76**	0.62**
Diet	0.43**	0.50**
Physiotherapy	0.86**	0.74**
Exercise	0.71**	0.60**
Vitamins	0.62**	0.48**
rhDNase	0.77**	0.82**

* Correlation is significant at the .05 level (2-tailed).
** Correlation is significant at the .01 level (2-tailed).

Table 4.2: Comparison of correlations between reported adherence to different treatments and both short and long term perceived importance of the treatments.

the longer term. Correlations for perceived importance of a treatment in the short-term compared with the long term were moderate for vitamins ($r = 0.61$), stronger for antibiotics ($r = 0.72$) and quite strong for the remaining treatments ($r = 0.82$ to $r = 0.89$). Stronger relationships were observed however, between self-reported adherence and the perceived importance of most treatments in the short-term than for the longer term (see Table 4.2). The limited additional information provided by participants perceptions of the longer-term importance of CF treatments, resulted in a decision to remove the scale for long-term perceived importance from the measure, as previously discussed in Chapter 3.

4.3.6 Aims 2 and 3: Using the CFPI to investigate links between adherence and perceptions

As described above, this measure aims to elucidate the cognitions, perceptions and opinions that people with CF hold about their illness and its treatment program. The ratio of variables to participants in this study did not allow a standard factor analysis procedure to be performed to reduce this data. Instead, modified McQuitty cluster analyses were performed to examine the links between items on this measure. Within this sample five internally reliable sub-scales emerged, representing *Treatment Value* ($\alpha = 0.82$), *Denial* ($\alpha = 0.58$), *Concerns/Attention* ($\alpha = 0.83$), *Lifestyle/Energy* ($\alpha = 0.88$) and *Cost versus Benefit* ($\alpha = 0.85$). Full details of the development, validation and properties of the CFPI

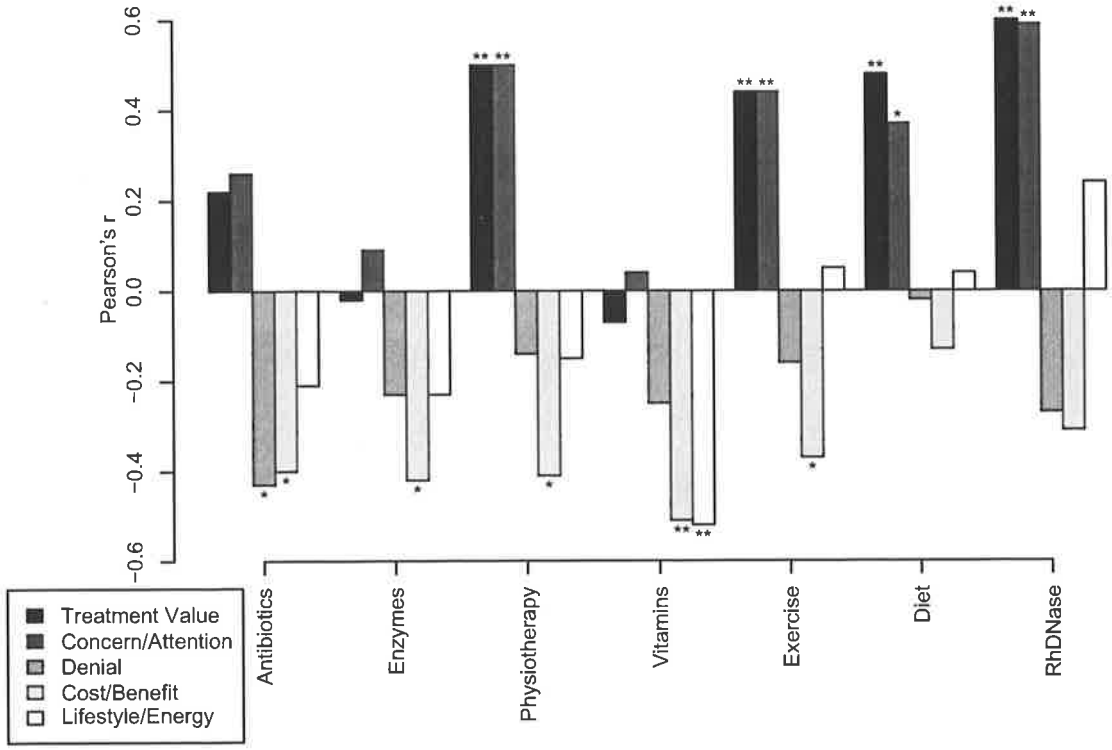

Figure 4.3: Correlations between the sub-scales of the CFPI and reported adherence to 7 CF treatments.

were discussed in Chapter 3.

Pearson's correlations were performed to examine the relationships between reported adherence to the seven different CF treatments, and the sub-scales of the CFPI. As seen in Figure 4.3, a number of statistically significant relationships of moderate effect size emerged. A belief that the costs associated with CF treatment outweighed the benefits was associated significantly with poorer adherence to all of the treatments except for dietary management and rhDNase, while an overall belief in the effectiveness of CF treatments and the importance of following treatment plans was related significantly to better adherence to physiotherapy, exercise, dietary management and rhDNase. High levels of concern about CF or attention to changes in the disease process were positively associated with adherence to physiotherapy, exercise regimens dietary management and rhDNase. A busy lifestyle and lack of energy were associated with poorer adherence to vitamins, while denial of the disease process was related to poorer adherence to antibiotics.

4.3.7 Specific items of the CFPI

Some individual items of the CFPI generated responses within this sample that merit reporting in their own right. Around 48% of participants strongly agreed that treatment decisions must be made jointly by themselves and their doctors and about 56% believed that their treatment works well overall when they do it properly. In this sample however, 25% were either uncertain whether they would feel comfortable about telling their doctor if they were having trouble keeping up with prescribed treatments or quite clear that they would not feel comfortable. There was agreement from 49% of participants that they will 'beat CF' and substantially more respondents agreed that they 'focus on today and let the future take care of itself'(51%) than those reporting a focus on the future (36%). Almost 54% of respondents agreed or strongly agreed with the statement 'I need 'time-out' from my CF treatment routine from time to time'. A substantial 69% of respondents agreed or strongly agreed that 'When my lung function drops I keep up with more of my CF treatment'. More than half of this sample (53%) agreed or strongly agreed that they forget to do some of their treatment at times. About three in five participants agreed that they keep up with more of their CF treatment when they feel worried about their CF.

4.3.8 Hypotheses 4 and 5: Adherence and family environment.

The majority of participants in this study reported high levels of cohesiveness and expressiveness in their families and low levels of conflict. Each subscale is scored out of 9.0, with higher scores representing higher levels of the attribute within the family. The mean score on the Cohesiveness sub-scale of the Family Environment Scale was 7.9 (SD = 1.65) while the mean score for the Expressiveness sub-scale was 6.5 (SD = 2.01). The mean score for the Conflict sub-scale was 1.83 (SD = 1.83). Pearson's correlations were calculated to examine the association between reported adherence to different CF treatments and the family variables. Better adherence to physiotherapy was moderately related to higher levels of family cohesiveness ($r = 0.49$, $p < 0.01$), while poorer adherence to physiotherapy was related to higher levels of family conflict ($r = 0.35$, $p < 0.01$). None

of the other relationships examined reached statistical significance. One-way analysis of variance tests were performed to determine whether differences in reported cohesiveness, expressiveness or conflict in families could be determined as a function of variability in reported adherence to the different treatments. None of these findings were statistically significant.

4.4 Discussion

In this study the beliefs and perceptions that adults with CF may hold about their disease and its treatment were examined. The CFPI was trialled for the first time, bringing together elements of the self-regulatory model, perceptions drawn directly from Australian adults with CF and some factors previously identified as associated with adherence in adults with CF. Relationships between family functioning and adherence in adults with CF were also examined.

4.4.1 Demographics and disease characteristics

The outcomes from this study lend further support to the growing body of research evidence that demographic differences are of limited importance to the issue of adherence to treatment in adults with CF. Only three statistically significant or meaningful relationships between any of the demographic variables and adherence were found.

Women reported themselves to less adherent to antibiotics than men, people with the most severe disease reported less adherence to enzymes and country people reported less adherence to exercise than their metropolitan counterparts. In one previous CF study involving mostly children, females were shown to be less adherent than males (Czajkowski & Koocher, 1987), while in others, the opposite finding emerged (Abbott et al., 1994; Patterson et al., 1993). The findings for gender in these previous studies were more general though and not isolated to one treatment. There is no clinically obvious reason to explain why women might adhere less to their antibiotics than men.

The finding that people with the most severe respiratory disease adhered less to their enzymes than people with less severe disease is consistent with previous findings about

poorer adherence in those with more severe disease (Abbott et al., 1995; Gudas, Koocher & Wypji, 1991), however it is somewhat surprising that this relationship emerged for a treatment associated with nutritional health but not for treatments more directly associated with respiratory health. It may be that for those with the most severe respiratory illness, more effort is reserved for adherence to treatments directed specifically at managing the respiratory condition and less attention is given to other treatments, including enzyme replacement therapy.

The finding that people residing in the country reported less adherence to exercise regimens has not been previously reported in the literature. A possible explanation for this finding is that some people residing in country areas may have less access to structured physical activities or facilities such as team sports, fitness centres and swimming centres that might be included or used in a prescribed exercise regimen. People living in the country may be more reliant on exercise activities such as walking that require a higher degree of self-motivation and independent planning, and are consequently more at risk of being omitted or forgotten.

It is possible that there are associations between demographic factors and adherence that are not sensitive to the methods employed in this and other studies of adherence in adults with CF. Further, it may be that associations are present, but have not been demonstrable from the small samples employed in most CF studies. The relatively low incidence of this disease can mean that it is difficult to recruit sufficient numbers of research participants to adequately examine more subtle relationships. Despite these issues, the fact remains that few, if any, consistent links have been made in the literature between adherence and demographic or disease parameters. The findings from this study do not make an appreciable difference in clarifying such relationships.

4.4.2 Patterns of adherence

This study provides new support for the previous findings (Abbott et al., 1994; Conway et al., 1996), that even on the basis of self-report, adherence to treatments in CF varies considerably. Further, in this sample, there were only two treatments to which more than

50% of the sample reported that they *Always* adhered. Of concern were the reports by 20% and 25% of participants respectively that they never took their prescribed antibiotics nor did their prescribed physiotherapy, when these two treatments are arguably two of the three most important and widely prescribed treatments for CF. Given that previous research (Cluss & Epstein, 1985; Ley, 1982) has highlighted that self-report generally overestimates true adherence, it seems probable that the degree of adherence in this study may be lower than reported. The same previous research however, has also highlighted the relative accuracy of patients' reports of *non*-adherence. It seems likely therefore, that patients' reports of adherence to one treatment relative to the others were sufficiently accurate to serve their intended purpose to allow valid comparisons of people's behaviour and perceptions in relation to different treatments.

The particular findings about which treatments were reported to be adhered to best, challenge the widely held idea (Sackett & Snow, 1979; Rapoff, 1999) that more time-consuming and complex treatments are adhered to less well than more simple treatments. Use of that principle would predict poorer adherence to time-consuming nebulised medications such as rhDNase than to tablets, and poorer adherence to pancreatic enzyme supplements consisting of many tablets taken frequently throughout the day, than to vitamins (once per day) and antibiotics (usually 2-3 tablets per day). These predictions were not borne out by the findings of this study, in which participants reported poorer adherence to antibiotics than to rhDNase and better adherence to pancreatic enzymes than to either of the other oral tablet medications. It may be true that physiotherapy treatment, the treatment which takes longest for patients to perform, does conform to the principle of increased time and complexity. Certainly, physiotherapy was the treatment that the fewest patients reported keeping up with well. Physiotherapy is also the treatment most likely to result directly in discomfort from coughing.

4.4.3 Adherence and illness and treatment perceptions

Considering then that issues of time and complexity are inadequate explanations for treatment adherence, there was much better support in this study for links between how

important people perceive the treatment to be to their day to day health and how well they adhere to the treatment. For example, participants reported better adherence to and a higher level of importance for exercise than for physiotherapy. Discussions with the the physiotherapist for the particular clinic considered here confirmed anecdotally that the value of exercise is emphasised in the clinic and that for some patients at least, exercise is promoted as an equivalent or better airway clearance method than traditional chest physiotherapy. Exercise is also widely promoted in the western cultural context as valuable for good health and the prevention of health problems, messages that people with CF are likely to be exposed to with the same degree of frequency as people in the general population. Ratings of importance were also, as reported earlier, quite strongly predictive of adherence to rhDNase and to enzyme replacement therapy.

The decisions people with CF are apparently making about how much to adhere to the different treatments fit well into the system of explanation or understanding provided by the SRM. In this model the patient is conceived of as an active problem-solver, who is trying to "close the perceived gap between perceived current health status and an ideal or goal state" (Horne, 1997, pg. 158). Decisions about whether to follow treatment recommendations will, according to the model, be made on the basis of whether there is a sense of coherence between the patients' own internal representations of the illness and the view that they form from both this representation and their experience of the treatment. Failing to take enzymes may quickly increase the perceived threat of the illness, with an acute and unpleasant increase in gastro-intestinal symptoms. However, the common clinical observation that some patients (usually young women) purposely under-use their pancreatic enzymes in order to maintain a fashionably thin appearance in preference to a body weight that is nutritionally healthy, also highlights this idea of rational decision making, regardless of whether the patient's goal matches that of the health care provider. Failing to adhere to physiotherapy may not result in any perceived (or possibly even actual) short-term change in disease status or perceived health threat and may not, therefore, be experienced as having sufficient value to warrant good adherence.

The findings of links between the CFPI sub-scales and reported treatment adherence provide further support for the value of the SRM in improving understanding of adher-

ence to treatment by adults with CF. There were statistically significant links between poorer adherence to most treatments and a belief that the costs of treatment outweigh the benefits. At the same time there were significant links between better adherence to several treatments, particularly those which were more difficult (such as rhDNase), or required more time or effort to perform (such as physiotherapy and exercise) and a stronger belief in the value of treatments. Additionally, there was evidence that for some treatments (e.g., physiotherapy and rhDNase), heightened concern about the illness and its consequences combined with responses to clinical health changes or contact with health carers was also associated with better adherence to the treatments. All of these findings support the importance of the role of patient cognitions and beliefs in understanding and predicting the management of home-care treatment regimens in adults with CF.

The preliminary validity data from the CFPI were encouraging. While this sample was too small for traditional factor analysis (as discussed in Chapter 3), the cluster analysis performed did identify five internally reliable and conceptually different groups of items. Further, as just discussed these sub-scales were associated differentially with adherence to different treatment components, providing some evidence of the construct validity of the measure. It does seem likely however that at least some of the constructs, particularly those represented in the Treatment Value and the Concerns/Attention sub-scales are not fully independent of one another. Although the variability in sub-scale scores suggests a range of perceptions about most of the items in the CFPI, there were a number of items that appeared to reflect more widespread beliefs or opinion among adults with CF and that may warrant further investigation in their own right.

4.4.4 Family functioning and adherence

The efforts to examine relationships between family functioning and adherence in this study were not very fruitful. The sub-scales of the Family Environment Scale used in this study were in general poorly received by the participants despite their well established validity and wide use in many areas of psychological enquiry. Some people found the items to be intrusive and expressed reservation about answering personal family questions. Some

participants commented that they did not see what the items had to do with their CF and opted either not to complete the items at all or to complete only those which they found to be least intrusive. Some participants completed all the items but reported that they found the questions ambiguous or irrelevant. Finally, some people found it difficult to answer the questions as they did not live with family and had not for some time. In combination, these factors resulted in a smaller sample on which the analyses using this measure were made. Further, it seems likely from the generally inflated levels of family cohesiveness and low levels of conflict reported in this sample, that the transparency of the items led to some amount of socially desirable responding, limiting the integrity of the data collected. It is recommended that the results reported from this measure be interpreted with great caution.

Not withstanding this caution, it does make clinical sense that adherence to physiotherapy, one of the more difficult and time consuming of the CF treatments, should be enhanced by better family cohesiveness and disrupted by high levels of conflict within the family. The direction of these isolated findings is also consistent with the hypotheses made about associations between family functioning and adherence and also with the previous findings in relation to this issue in people with Cystic Fibrosis and other chronic illnesses. The limited statistically significant results from this study do not necessarily reflect a lack of association between family factors and adherence in adults with CF. The issue of relationships between family functioning and adherence requires further examination, using different methodology and different measurement tools.

4.4.5 Limitations of the study

The results of this study, as in previous international research, are limited in particular by two aspects of the study methodology. Firstly, this study was cross-sectional. It is important that future research examines the stability of adherence to different medications over time, rather than considering only a single point in time. Secondly, this study made use of only one method of measurement for adherence. As previously discussed in Chapter 1, the current consensus in this field is that multiple methods of measurement offer

the best possibility of obtaining sufficient information to be confident of the reliability of the adherence data gathered. This therefore offers the best approach to increasing knowledge about the role of illness perceptions and treatment perceptions in understanding adherence to treatment in adults with CF.

Chapter 5

Study 3: Electronic monitoring study

5.1 Introduction

A study using more objective measurement of adherence was considered essential to further examine the thesis that perceptions and opinions about both CF and its treatment are linked with adherence to treatment. As discussed in Chapter 1, measurement of adherence is difficult to do with any level of objectivity or accuracy. There are significant risks of error or mis-reporting with self-report, diary methods, physician reports or family reports. There are problems with biological markers and tests due to issues of pharmacokinetic variation and testing at isolated points in time rather than obtaining data on a day to day basis over a long period of time. Many of these biological methods are also quite intrusive. As argued earlier, despite its own set of limitations and difficulties, electronic monitoring of the use of medication dispensers is emerging as a valuable tool for the measurement of adherence, that carries numerous advantages over the other methods described and has fewer disadvantages.

At the outset of this research, it was understood that electronic monitoring of adherence, while representing the current best practice in the objective measurement of adherence, was still a relatively new technique and one for which the required technology was going to be expensive and difficult to obtain. The substantially more detailed and

accurate data which could be gained from using these techniques was considered important for the contribution to knowledge which this research might make. It was decided therefore, to pursue electronic monitoring as the main measurement technique for adherence in Study 3. Details of the investigation, planning, funding and acquisition of the electronic monitors are described later in this chapter.

As this thesis is based on a discussion of CF, a chronic illness, the examination of ongoing treatments was considered preferable to an examination of treatments that are prescribed repeatedly, but for only a short time on each occasion. It was decided that more than one such treatment should be monitored, as Study 2 and those in the literature (Abbott et al., 1994, e.g.,), had demonstrated that people report adhering differently to different treatments. Information about adherence to at least two treatments could be compared and considered in relation to beliefs and perceptions about CF and CF treatment. Decision making about which treatments to study was constrained further by the current technology in electronic monitoring. The logistical challenges of attempting to monitor exercise, dietary or physiotherapy treatments were considered to be beyond the scope of this study. Consideration was also given to the importance of comparing treatments with similar behavioural or performance characteristics, and those that would be unlikely to change in terms of prescribed frequency or dosage.

These considerations limited the choice to medications and further, to those medications which were most likely to be prescribed at the same dose frequency over the full data collection period. In order to maximise the probability that the findings of the study would have the greatest chance of being clinically relevant, the two treatments needed to be in the core group of CF treatments. This ruled out monitoring treatments for diabetes or liver disease and also ruled out adjunctive therapies such as bronchodilators or allergy treatments. The remaining treatments which are generally considered typical in CF are enzyme replacement therapy, antibiotics and vitamins (which are all taken orally as tablets or capsules), and more recently and increasingly, recombinant human deoxyribonuclease (rhDNase), marketed as Pulmozyme. A nebuliser is used to inhale rhDNase and the medication acts by reducing the viscosity of the mucus in the lungs, making the mucus easier to clear and less likely to be colonised by infective bacteria. The tablet

monitoring technology which was available, was not able to account for tablet counting as well as dispenser opening, and therefore not suitable to monitor medications requiring people to remove several tablets at one time, such as with enzyme replacement therapy. Finally, while some people with CF are prescribed antibiotics prophylactically, antibiotics are more usually prescribed in short courses and were therefore not considered appropriate for this study.

The two treatments chosen for monitoring in this study were rhDNase and vitamins—more specifically, vitamin D, which is usually prescribed as a once-daily dose, as is rhDNase. vitamin D is prescribed as a treatment to counteract a deficiency of that vitamin and to assist in the management of osteoporosis. If the required equipment could be obtained to monitor both of these medications, it was expected that the matched dose frequency but different delivery method would provide an interesting comparison.

This study provided a further opportunity to test the construct validity of the CFPI and also the test-retest reliability of that measure over a longer period of time. To examine construct validity, CFPI responses would be compared with those in other measures of either illness perceptions or beliefs about medicines but which were not specific to CF. Both the Illness Perceptions Questionnaire (IPQ) (Weinman et al., 1996) and the Beliefs about Medicines Questionnaire (BMQ) (Horne et al., 1998) were studied for their suitability as a comparison. After consideration, it was determined that the items of the IPQ were further, conceptually, from what the CFPI is aiming to measure than were the items on the BMQ, and accordingly the BMQ was chosen as the comparison measure. Participants would complete the CFPI and the BMQ at both the beginning and the end of the electronic monitoring period. The findings of this aspect of the study were presented in Chapter 3, where the development and validation of the CFPI was discussed.

In the initial design for this study, it was decided to monitor adherence to the two chosen treatments for four months. This was expected to be long enough to observe any day to day variation in adherence. It was also achievable in the time available for data collection and was long enough that most participants would have had at least one outpatient clinic visit during the course of the data collection period, allowing for an examination of adherence behaviour in association with outpatient appointments. It was

also considered probable, based on an average of 2-3 inpatient stays per person per year, that at least some participants would have an inpatient stay during that time, so that adherence behaviour in relation to hospital visits could also be examined.

As described below, it transpired that only about half of the sets of monitoring equipment which were anticipated became available, resulting in the data collection taking about twice as long as predicted. When it became clear that there would be less equipment available than expected, a decision was made to reduce the monitoring time for each patient from four months to three and to accept the risk that there would be less data available to analyse in relation to clinic appointments and inpatient stays.

5.1.1 Aims

There were a number of aims for this study:

- To gather objective and accurate data from a sample of Australian adults with CF on patterns of adherence to rhDNase and vitamin D over a period of three months.
- To examine the relationship between electronically monitored adherence behaviours, self-report of adherence and attendance at outpatient clinic appointments.
- To examine the relationship between overall adherence patterns and evidence of daily routines.
- To examine whether electronically monitored adherence behaviours can be predicted from patient perceptions and beliefs about their disease, its treatment and its importance.
- To explore the role of the Self-Regulatory Model (SRM) in adherence to treatments by adults with CF.

5.1.2 Hypotheses

Based on the aims described above and on findings from the previous interview and questionnaire studies, the hypotheses for this study were as follows:

1. **Demographic variables and disease status will be poor predictors of adherence to rhDNase and vitamin D.**

   Research considering the behaviour of adults with CF (e.g., Abbott et al., 1994; Conway et al., 1996), including Study 2, described in Chapter 4, has failed to find consistent links between adherence to treatment and demographic or disease parameters. Previously, it has been hypothesised that people with more severe disease would adhere better, however this hypothesis has not been supported, despite repeated investigation. Therefore, neither demographic variability or disease status are expected to make a substantial contribution to the prediction of adherence in this study.

2. **Patients will demonstrate better adherence to rhDNase than to vitamin D averaged over three months.**

   Higher levels of adherence are predicted for rhDNase for several reasons. First, rhDNase can only be prescribed to patients in an ongoing way on successful completion of a clinical trial of effectiveness. It is anticipated that patients who meet the prescription criteria will hold the perception that the drug is beneficial to them and therefore feel motivated to adhere to it. Secondly, while patients rarely bear the full cost of expensive treatments, rhDNase is known to be a much more expensive drug than vitamin D (over $1100 per month in comparison to less than $20 per month), and it is considered likely that this substantial price difference may predispose participants to a perception of rhDNase being more important than vitamin D. Thirdly, many patients experience some level of symptomatic relief directly as a result of using their rhDNase, whereas the effects of adequate levels of vitamin D are much less immediately obvious. It is anticipated therefore that the symptomatic relief experienced by patients will motivate them to adhere better. All of these predictions are in keeping with the central tenets of the SRM, in which adherence decisions are based on perceptions of coherence between prescribed treatments and current perceptions of the illness. Finally, previous research has indicated generally poor levels of reported adherence to vitamin therapy (Abbott et al., 1994) while some recent

research has found much better levels of adherence to rhDNase (Dapiran, 2000).

3. **Adherence to both vitamin D and rhDNase will vary within patients during the three months monitoring period.**

   This hypotheses is based on the findings of an early meta-analysis (Sackett & Snow, 1979) of adherence to medical treatments. In that exploration of the literature it was observed that people are inconsistent and variable in their management of prescribed treatments and so in this study it was considered likely that adults with CF would also display variability in their day-to-day management of treatments. This hypothesis also fits with the SRM view of health behaviour and health appraisals as dynamic.

4. **Adherence to rhDNase and vitamin D will be higher on weekdays than on weekends.**

   This hypothesis arises from an expectation that good routine will lead to greater consistency and therefore higher levels of adherence to prescribed treatments. In the interview study described earlier, some participants reported routine to be an important motivating factor for their ongoing adherence to treatments and in Study 2, 69% of participants agreed that they kept up better with their CF treatments when they were in a good routine. It is anticipated that for most people, weekdays will be more structured and bound by routine than will weekends and that adherence is therefore likely to be better on weekdays than on weekends.

5. **Participants will adhere to rhDNase and vitamin D on more days in the week following hospital discharge than in the week prior to admission.**

6. **Participants will adhere to rhDNase and vitamin D on more days in the week following an outpatient clinic visit than in the week preceding a clinic visit.**

   Hypotheses 5 and 6 are derived from an expectation that the medical contact of the hospital admission or the clinic visit will increase the short-term salience of both

the illness and the prescribed treatments. Both a hospital admission for treatment of a CF exacerbation and an outpatient clinic visit for a review of current health status and treatment require the patient to focus on their CF and may increase the perception of the illness threat as discussed in the SRM. It is hypothesised therefore that the behavioural response to the increased salience or perceived threat of the illness will be at least a temporary increase in adherence relative to pre-hospital or pre-clinic days.

7. **CFPI ratings of perceived importance of rhDNase and vitamin D for patients' health will predict levels of adherence to those treatments.**

   Findings from Study 2 indicated a statistically significant relationship between perceived importance and adherence for both of these treatments and a significant relationship is therefore predicted using electronic monitoring data.

8. **CFPI ratings indicating high perceived costs relative to benefits will predict poorer adherence to rhDNase and vitamin D.**

   The SRM posits the importance of coherence between perceptions of the illness and the choice of coping response, to decisions about treatment. It is predicted therefore that for those people who perceive the costs associated with the prescribed treatment to be higher than the benefits, adherence will be lower. This relationship was evident for both rhDNase and vitamin D in Study 2.

9. **Greater belief in the value of treatment expressed via the CFPI will predict better adherence to rhDNase but not to vitamin D.**

   The other side of the argument put forward about high costs associated with treatment is that where treatment is highly valued and considered effective, adherence will be higher. In Study 2, this relationship was found to be statistically significant for rhDNase but not for vitamin D. At this stage, while it is not clear why the relationship emerged for rhDNase but not for vitamin D, the same finding is anticipated using electronically monitored adherence to test the hypothesis.

10. **Greater belief in the necessity of medicines and lower levels of concern about medicines, as expressed in the BMQ will predict better adherence (electronically monitored) to rhDNase and vitamin D.**

    This final hypothesis was developed with the expectation that the relationships found by Horne & Weinman (1999) in several chronic illness groups, indicating that higher beliefs in the necessity of medicines was predictive of better adherence while greater concerns about medicines was predictive of poorer adherence, would also be found in adults with CF.

5.2 Methods

5.2.1 Setting

Two settings were used for this study. As for Studies 1 and 2, the Royal Adelaide Hospital Adult Cystic Fibrosis Unit was the location for the collection of most of the data. The Alfred Hospital Adult CF Unit in Melbourne, Victoria, Australia was the second site for data collection in this study.

At the time when this study was being developed, a decision had to be made about the sites for data collection. It was clear, as there is a relatively small population of adults with CF in each Australian state and that people would need to be taking both rhDNase and vitamin D, that more than one clinic would need to be involved in this study. Adult CF Units operate in the states of Victoria, New South Wales, Queensland, Western Australia, South Australia and Tasmania. Tasmania has the smallest population of adults with CF and was therefore considered an unsuitable state in which to attempt to recruit additional study participants.

Long distances between major cities in Australia result in travel between cities being expensive and time-consuming. As it was expected that there would be significant limitations to both the funding and the time available for travel for this project, it was desirable to engage the closest clinic, Melbourne (around 900kms from Adelaide) in preference to the others. Nevertheless, all the mainland clinics were approached to determine their

interest in the project and to try to establish the likely number of potential participants.

The director of the CF clinic in Queensland said that very few of their patients were prescribed vitamin D as almost all patients received ample exposure to the sun and few suffered from a deficiency requiring treatment. The director of the adult CF service in New South Wales expressed some interest in the project, but was concerned that the clinic had committed itself to several other CF research projects and that the addition of another project would place an undue burden of research participation on the clinic population. The director of the CF Unit in Western Australia expressed considerable interest in the project. It was determined though that only a small subset of the population at that clinic would be eligible to participate (around 10 people) and that it may not be worthwhile to pursue the study there. The director of the CF unit at the Alfred hospital in Victoria indicated a considerable level of interest in the project and estimated that there would be a substantial number of patients eligible to participate in the project. The decision was therefore made to pursue the collaborative relationship with the Alfred CF Unit for this study.

The Alfred Adult CF Unit serves the same function for people with CF in Victoria as does the RAH CF Unit in South Australia. At the time of this study the CF clinic population at the Alfred was around 280 people. While the number of patients using the clinic is larger, reflecting the larger state population and proportionally larger number of people with CF, in other respects the clinics operate in a similar way. They have the same medical and allied health disciplines involved in CF care and a similar average interval between outpatient clinic visits.

5.2.2 Participants

Eligibility

To be eligible to participate in this study, participants were required to have a confirmed diagnosis of CF, be aged 18 years or more, be able to speak, read and write in English and be relatively well on the day of recruitment (i.e., not in hospital).

Further, only those patients who were concurrently prescribed both rhDNase and

vitamin D were eligible to participate. The length of time for which people had been prescribed these treatments previously was not considered important for this study and was not part of the inclusion criteria.

Finally, to limit the burden of research involvement on this small population, people who were involved in any other major research study at the time of recruitment, were considered ineligible for participation in this study.

Sample characteristics

The planned sample size for this study was 50 participants. Using a statistical power rating of 0.80, a sample of this size would be adequate to demonstrate statistical significance for effect sizes equal to or greater than 0.30 for tests of directional hypotheses. The chances of being able to recruit a larger sample of participants than this, within the limitations imposed by the amount of time and money available, were considered small.

Unfortunately it proved to be extremely difficult and time consuming to identify and recruit eligible patients to this study in Melbourne. In addition, it was not until several months after a commitment had been made to pursue the study there that it came to light that the number of eligible participants was much smaller (a total of 12) than about 40 as had been estimated by the Head of the CF team. Due primarily to the limited resources available to manage the study in Melbourne, lengthy and unexpected time delays totalling more than a year were encountered during the development of the collaborative relationship, planning of the study, in the process of submission for ethics approval and later, in determining who was eligible to participate in the study. After the first two participants in Melbourne had commenced data collection, recruitment was stalled for more than 6 months.

Twenty five people participated in this study; half of the planned sample. At the time of completing this dissertation a further nine people from the Alfred had consented to participate and commenced the monitoring period. An additional ten people from the clinic at the RAH had become eligible to participate in the study since the previous data collection round there, and recruitment preparations were underway. Recent tightening of University of Adelaide protocols for Scholarship and Candidature lengths restricted the

time available for this research. It was not possible therefore, to wait for the additional data before preparing this thesis. That data will be considered in due course and the overall outcomes submitted for consideration to a suitable peer reviewed publication. The effects of the smaller than expected sample size on statistical power for the study are discussed in section 5.4 and the wider implications are discussed throughout the chapter and also in Chapter 6.

The characteristics of the final sample were necessarily shaped in part by national restrictions on the prescription of rhDNase. In Australia only those patients who can demonstrate an improvement in FEV1 of at least 10% over a one-month trial period, are eligible for ongoing prescription of the drug. No such restrictions apply to the prescription of vitamin D. The restriction on the availability of rhDNase creates a pre-selected sample of people who have qualified for prescription of the drug and may therefore be considered likely to demonstrate adequate rates of adherence to the treatment. However, as discussed in detail in the literature review, treatment outcome can be influenced by so many different behavioural and biochemical factors that adherence cannot be considered as the only important factor involved in the success or failure of prescribed treatments. This element of self-selection was not considered likely therefore, to skew the findings unduly, although it was expected to have some influence on the findings as described in Hypothesis 2.

Twenty three of the participants were recruited from the Royal Adelaide Hospital, representing 85% of the population of eligible people at that clinic. Thirteen of the participants in this study had also participated in the study described in Chapter 4. On average there was a time gap of 15 months between participation in the questionnaire-only study and commencing involvement in this electronic monitoring study. Of the four eligible people who did not participate, one agreed to participate, but then withdrew from the study early; one had recently purchased a new model compressor to nebulise rhDNase and was concerned that the compressor to be used in the study was slower than the new model and would therefore be inconvenient to use, and one person was planning an overseas trip and did not want to commit to involvement in the study. The last person gave no reason for not wanting to be involved in the study. The remaining two participants for the study were recruited from the Alfred CF clinic. These two participants were the

only people approached at that time.

Given the small pool of eligible patients in each state and the effort to recruit as many of them as possible, no attempts were made at randomisation of the study sample for this project.

Ethics approval for this project was granted independently by the Human Ethics Committees of the three relevant institutions; The University of Adelaide, the Royal Adelaide Hospital and the Alfred. Recruitment began in July 2001.

5.2.3 Measures and equipment

Demographic and health status information

Descriptive and health status information about each of the participants was collected, to allow for an examination of the role these factors might play in adherence to the two monitored treatments. As in Study 2, the details of age, gender, marital status, employment status, living arrangements and location (country or metropolitan) were collected from participants, along with information about their height, weight, lung function, a self-rating of health in comparison with people without CF and a self-rating of CF disease severity. In CF, as described elsewhere in this dissertation, the most useful indicator of lung function is the measure of forced expiratory volume in one second (FEV1), expressed as a percentage of the predicted FEV1, based on the person's height, age and gender (FEV1%).

CFPI

The revised version of the CFPI as described in Chapter 3 was completed by each participant at the beginning and the end of the three months data collection period for this study. A copy of the CFPI is presented in Appendix B.

Beliefs about Medicines Questionnaire

The Beliefs about Medicines Questionnaire is a recent ten item self-report measure developed in the United Kingdom (Horne et al., 1998). There are two forms of this question-

naire, one answered in terms of beliefs about medicines in general and another answered in terms of beliefs about medicines prescribed specifically for the person. The specific form is used in this study and a sample of the questionnaire is included in Appendix B. This measure provides two summary scores representing a persons *Concerns* about the medicine prescribed for them and the other representing their perception of the *Necessity* of the medicine. These two summary scores have been shown to be associated with adherence to treatment by patients with chronic illness (Horne et al., 1998).

Pill counts

A pill count of vitamin D tablets remaining at the end of the study period was made for each participant. At the commencement of the study, participants were instructed not to remove any remaining tablets from their special vitamin container before they returned their study equipment. A reminder about this was given when participants were contacted shortly before the end of the study to make an appointment to return their equipment. Anyone who expressed interest in keeping any remaining tablets was offered the opportunity to take the remainder home in a standard, clean vitamin bottle at the end of their final meeting with the researcher for the study.

Attendance records

The Cystic Fibrosis Unit at the Royal Adelaide Hospital maintains a database of all outpatient clinic appointments for each person who uses the clinic. The database contains information about kept appointments, cancelled appointments and missed appointments (appointments that the appointee made but did not attend or cancel). For each participant, consent was gained to access those records for the period of the study and for the preceding 12 months. A medical record search was conducted to determine the clinic attendance data for the two participants from the Alfred.

Hospital admission and discharge records

The RAH CF database also contains information about hospital admission and discharge dates. As for clinic attendances, participants gave consent for their hospital admission

and discharge data for the study period (and the prior 12 months) to be accessed for this study. Similar information for the participants from the Alfred was obtained from that hospital's computer database of hospital stays.

Electronic monitoring

General Remarks A substantial Internet and literature search was conducted to establish whether the monitoring equipment required was manufactured and available for purchase commercially. Although there were several commercial companies identified that make electronic monitoring devices to measure adherence to tablet taking, there were no commercial devices available to measure adherence with nebulised treatments. In previous studies in the literature reporting on the use of these devices, the monitors were developed specifically for the study and manufactured in small numbers with a high unit cost price (Quittner et al., 2000; Starr et al., 1999).

Just prior to the development of this study, an Australian research team based at the Royal Children's Hospital in Victoria, had encountered a similar difficulty in securing electronic monitoring equipment for a study of adherence to rhDNase among adolescents with CF (Dapiran, 2000), and had secured research funding to develop an electronic recording device for a nebuliser compressor pump. The monitoring device was developed by Mr. Richard Newman, Compumedics, and was based on a micro-electrical tablet taking monitor which he had designed for an earlier study which monitored adherence to preventative therapy for tuberculosis (Starr et al., 1999).

The devices were made and fitted to the nebuliser compressors by the Biomedical Engineering Department at the Royal Children's Hospital. This department was approached about their willingness to make more of the devices for this study. An "in principle" agreement was reached with them, to produce more of the monitors at a cost of $500 per unit if funding could be secured for the project.

Funding for and source of the equipment In June 2000 and again in June 2001, I made applications for grant funding for this project from the Cystic Fibrosis Research Trust and CF Australia, the major source of research funding for projects related to

CF in Australia. Both of these applications for funding received positive reviews but were unsuccessful. I made a successful application for research funding in February 2001, to Roche Products. Roche Products manufacture rhDNase under the brand name of Pulmozyme in Australia. They were the providers of the research funding for the studies conducted by the Royal Children's Hospital team.

Grant funding of $3000 was awarded by Roche for equipment maintenance, travel costs and other administrative costs associated with the study. In addition, 30 Pari LC Plus nebulisers (recommended for use with rhDNase) were supplied, and the long term loan of a laptop computer for the project was made. Funding for more equipment was not awarded, as the company felt they had already invested a significant amount of research funding into the monitoring equipment, and were advocating a collaborative venture in which the equipment could be made available for this study at the completion of the study underway in Victoria at the time. Ms. Elizabeth Cook, Product Manager for Roche Products, was instrumental in introducing the Victorian and South Australian Research Teams that were studying adherence to rhDNase, and in facilitating the development of a collaborative relationship.

An agreement was reached that the electronic monitors manufactured for and in use in the Victorian study (20 in all) would be made available for this project when that one was completed. In May 2001, 14 nebuliser monitors, along with the required data transfer equipment and analysis software, were made available for this project. In addition, 20 of the electronic tablet monitors designed by Mr. Newman, and previously used by Starr et al. (1999) were made available by Dr. Starr for use in this project. These tablet monitors used the same interpretive software, and had the same basic internal design for the monitoring device as the nebuliser monitors. There was a considerable economic and practical advantage in using tablet monitors that provided data in the same format as the nebuliser monitors and could also be downloaded and prepared for analysis using the same software.

The electronic monitors The electronic monitors record–in real time–the date and time of day when the tablet container or nebuliser pump is used, and the duration of use in

seconds. The following description of the design and functioning of the nebuliser monitor is drawn mostly from the description contained in the thesis "Patterns of medication use in patients with Cystic Fibrosis" submitted by Ms. Elizabeth Dapiran for her Bachelor of Medical Science degree from the University of Melbourne in 2000. As her thesis is not readily accessible and the findings have not yet been published, Ms. Dapiran has given her permission for the details of the monitor to be described again here.

A Pari ProNeb Turbo compressor (model number 38V0232) was used for these studies. At the time this was a new model and it is still considered to be compact, efficient and powerful. As described above, the pumps were used with Pari LC Plus nebulisers. The dimensions of the compressor are 16.5 cm × 14 cm × 8 cm. The monitoring device, enclosed in a black plastic box, is attached to the back of the pump. The dimensions of the black box are 12 cm × 3.5 cm × 8 cm.

The compressor and the monitoring device are powered independently. While the compressor uses mains supply, there is electrical isolation between the compressor and the monitor, to ensure that the pump and monitor do not interfere with one another electrically. The monitoring device is powered by a 9 volt alkaline battery which has a life of approximately 180 hours use. It is estimated to last for one year if the patient uses the pump for less than 30 minutes per day. Power is only consumed when the compressor is turned on.

When the pump is switched on, an infra-red LED diode, using mains power, is switched on. A photo-transistor is activated via optical transmission from the infra-red LED. This turns on the power in the monitor via an electronic switch and activates the monitor to begin recording.

The electronic device which records the use of the pump and nebuliser is a Dallas DS5000T microchip. This consists of a real time clock and a non volatile static memory and is powered by a lithium battery, which has a lifetime of approximately 10 years. The memory lasts for up to 10 years and has a capacity to record 2500 uses of the pump and nebuliser. The memory can be cleared using a computer interface so that new data can be collected.

The electronic monitors for tablet taking behaviour use the same kind of microchip

Figure 5.1: Electronic Monitoring Equipment: on the left is the tablet monitor and on the right is the nebuliser monitor.

and power system but the system of activation for the monitor is different. The electronic monitoring device for tablet taking is housed in the lower half of a large, screw top tablet container, with a diameter of 8cm and a depth of 7cm. No power source is required to trigger the monitor in the tablet container. A magnet in the lid activates a switch in the monitor when the lid is removed from the container. When the lid is removed recording begins in essentially the same way as for the nebuliser monitors. When the lid is replaced, the magnetic seal is reactivated and the device stops monitoring.

Both of these monitoring devices record "blindly"; that is, the patient has no access to the information collected by the monitor. For research purposes, this means that the patient cannot make use of the data as a prompt or memory aid for adherence. The devices are illustrated in Figure 5.1.

A "communicator" device is required to download the information that is stored in the monitors to the Medmon software used to read, display and summarise the data. The

software, also designed by Mr. Richard Newman, can be used to change the patient code and clear the memory in the monitor. This allows the monitored compressor to be used by another patient. The time on the clock in the microchip can be checked and changed and an indication is also given about whether the 9 volt battery in the monitor needs to be changed. The data from the monitors can be exported to other computer programs for more sophisticated analysis.

Given the risks of malfunction with any electronic device, due to battery failure, component failure or accident, all of the electronic monitors were thoroughly inspected, re-set and fitted with new batteries, then tested before distribution to the next patient. In CF, the specific pathogens which colonise the lung can be readily transferred from one patient to the next by contact, so meticulous cleaning and disinfection of any shared equipment is essential and was conducted in all cases, to minimise the risk of cross-infection. Carry bags for the compressors were washed in hot soapy water and all electronic equipment was cleaned and disinfected with alcohol.

5.2.4 Procedure

Participants were recruited during waiting time for their outpatient clinic appointments. Eligible patients were approached in the waiting area by the researcher and asked whether they would be interested in finding out more about a research study for which they were eligible to participate. Patients who indicated that they were interested in finding out more, were given an information sheet to read (See Appendix F). After about 10 minutes, the researcher asked those patients whether they were interested in participating in the study. People who said that they were interested, were invited to accompany the researcher to an office within the clinic where the full details of the study could be explained.

During this brief meeting, written consent was obtained, participants completed both the CFPI and the BMQ, and the monitoring equipment was set up with the starting date and patient details. Recruitment and set up for this study took between 10 and 15 minutes per person, depending on how many questions the person asked about the

study and how long he or she spent completing the questionnaires. It was ensured that participating patients had their monitored tablet container filled by the hospital pharmacy with a three months supply of vitamin D before they left the clinic that day. It was hoped that this would minimise the chance of extra container openings being needed to refill the container and therefore contaminating the data with spurious information.

The verbal information given to participants in the meeting included a "normalisation" of the difficulty in maintaining adherence to all CF treatments all of the time. It was explained to participants that the researcher was interested in understanding better how different people manage that task on a day to day basis, with a long term view to CF clinicians being able to better assist people to develop realistic treatment maintenance plans. It was further explained that the researcher was interested in the opinions which people hold about their CF and their CF treatment and the way that people's different opinions about these matters may be linked to differences in the way they manage their treatment.

The electronic monitors were introduced as a tool to assist the researcher to "keep track of" how much of the two treatments the participants were "needing". The convenience of the monitors was emphasised (no diaries or other reporting methods would be required) and participants were reassured that the study was not designed to "check up" on them and that their personal information would not be accessible to clinic staff. Specific details of what the monitors would record was not routinely given, but any questions from participants about how the monitors worked or what they recorded, were answered truthfully. Participants were requested to maintain their current management practices for the two medications unless specifically instructed by their physician to make a change. It was explained that for the results of the study to be useful it was particularly important that people avoid changing the way they normally managed the medications, with the exception of some minor points described below.

Participants were told that the duration of the study was three months. Instructions were given on how to use the tablet container and the compressor and nebuliser. The importance of using the assigned equipment for each dose of the respective medications for the whole of the study was stressed. In particular, participants were asked to ensure

that they only removed their dose of vitamin D from the container at the time they were intending to take the dose and especially, not to remove several days of doses at one time and put them into a daily pill organiser, as was the usual practice of some participants. Also, patients were asked to ensure that the compressor assigned for the study was only used to nebulise their rhDNase and not used to nebulise any other treatment managed in the same way. Participants were asked to take their assigned equipment with them if they were admitted to hospital during the three months of the study and to take it with them if they went away for a holiday at any time during the study.

A dot point list of instructions was given to participants, to assist them to remember how the study equipment was to be used and to list some care and safety details for the use of the equipment. A copy of the instruction sheet is included in Appendix G.

Patients were informed that where possible, the equipment would be collected from them at their next clinic appointment which coincided most closely with the end of the three month period. In some cases, this meant that the equipment was returned after slightly less than the full three months and in some cases after a little more than three months. In cases where a participant was not expecting to return to the clinic for a routine appointment any time close to the three months study duration, a special arrangement was made that they would return the equipment to the clinic on an appointed day that was mutually convenient for both the participant and the researcher. Participants were asked to provide a contact phone number, which would be kept by the researcher only for the duration of the study. All participants were telephoned about one week prior to the end of their three months data collection period, to remind them that their participation time was almost complete and to request that they remember to bring their equipment with them to their next clinic appointment.

When participants returned their equipment, remaining vitamin D tablets were counted and any leftovers were offered back to the patient as described above. The participants were also asked to complete the CFPI and BMQ questionnaires again and to inform the researcher of any difficulties they may have encountered in relation to the study. In several cases, participants had had trouble with the lid of the tablet container cracking or splitting, mostly around the screw thread. Fortunately, the container was still usable

and the data collection had not been compromised. Those containers had new lids fitted before being assigned to the next patient.

The analyses to follow were conducted on data collected in three rounds, over approximately 17 months. As mentioned earlier, data collection for this study is still taking place and will continue beyond the completion of this thesis. It was not possible, due to lengthy and unavoidable delays and less equipment than planned for, to report on the full sample originally expected for this study.

5.3 Electronic data preparation

Data from the electronic monitors were downloaded to a computer using the communicator device and Medmon program described earlier. The information was then exported to a text file, where it could be viewed to check for any anomalies or evidence of device malfunction. Each raw data file was then passed through another computer program to fully prepare it for analysis. Several actions were performed on the raw data to ensure that later analyses would be operating on valid information. The file for each person was truncated to conform exactly to the start and end dates of the agreed monitoring period. Once this had been done, the first and last days in the monitoring period were removed from each file, to ensure that spurious lid openings or operations (such as for putting tablets into the container, removing left over tablets or for demonstrating the use of the nebuliser pump) were not counted as medication taking events.

The raw data showed that many people in the sample had, at times, turned their nebuliser pump on and off several times in the space of a few minutes. Together, these short uses of the pump almost always represented a reasonable length of time for full nebulisation of an ampule of rhDNase. The pumps could be turned off during treatment for any of several reasons:

- for the patient to cough
- to speak to someone
- to make an adjustment to their equipment or their personal comfort.

Clearly, these episodes were not to be considered separate uses of the pump and a decision was made to concatenate all uses of the pump occurring within half an hour of one another, into one episode. Further, on any day except when the rule just described could be applied, a use of the pump was only considered to have taken place if the pump was turned on for at least 180 seconds. Adequate nebulisation of an ampule of rhDNase, using the same pumps, was estimated by Dapiran (2000) to take a minimum of 360 seconds. A visual inspection of the raw data revealed that where the pump was used at all, there were very few instances of use for less than 360 seconds. In the case of the vitamin D dispensers, a count was made of the number of times in each 24 hour period that the dispenser was opened for at least three seconds, however only the first opening was used in the analyses.

For rhDNase, adherence was considered to have taken place if the nebuliser pump had been used for a minimum of 180 seconds over a maximum period of half an hour on any day. For vitamin D, adherence was considered to have taken place if the lid of the container was opened for at least three seconds duration on any day. Overall adherence to each treatment was then considered as a percentage of days on which the treatment had been managed as just described. Over-use of the pump or tablet container was not addressed in the analyses.

On inspection of the data sets for subject 26, the data for the use of the vitamin dispenser were consistent with appropriate use. There was a significant problem however, with the data for the nebuliser pump. This person had used the nebuliser pump at least twice and up to eight times each day. Often, the duration of use of the pump on any one of these occasions was indicative of nebulisation of a complete ampule of rhDNase. As rhDNase is prescribed at the rate of one ampule per day, and new scripts can only be dispensed monthly, it seems highly unlikely that this person was nebulising rhDNase more than once per day. Instead it is likely that the patient forgot that the pump was to be used only for rhDNase, and used it for all nebulised treatments. It was not possible to reconstruct which uses of the pump were for rhDNase and as a result, the data for participant 26 were not included in the analyses.

5.4 Analysis procedures

As for Study 2, SPSS version 10 for Windows was used for the analyses in this study. With an $N = 25$ and using $p = 0.05$ as the accepted minimum level for statistical significance this study, this study had a statistical power level of 0.80 for correlation effect sizes of 0.50 or greater for between subjects investigations. This means that in this study the probability of a Type One error occurring for effect sizes smaller than 0.50 was quite high. As was the case in Study 2, the small sample size reduced the power of this study to elucidate more subtle relationships between the variables under investigation. For within subjects investigations, such as those examining differences in routine for different medications, where there were many observations per person, the risk of Type One errors was considerably lower.

Frequencies analyses were conducted to explore the demographic data, self-reported and electronically monitored adherence rates and ratings of importance for different treatments. Relationships between demographics, disease parameters and treatment adherence were examined using either independent samples t-tests or one-way analysis of variance (depending on the number of categories). Some relationships between data of at least interval level (such as BMI and percentage of days adherence as measured by the electronic monitors) were also investigated with Pearson's correlations.

Differences in adherence between the two electronically monitored treatments were examined using related samples t-tests and this technique was also employed in examinations of differences between most of the measurement methods for adherence. Variation in adherence over time was examined visually, using a graphical representation of behaviour for each person. Relationships between adherence to treatments and management routines were examined using a combination of related samples t-tests and Pearson's correlations as was the impact of clinic visits and hospital admissions on adherence behaviour.

Pearson's correlations were used to examine the inter-relationships between adherence and the perceptions and beliefs about treatment recorded by both the CFPI and the BMQ.

5.5 Results

The participants for this study were 15 men and 10 women with CF, aged between 19 and 48 years, with an FEV1 as a percentage of predicted of between 24% and 110%. The Body Mass Index of all participants fell between 19 and 26, putting them in the accepted range for healthy weight in CF. The majority (68%) of the participants were single, 28% were married or living in defacto relationships, and the remainder were separated or divorced. Employment status varied within the group, with 48% indicating that they were employed, 40% receiving a disability pension, 9% studying and 4% unemployed. Most of the participants lived in metropolitan areas, but 26% reported living in country areas. In keeping with their marital status, 28% reported that they lived with their spouse or partner, while 44% lived with their parents. Around 13% of participants lived alone and the remainder lived in shared accommodation.

Prior to an examination of the specific hypotheses for this study, summary descriptive information about rates of adherence to rhDNase and vitamin D, as measured by the electronic monitors is presented in Table 5.1. It can be seen that adherence to the rhDNase regimen occured on average on many more days than did adherence to Vitamin D. The statistical significance of this discrepency is discussed in full later in this chapter. In addition, summary descriptive information about scores for this sample on the five clusters of the CFPI is presented in Table 5.2 and for scores on the BMQ, in Table 5.3. For the CFPI, scores on each item were between 1 and 4 and the cluster score was calculated by taking the average score across items in the cluster. Higher scores represent greater agreement with the item statements in the cluster. It can be seen that overall, most patients agreed that their treatment was valuable, while there was a little more variability in opinions about items on the other clusters. For the BMQ, a score is computed for the *necessity* scale and the *concerns* scale. Scoring is done by adding the raw scores for each of the items in the scale, to a maximum of 25. As with the CFPI, a higher score represents greater agreement with the items in the scale. In this sample, participants generally had a strong belief in the necessity of their medicines and a relatively low level of concern about them.

Medication	N	Mean (%)	Median (%)	SD	Minimum	Maximum
rhDNase	23	73.7	91	30.7	0	100
vitamins	23	43.4	44	28.1	1	100

Table 5.1: Relative percentage of days adherence to rhDNase and vitamin D as measured by the electronic monitors.

Cluster name	N	Mean score	SD	Minimum	Maximum
Treatment Value	23	3.12	0.32	2.57	3.86
Cost vs Benefit	23	2.61	0.42	1.86	3.86
Concern / Attention	23	2.80	0.43	1.88	3.57
Denial	23	2.52	0.76	1.67	4.00
Lifestyle / Energy	23	2.50	0.51	1.71	3.71

Table 5.2: Mean scores for CFPI clusters. Each item receives a score between 1 and 4

Scale	N	Mean score	SD	Minimum	Maximum
Necessity	22	20.73	2.68	15	25
Concerns	22	11.95	3.55	6	21

Table 5.3: Mean scores for BMQ scales.

5.5.1 Hypothesis 1: Relationship between demographic and disease characteristics and both self-reported and electronically monitored adherence

It was hypothesised that both demographic and disease characteristics would be poor predictors of adherence to treatment. This hypothesis was examined first using the self-reported adherence data for seven different CF treatments (collected using the CFPI), and then examined again for rhDNase and vitamin D using the data from the electronic monitors. Self-reported adherence was recorded on a four point scale where 1 means 7 or 6 days of the week, 2 means 5 or 4 days of the week, 3 means 3 or 2 days of the week and 4 means 1 or 0 days of the week.

Pearson's product-moment correlation was calculated to examine the strength of association between reported adherence to each of the treatments and participants' age, Body Mass Index (BMI) and FEV1%. There were no significant associations between self-reported adherence to the seven treatments in the CFPI and these three variables but

there was a moderate association between higher BMI and better adherence to vitamin D as recorded by the electronic monitors ($r = .54$, $p = .01$).

Possible differences in reported or electronically monitored adherence as a result of gender, marital status (married, defacto, separated/divorced or single), employment status (employed, student, unemployed or disability pension) living arrangements (family home, alone, with spouse/partner or share), and location (country or metropolitan) were explored using t-tests for independent samples (for gender and location) and one way analysis of variance.

There were no significant differences in reported or electronically monitored adherence to any of the treatments due to gender, location or living situation. When the effect of marital status on reported adherence was examined, there were only two people who described themselves as being in a defacto relationship and one person who said that he or she was separated or divorced. In the one-way analysis of variance, the outcome was significantly and unreasonably influenced by the one person who was separated or divorced and further influenced in a way that did not appear to reflect true differences by the two people reporting themselves to be in defacto relationships, so it was decided to drop these three participants from the analysis. This data was re-analysed using a t-test for independent samples, with only the data for people who were married or single included. In that examination, people who were married reported less frequent adherence to physiotherapy than single people ($t = 2.25$, df $= 17$, $p = .04$). No significant differences were found for marital status when the electronic monitoring data were examined for rhDNase and vitamin D. When employment status was examined, students reported adhering less often to their antibiotics than other groups ($F(3,12) = 3.5$, $p = .05$). Electronic monitoring of rhDNase and vitamins revealed no differences due to employment status.

5.5.2 Aim 2: Comparison of different measures of adherence.

Several approaches were used to measure adherence in this study: pill counts, attendance at clinic visits, self-report, and electronic monitoring. The relative value and accuracy of the methods in providing information about participants' home care adherence behaviour

was considered. An examination was also made to compare the accuracy of participants' self-report of the severity of their lung disease (mild, moderate or severe) with the measured severity as indicated by their FEV1%.

A related samples t-test was used to compare the number of tablets remaining in the electronically monitored vitamin D tablet dispenser at the end of the study, with the number that was expected. The expected number was calculated by subtracting the the number of days on which the monitor recorded that the dispenser was opened, from the number of tablets originally put into the container. A significant difference was found ($t = -7.1$, df $= 21$, $p < .001$), with many fewer tablets left than was expected for most participants. Only two participants returned the expected number of tablets; the most adherent participant and the least. Overall, as fewer pills remaining represents more doses taken, pill counts overestimated the electronically monitored number of doses taken by 47%.

Pearson's product-moment correlations were used to examine the relationship between the percentage of days on which participants were adherent to the electronically monitored medications and the percentage of clinic appointments which they either attended, cancelled or missed (DNA). A small-to-moderate association was found indicating that those participants who attended a higher percentage of scheduled clinic appointments had better adherence to rhDNase ($r = .42$, $p = .05$) and a trend was observed indicating that a larger percentage of cancelled appointments was related to poorer adherence to rhDNase ($r = -.39$, $p = .06$). No significant associations between the percentages of attended clinic visits, cancelled visits or missed visits and electronically monitored adherence to vitamin D were found.

The relationship between self-reported adherence to CF treatments and percentage of clinic visits attended, cancelled or missed was examined in the same way. People who reported adhering to their enzymes and their dietary plans on fewer days of the week were more likely to miss their scheduled clinic visits (for enzymes, $r = -.50$, $p = .02$ and for dietary plans, $r = -.48$, $p = .04$). Poorer reported adherence to physiotherapy was related to a higher percentage of cancelled clinic visits ($r = -.44$, $p = .05$). Conversely, reported adherence to exercise plans on more days of the week was associated with a higher

percentage of clinic visits attended ($r = .42$, $p = .05$). A trend was observed for higher self-reported adherence to rhDNase to be associated with a higher percentage of clinic visits attended (in keeping with the relationship observed using electronic monitoring data for rhDNase), but the relationship did not reach statistical significance ($r = .35$, $p = .11$).

The percentage of clinic visits cancelled, attended or missed was also examined using independent samples t-tests, in relation to age, gender, and BMI (above or below median BMI); and examined for lung disease severity (mild, moderate, severe) using a one-way analysis of variance. The only significant finding was that older people (25 years or more) attended 10% more of their clinic appointments and missed 10% fewer than their younger counterparts ($t = 2.23$, df $= 20$, $p = .04$ for attendances, $t = 2.92$, df $= 20$, $p = .009$ for missed appointments).

A comparison was made between self-reported adherence to rhDNase and vitamin D and electronically monitored adherence. Participants were asked to indicate on a four point scale, how many days of each week they kept up with their treatments. The proportion of days per week was compared with the proportion of days per week on which the electronic monitoring data showed that they kept up with treatment, truncated to the same four point scale. These ratings were then compared using a paired samples t-test, to determine whether there was a significant difference between them. No significant difference was found between self-reported adherence to rhDNase and electronically monitored adherence ($t = 0.0$, df $= 17$, $p = 1$), however a difference was found between self-reported adherence to vitamin D and electronically monitored adherence ($t = -2.29$, df $= 17$, $p = .04$), with the mean self-report of adherence being 43% higher than the mean for electronically monitored adherence. Self-reported adherence to rhDNase proved to be an important cross-check mechanism for the electronic monitoring data of the least adherent person (person 21), who apparently did not use the medication at all during the study period (see Figure 5.23). In that case, the participant reported that she had not taken her rhDNase at all, providing reassurance that the electronic monitoring equipment had provided accurate data (or in that case, a lack of data).

It is important to note that the comparisons made between self-report and electronic

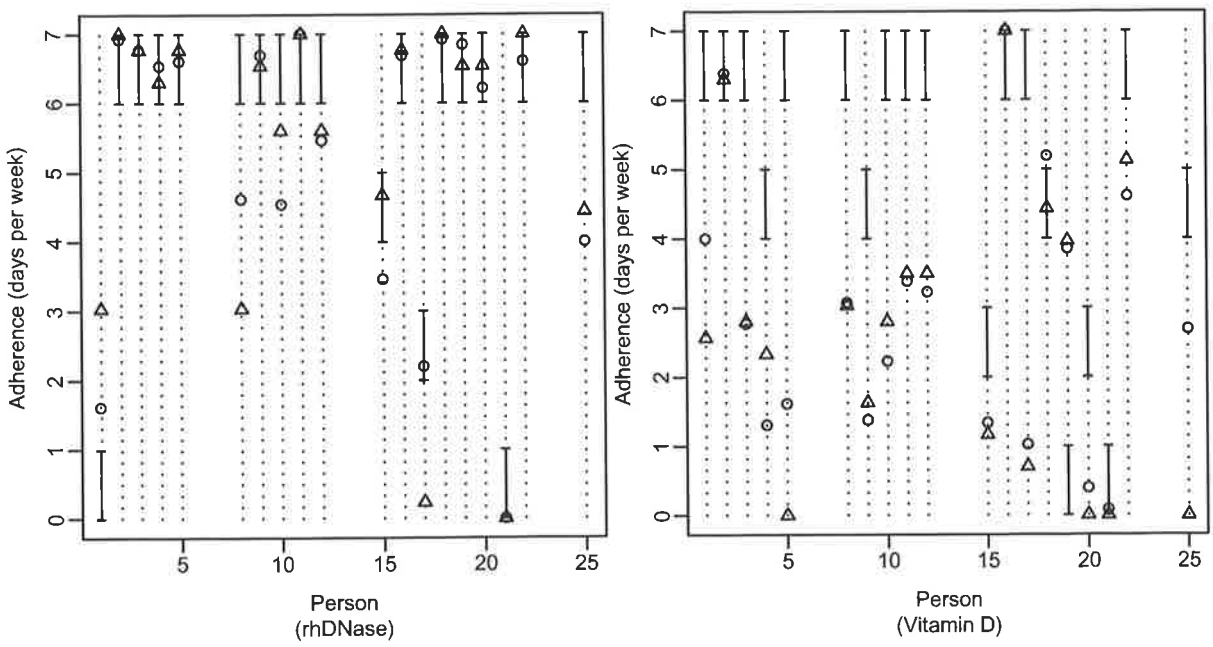

Figure 5.2: Comparison between self-report and electronically monitored adherence. Solid lines represent days per week of self-reported adherence over the last month, triangles represent electronically monitored adherence over the past month and circles represent electronically monitored adherence over the full study period.

monitoring were subject to a substantial risk of either over-estimation or under-estimation of the strength of the relationship. This risk arose because the self-report of adherence was represented in four categories rather than representing each day of the week separately. This relationship is therefore also presented in Figure 5.2, so that the self-reported range can be shown with the more specific information provided by the monitors. The figure shows the CFPI self report of days per week adherence in the last month of the study, the mean number of days per week of adherence over the last month as recorded by the electronic monitors, and the mean number of days per week adherence over the whole study period. Each person is represented on the abscissa on each graph. Data for six participants is missing from the figure as those participants either never returned the final questionnaire for the study or returned it very late so that their self-report data for the final month of the study was therefore not available for analysis.

Using FEV1%, an analysis was conducted to examine how well people judged the severity of their own lung disease. Participants had been asked to rate whether their

CF was mild, moderate or severe and a one-way analysis of variance was conducted to determine whether there was a mean difference in the FEV1% between these self-rated groups. A significant group effect emerged, with $F(2,19)= 10.12$, $p = .001$. The three group means fell within the generally accepted ranges for differentiating disease severity. People with an FEV1% of 40% or less are generally considered to have severe disease and the mean FEV1% of people who rated their CF as severe was 31%, (SD = 7.9%). People with an FEV1% of between 41% and 70% are usually considered to have moderate disease and the mean FEV1% of people who rated their disease as moderate was 56% (SD = 14.4%). If FEV1% is over 70%, disease is usually considered to be mild and in this group, people who rated their disease as mild had a mean FEV1% of 71.3% (SD = 22.7%). While it seems apparent that some people with an FEV1% of below 70% underestimated the severity of their disease, participants were overall quite accurate in their assessment of the severity of their lung disease.

5.5.3 Hypothesis 2: Difference between adherence to rhDNase and adherence to vitamin D.

It was hypothesised that adherence to rhDNase, as measured with the electronic monitors, and averaged over the three month study period, would be higher than adherence to vitamin D measured in the same way. The reasons for this hypothesis are described in detail above. This hypothesis was tested using a t-test for related samples, with the result demonstrating a significant difference in favour of adherence to rhDNase, with $t = 5.03$, df = 22, $p < .001$. The mean adherence to rhDNase was 74% of days (SD = 30.7%) with median adherence being 91% . The mean adherence to vitamin D was 43% of days (SD = 28.1%) with a median adherence of 44%. There was also a moderate correlation between adherence to rhDNase and adherence to vitamin D ($r = .52$, $p > .01$).

This difference was also evident from the self-report data given by participants on the CFPI. Figure 5.3 shows the percentage of participants reporting adherence to the seven CF treatments in the different response categories. Based on self-report, 83% of participants reported adhering to their rhDNase on 7 or 6 days per week, compared with

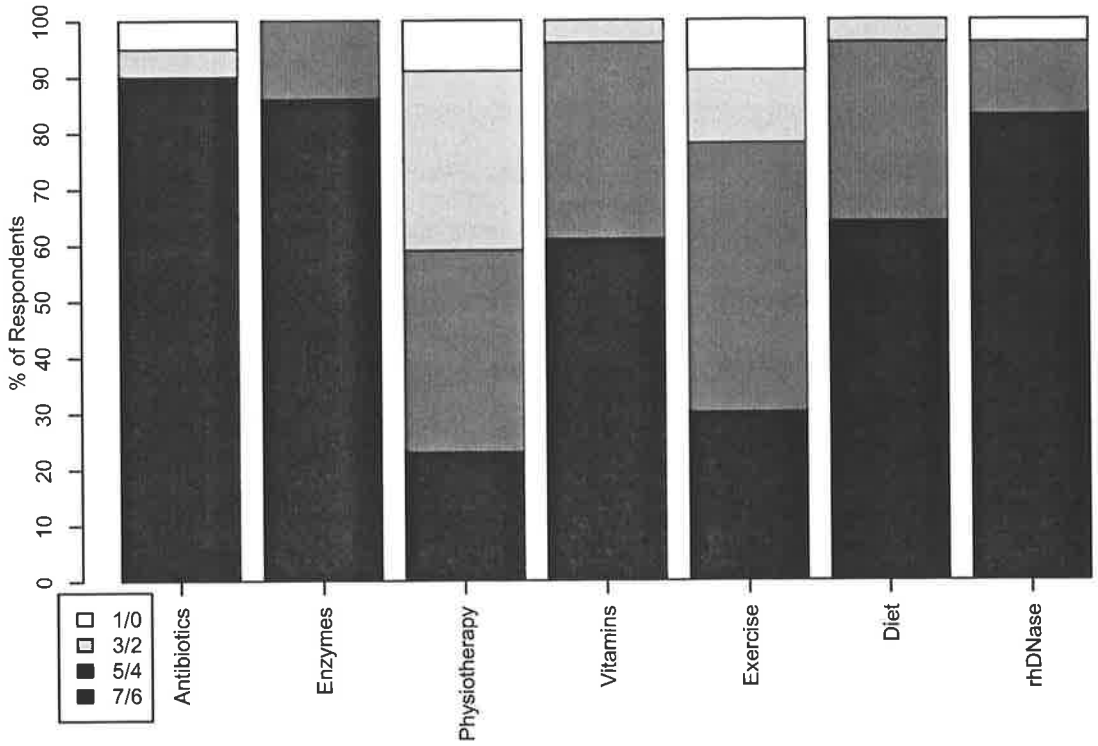

Figure 5.3: Self-reported adherence to the seven CF treatments.

61% of participants claiming the same for vitamin D. It will be noted that the percentage of responses falling into the category for the highest level of adherence (7 or 6 days) is considerably higher for most treatments, when compared with self-reported adherence in Study 2, perhaps reflecting the difference in the style of self-report asked for.

5.5.4 Hypothesis 3: Variation in adherence to rhDNase and vitamin D over three months.

It was hypothesised that adherence to both rhDNase and vitamin D, as measured with the electronic monitors would vary, or be dynamic over the three months monitoring period. This hypothesis was examined by observing the patterns of daily behaviour in relation to both medications for each participant. The hypothesis that adherence would be dynamic over three months was supported. This variability can be observed in Figures 5.4 to 5.27. A bar chart is presented for each person, for each medication, showing days on which the medication was taken and hour of the day when the dose was taken. The number for

each person refers to the identifying number in the study. Person 6 became very ill about one month into the study and elected to finish early. Person 7 is not represented as he completed the initial questionnaire for the study, but then withdrew and did not collect any data with the electronic monitors.

For most participants there was considerably more variability in their management of the vitamin therapy than in their management of rhDNase. For one third of participants, adherence to rhDNase was more than 95% of days and half of the participants took their rhDNase on more than 90% of days. In comparison, there were only two participants who took their vitamin D on more than 90% of days in the study period. Where variability was present for either medication, no consistent pattern to the variability was observed.

Two participants were very adherent to both medications, with only an occasional day of treatment missed (person 2 and person 16). For others, there were several days missed, followed by one or several days of adherence and so on (e.g., person 12 and person 13). A few participants displayed short patches of relatively consistent adherence, interspersed with long periods of time when the medications were not taken at all (e.g., person 15 and person 17). A small subset of participants displayed minimal or no adherence to either medication over three months (e.g., person 21 and person 24). For participant number eight, there is a period of two weeks in the middle of the three months when his use of the monitoring devices stopped. This period of time coincided with a two week hospital admission when the participant did not take the monitoring equipment to hospital. When asked about this at the end of the study he did not recall whether his treatment with rhDNase and vitamin D was continued (using hospital equipment) while he was an inpatient. Due to privacy regulations it was not possible to find out that information from his medical record. One participant reported that he would be going on a holiday for at least two weeks during the study period and did not intend to take any of his CF medications or equipment with him (person 24).

Evident from the graphs is the considerable variation for each person in time of day when the medicines were taken. While some patients clearly took most of their doses at around the same time each day (e.g., person 2), some graphs demonstrate a multi-modal effect (e.g., person 9 and person 23) or demonstrate no consistency at all for the time of

day when the dose was taken (e.g., person 11). The relationship between percentage of doses taken and reliability of time taken is discussed later.

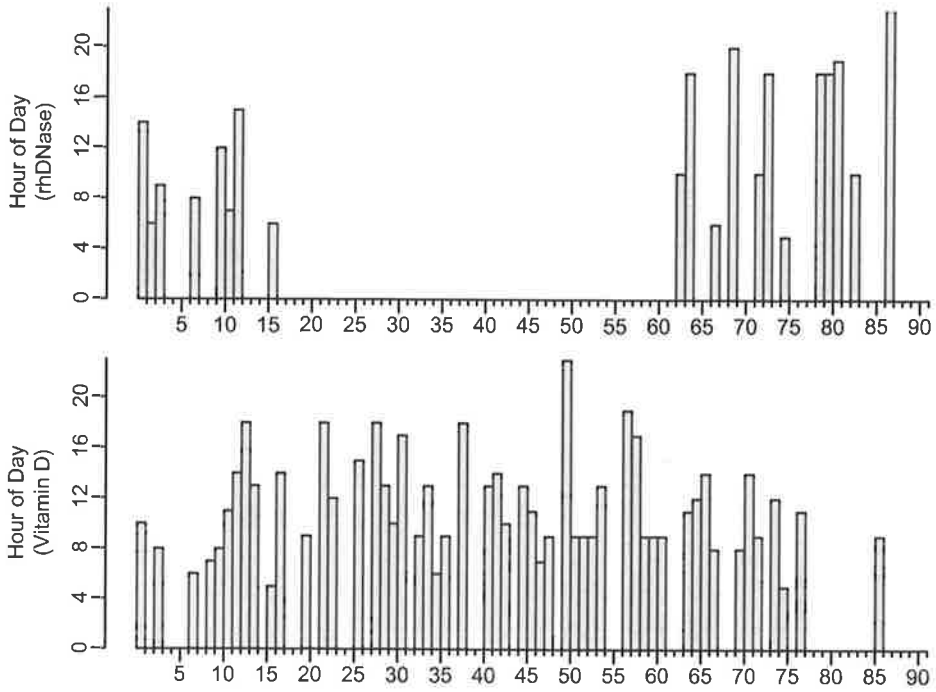

Figure 5.4: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 01.

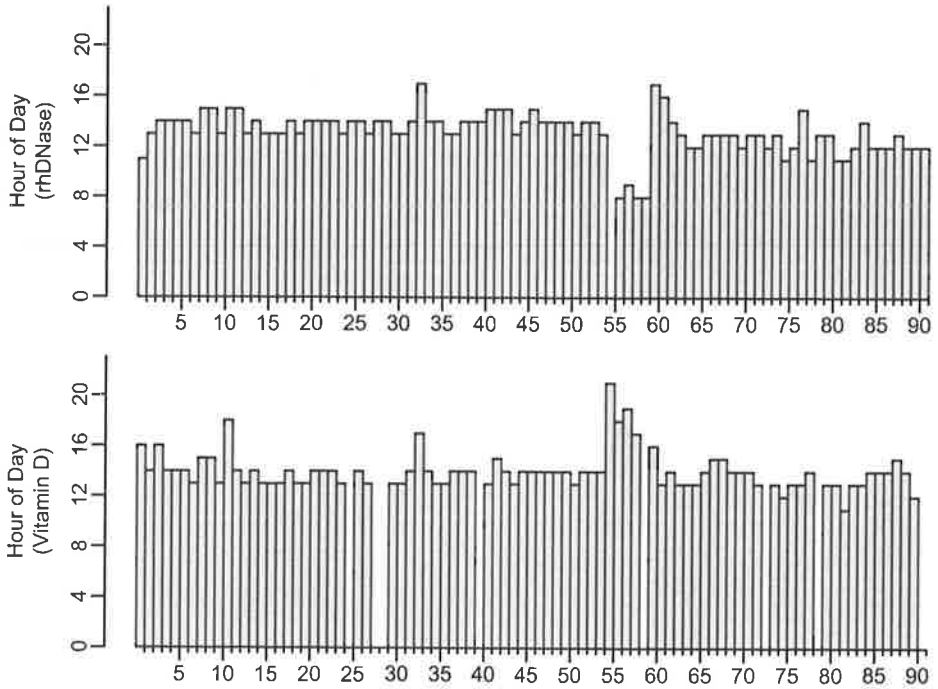

Figure 5.5: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 02.

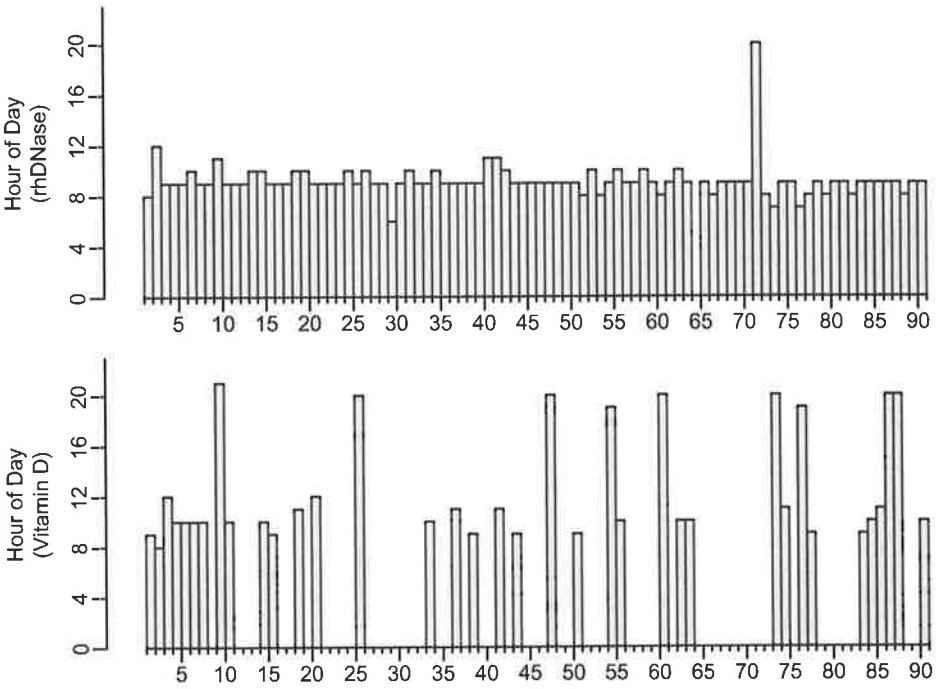

Figure 5.6: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 03.

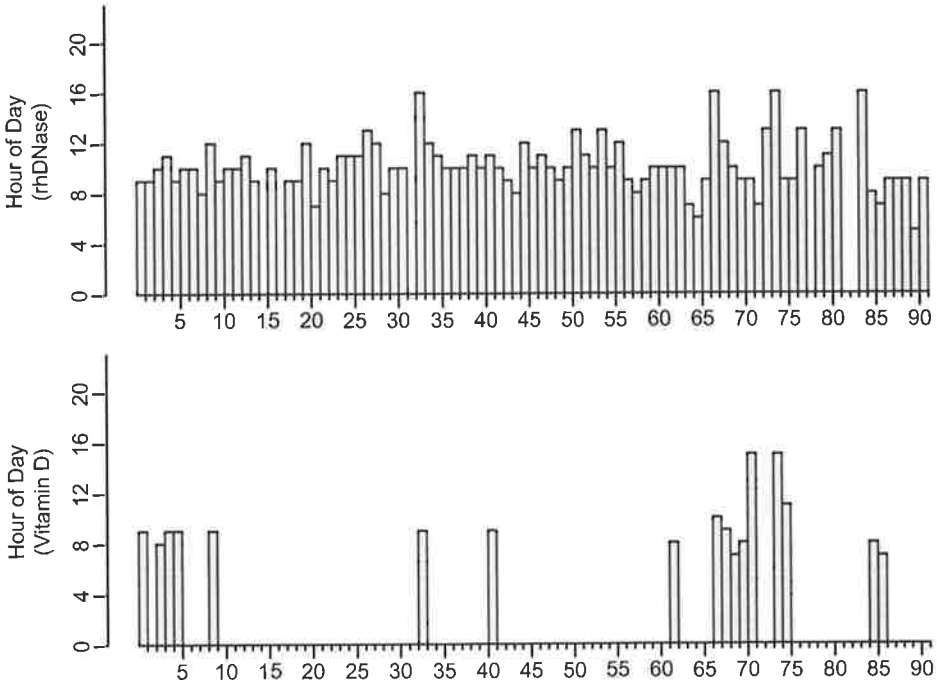

Figure 5.7: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 04.

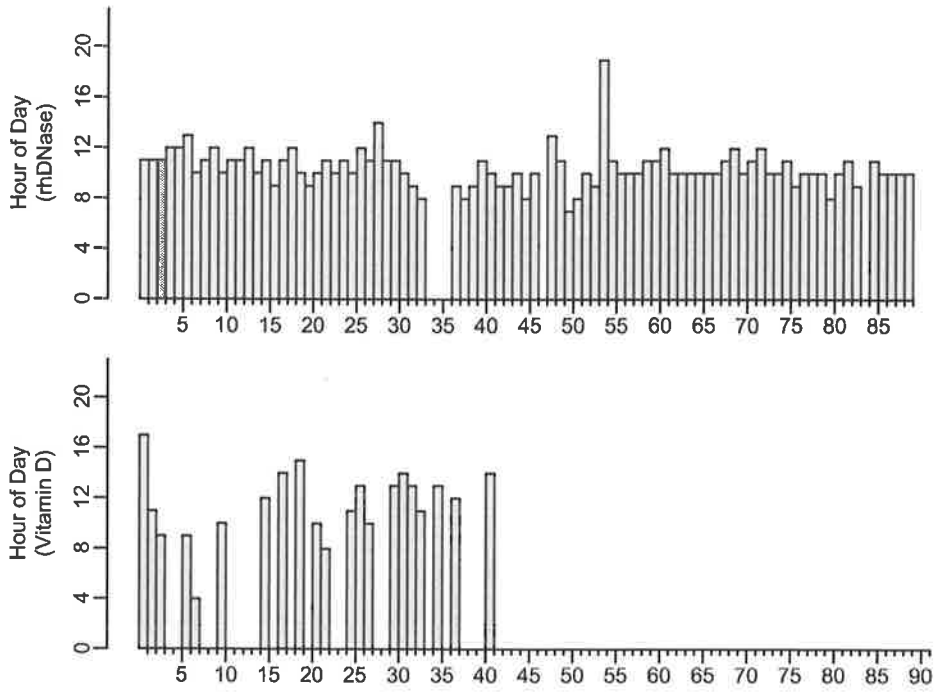

Figure 5.8: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 05.

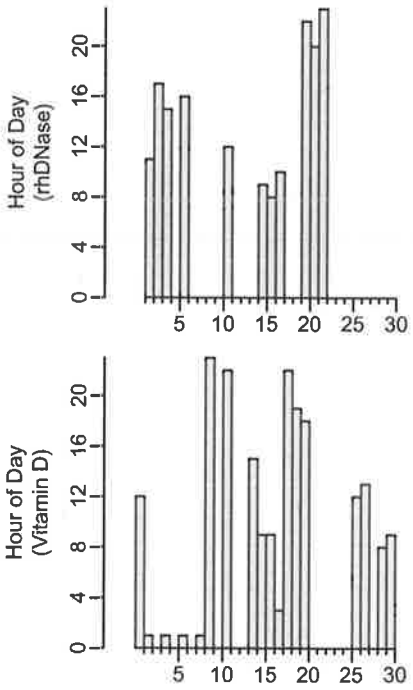

Figure 5.9: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 06.

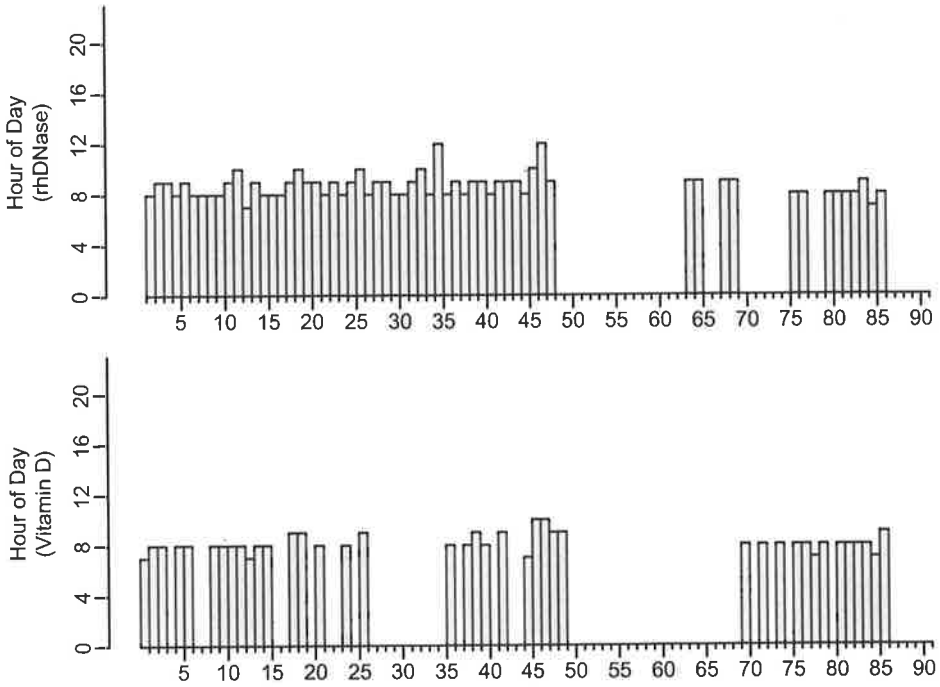

Figure 5.10: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 08.

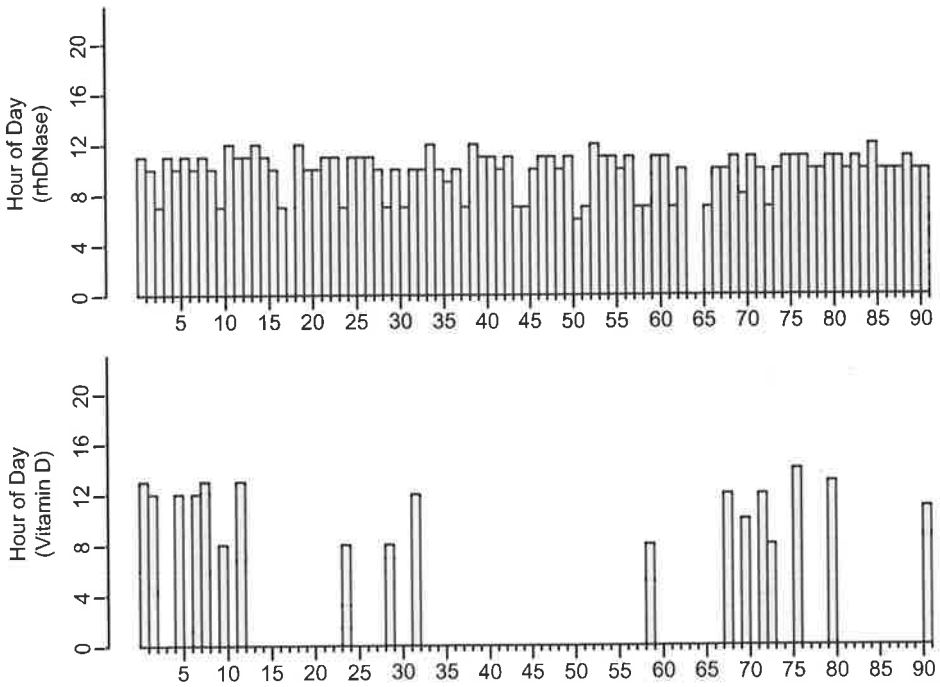

Figure 5.11: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 09.

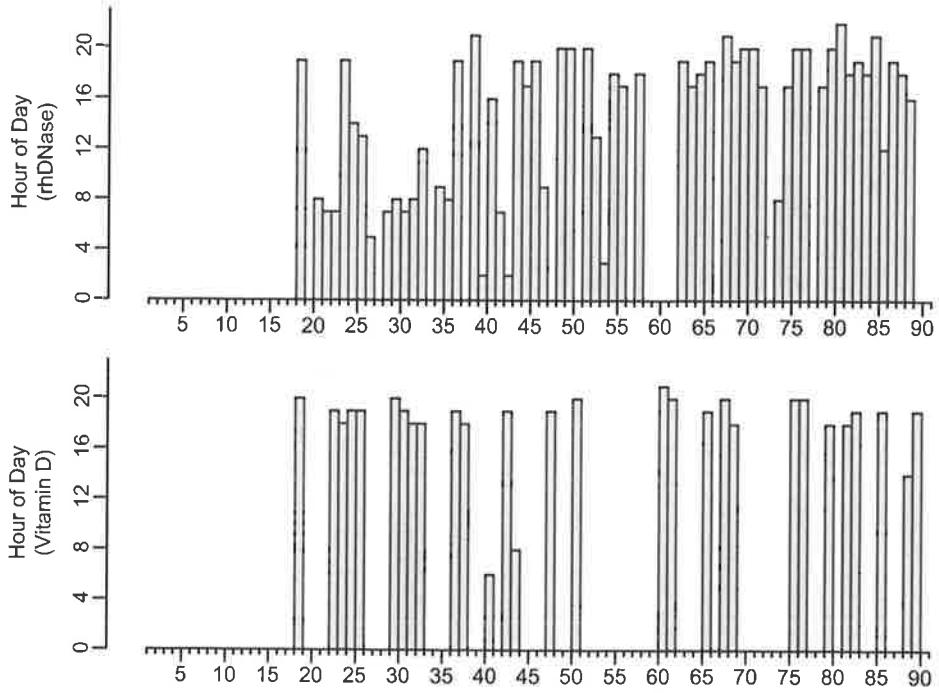

Figure 5.12: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 10.

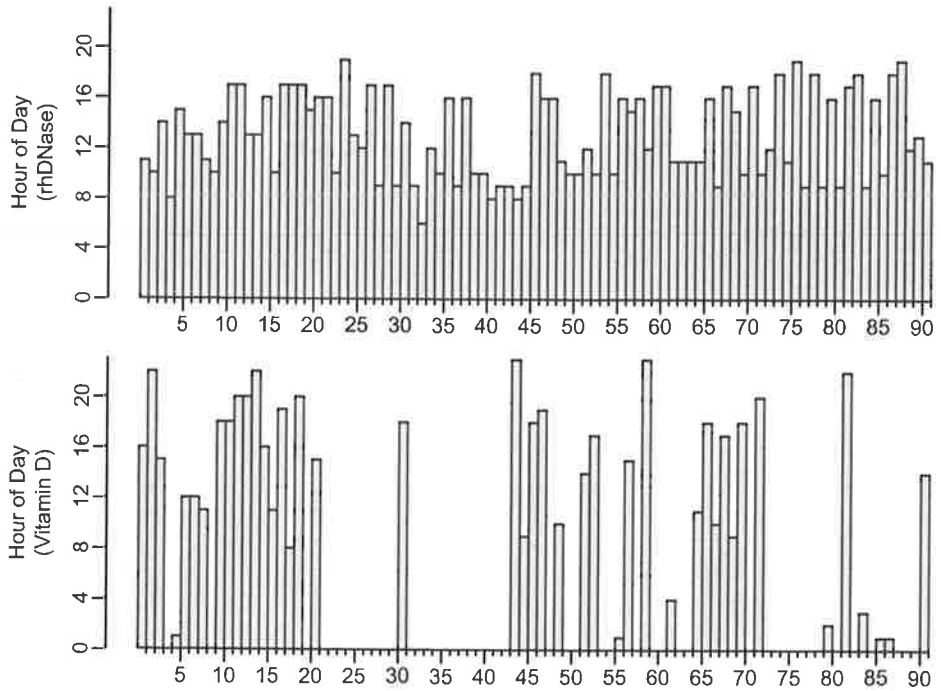

Figure 5.13: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 11.

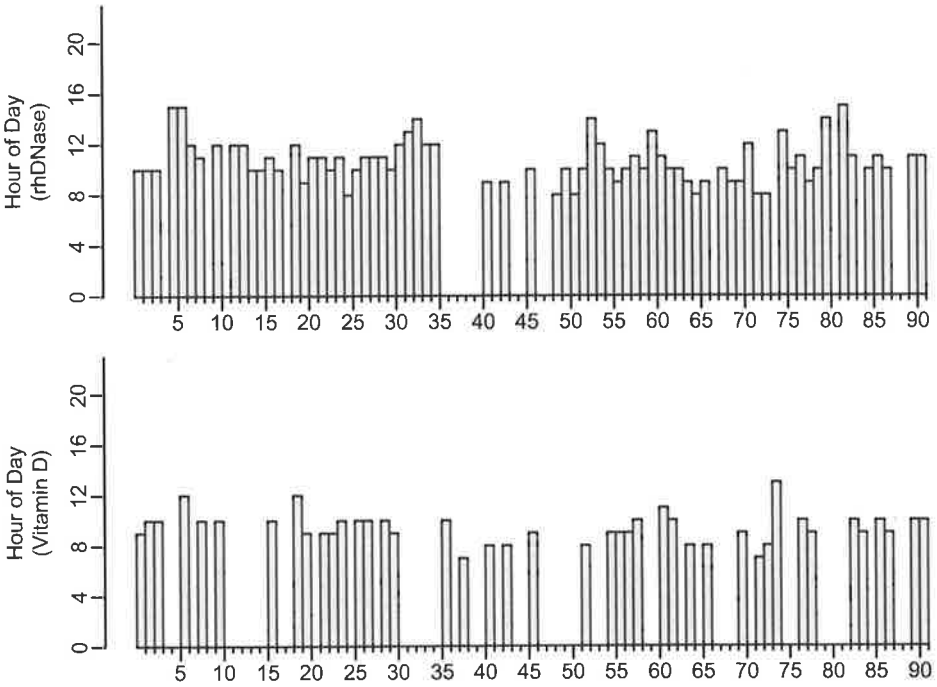

Figure 5.14: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 12.

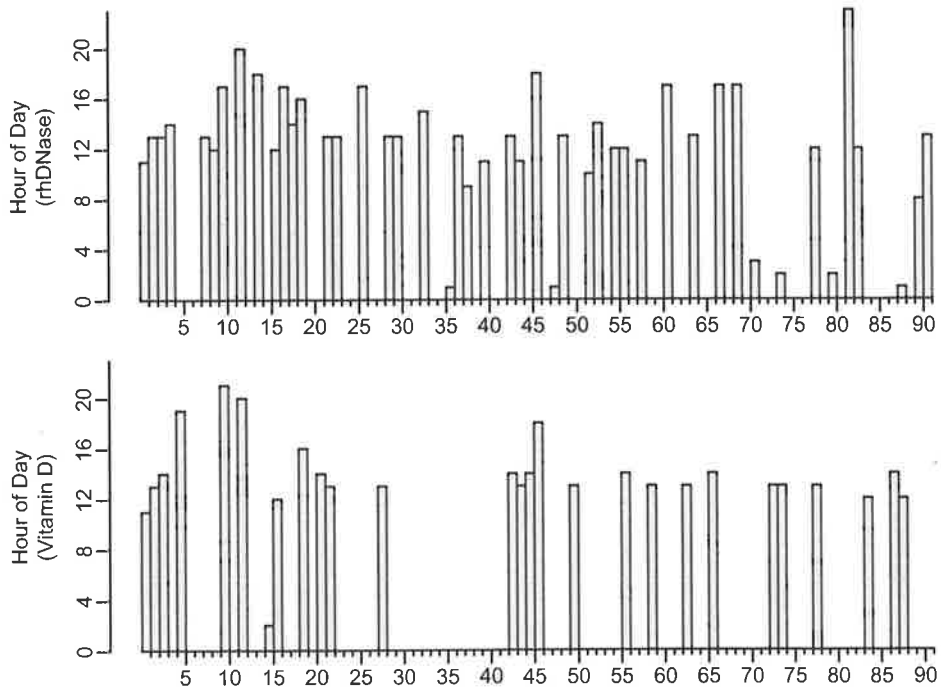

Figure 5.15: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 13.

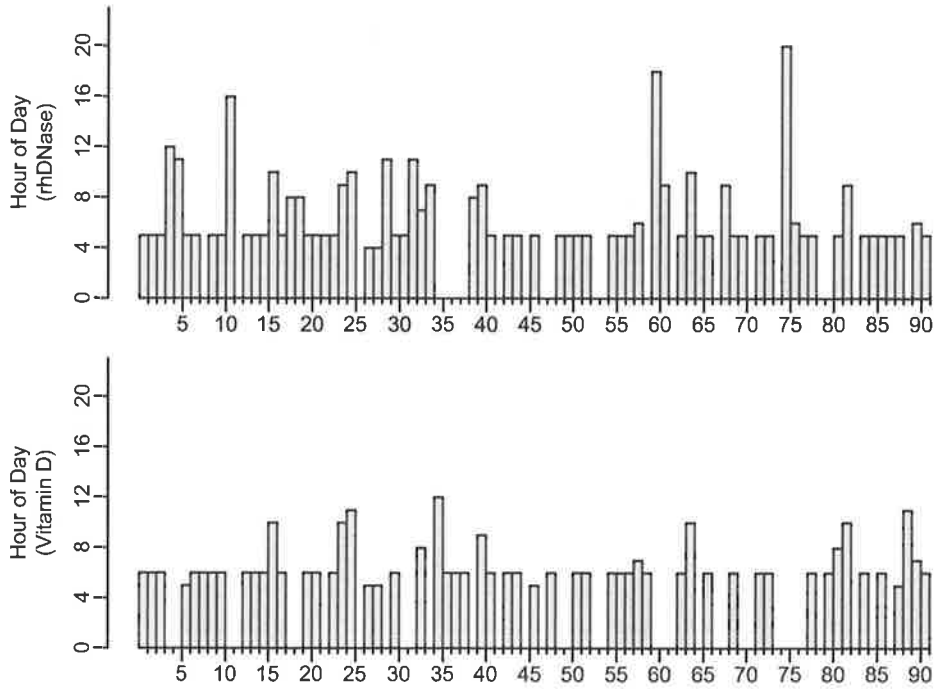

Figure 5.16: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 14.

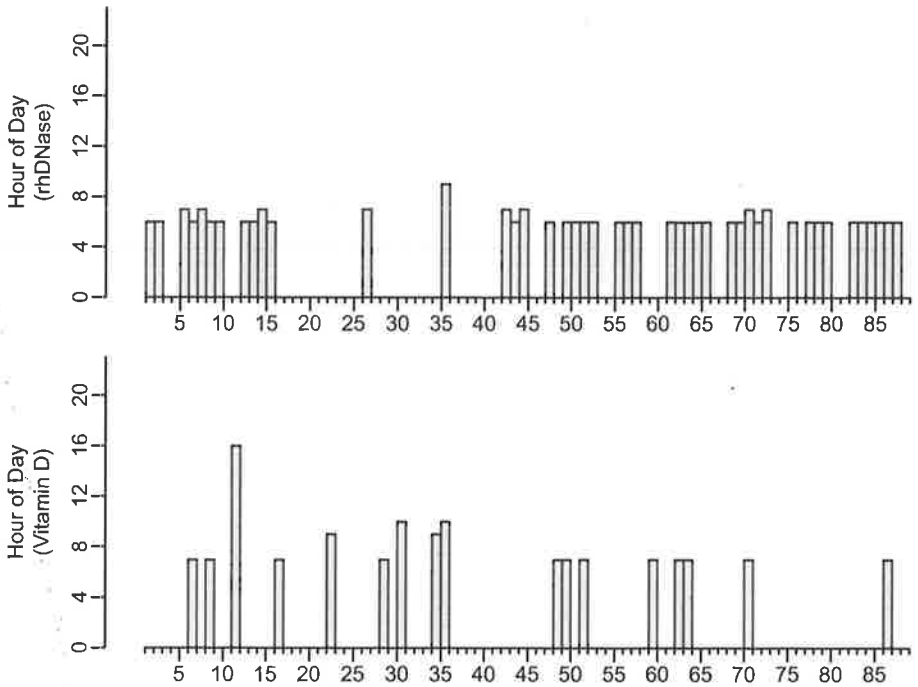

Figure 5.17: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 15.

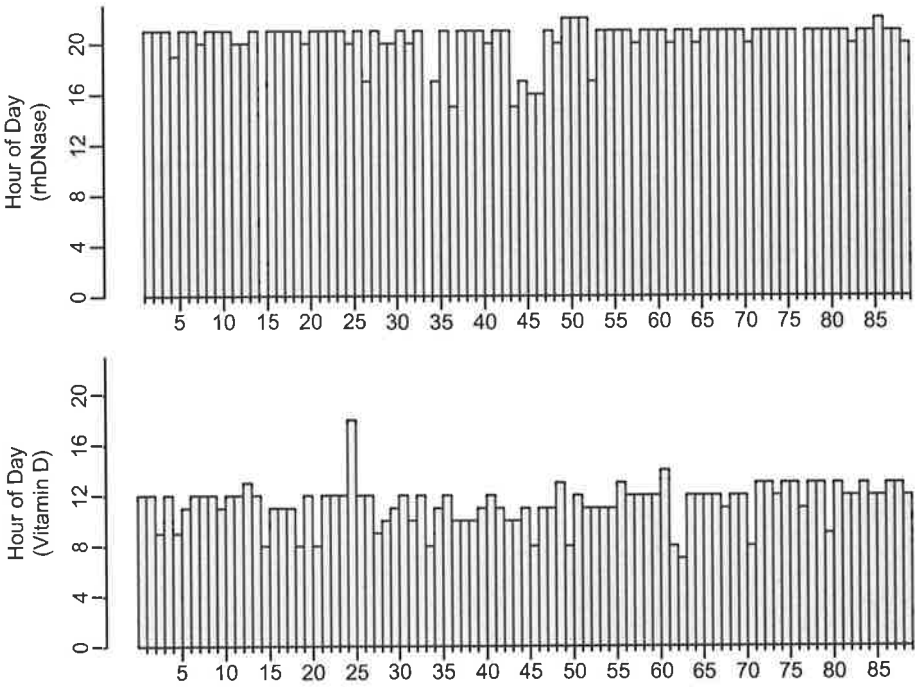

Figure 5.18: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 16.

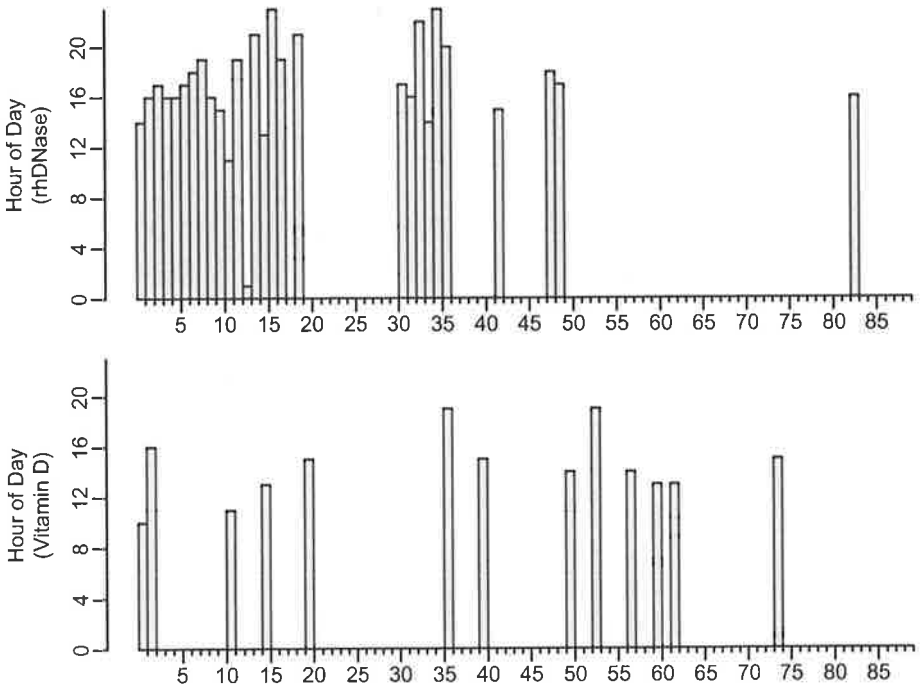

Figure 5.19: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 17.

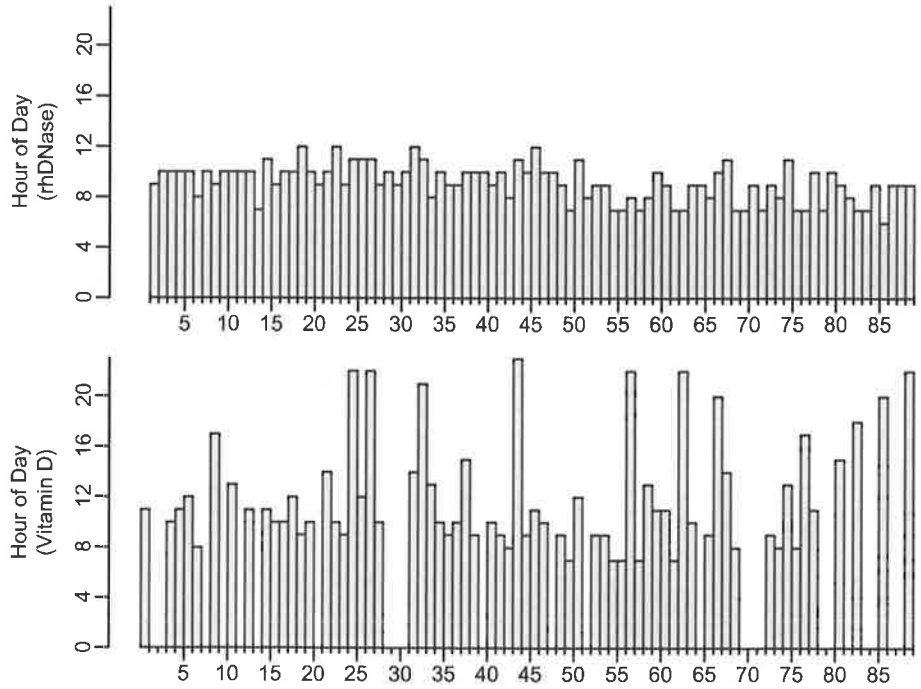

Figure 5.20: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 18.

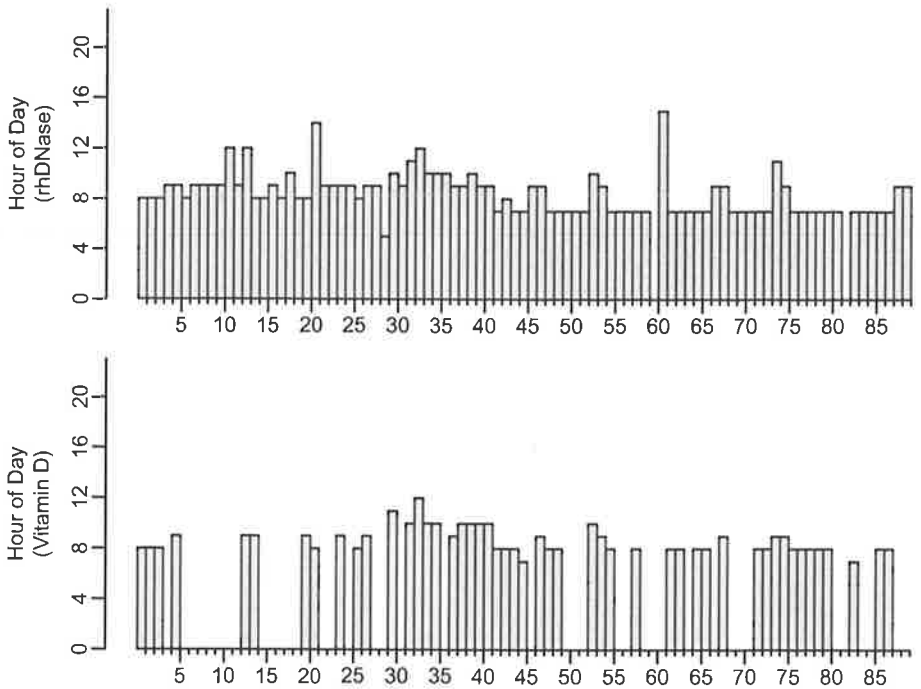

Figure 5.21: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 19.

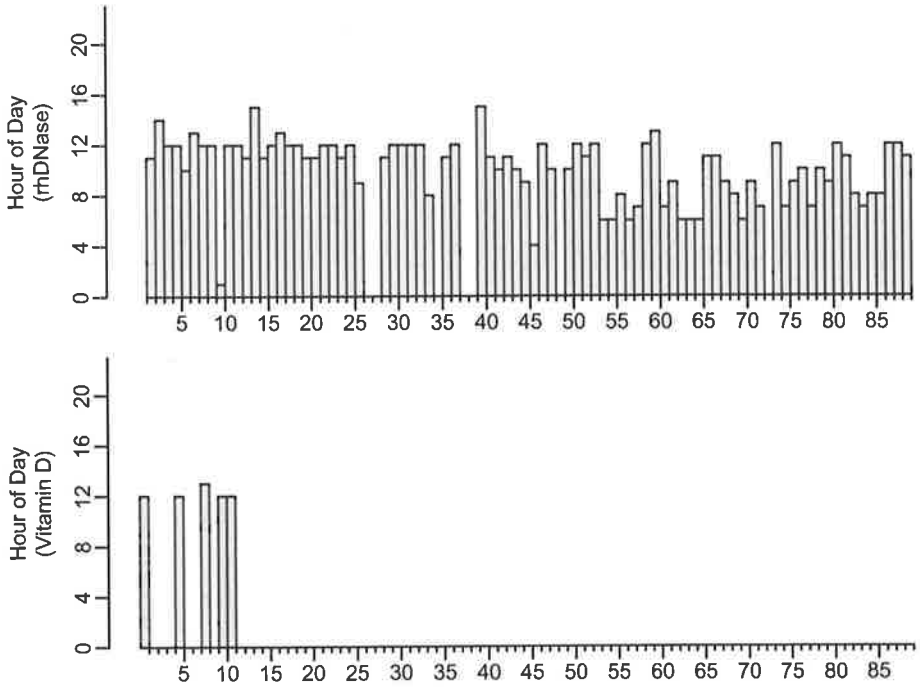

Figure 5.22: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 20.

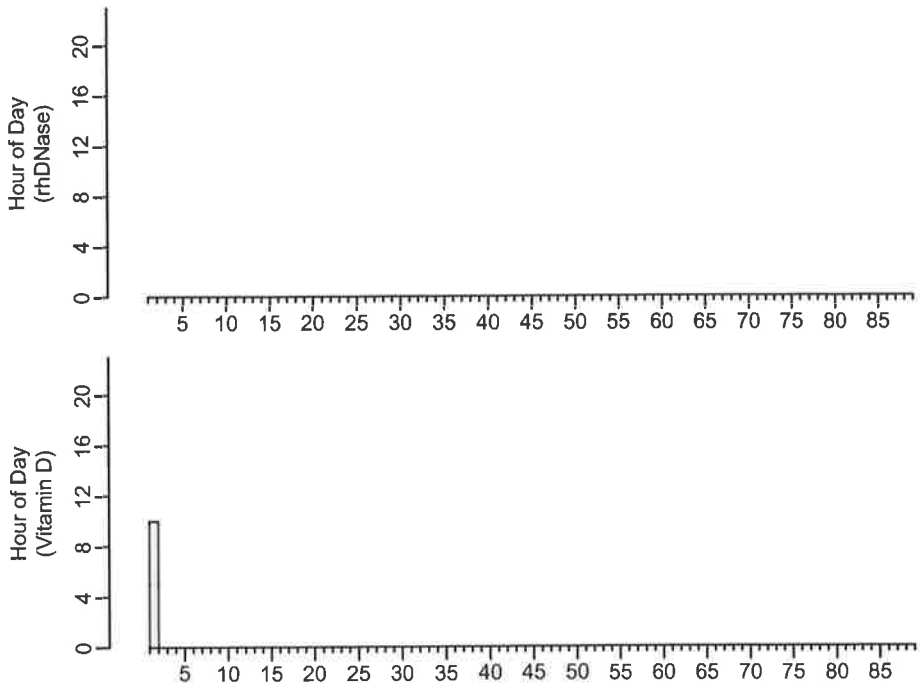

Figure 5.23: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 21.

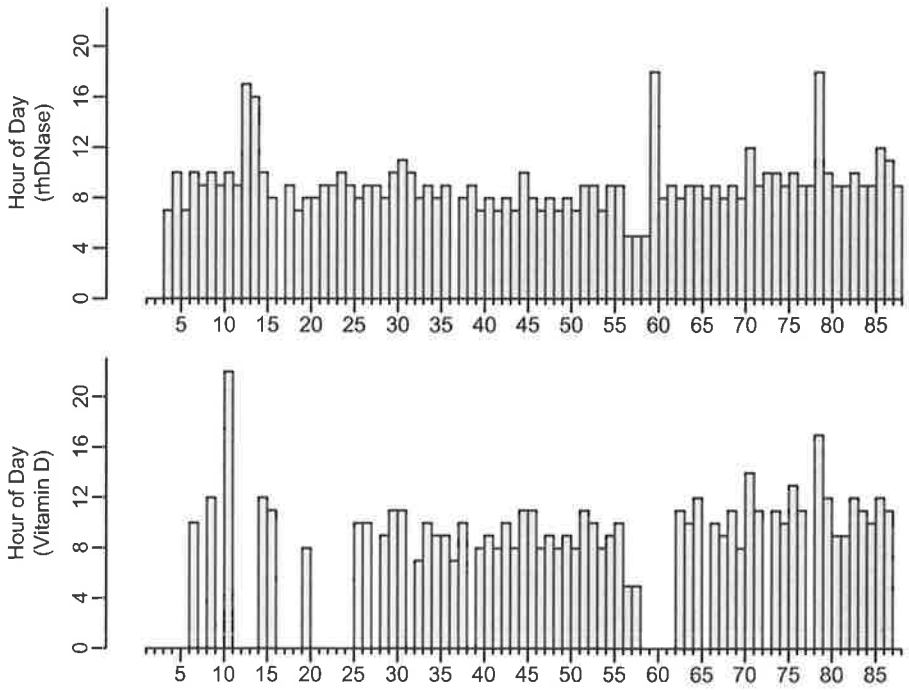

Figure 5.24: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 22.

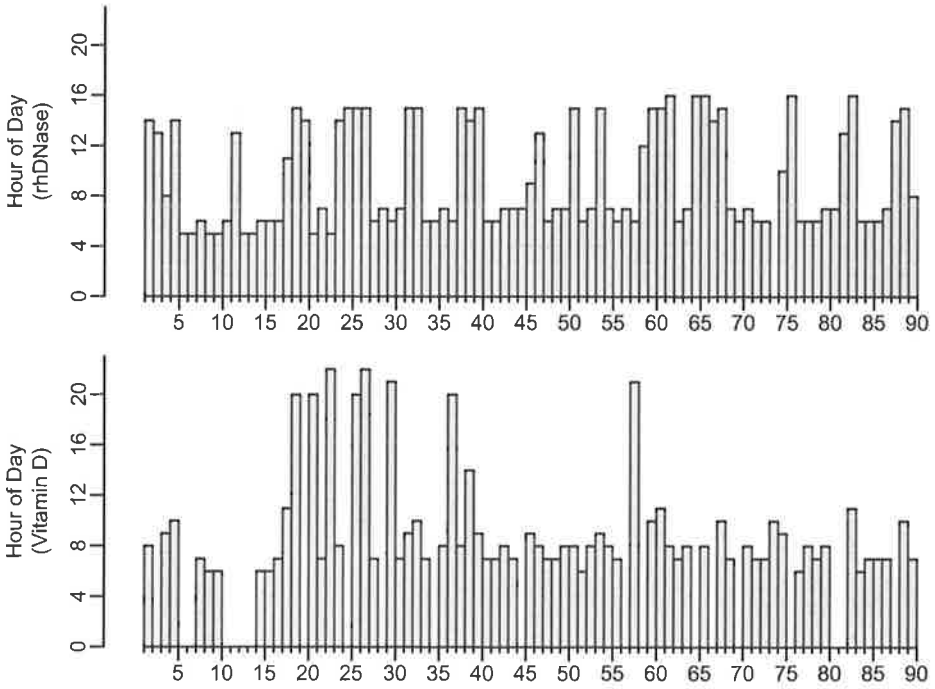

Figure 5.25: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 23.

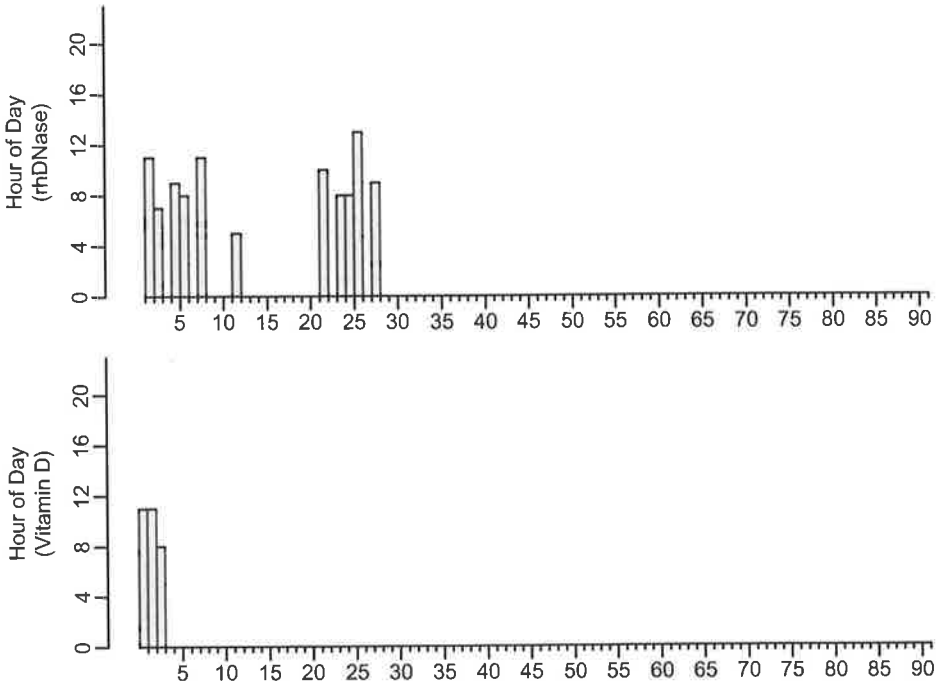

Figure 5.26: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 24.

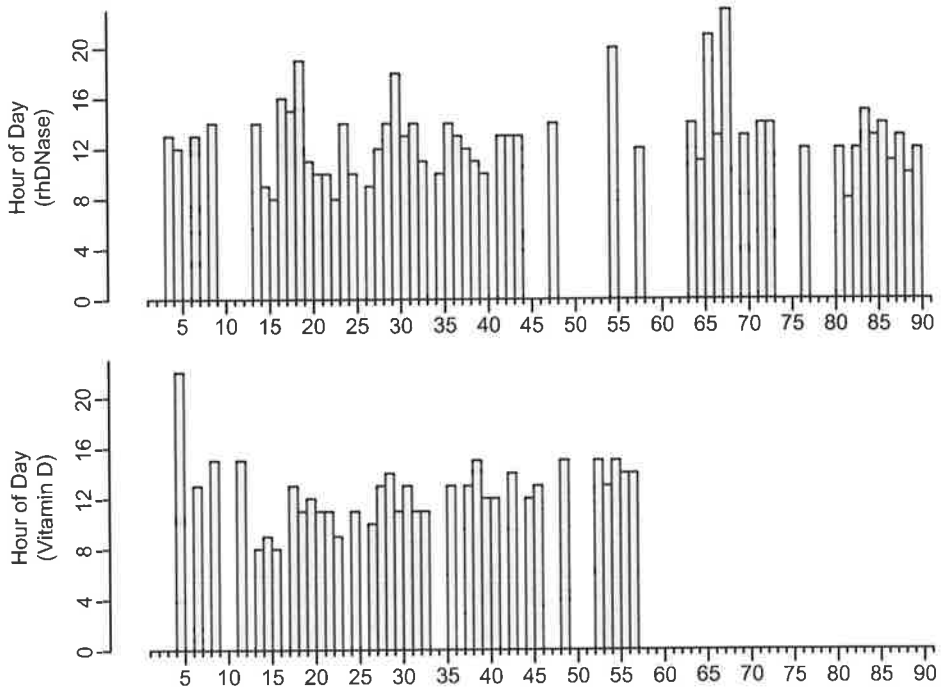

Figure 5.27: Day (abscissa) and hour of day (ordinate) when rhDNase and vitamin D were taken by person 25.

Medication	weekday%	weekend%	r	p
rhDNase	73.7	69.6	.90	< 0.001
vitamins	44.6	39.4	.89	< 0.001

Table 5.4: Correlation between adherence to rhDNase and vitamin D on weekdays vs weekends.

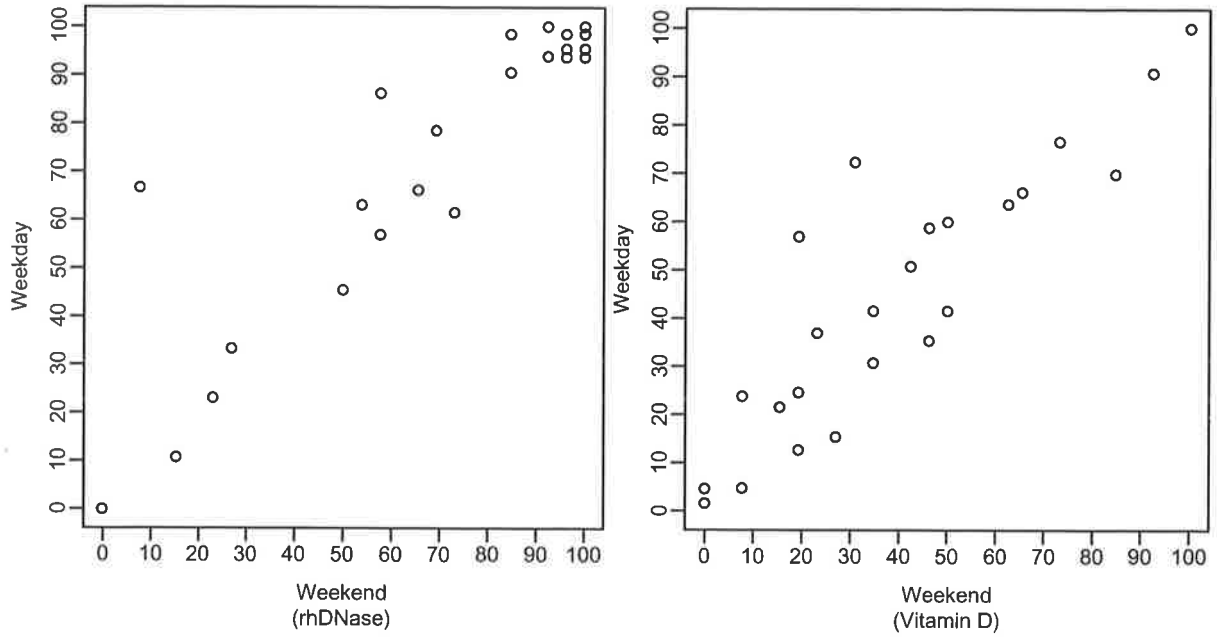

Figure 5.28: Percentage adherence on weekdays vs weekends.

5.5.5 Hypothesis 4: Relationship between adherence to treatment and management routine

It was hypothesised that adherence to rhDNase and vitamin D would be higher on weekdays than on weekends; with the expectation that people would use a more structured routine on weekdays than on weekends and that this would facilitate remembering to take the treatment. In order to examine this hypothesis, the percentage of days of adherence to each treatment for both weekdays and weekends was calculated. A percentage was used to account for the discrepancy in the number of weekdays versus weekend days and also to account for the slightly different number of days of data collection between participants. As can be seen in Table 5.4 and Figure 5.28, weekday adherence was strongly correlated with weekend adherence, for both rhDNase and vitamin D.

Paired samples t-tests were conducted to examine whether the small trend to higher weekday adherence for both medications was statistically significant. As person 21 did not adhere to rhDNase at all during the study period and on only one or two days for vitamin D, any difference in these scores was considered to have little meaning and the data was dropped from this analysis. No statistically significant differences were found for either medication (for rhDNase $t = 1.3$, df $= 22$, $p = .21$ and for vitamin D $t = 1.9$, df $= 22$, $p = .08$) although the trend for vitamin D did approach significance.

For most medications, consistency of dose interval is considered important to maximise the effectiveness of the treatment. Both rhDNase and vitamin D are prescribed as once daily medications and, while dose interval is not critical to the performance of these treatments, there is a preference that patients take these medicines at about the same time each day. It was therefore considered important to examine this aspect of routine and to determine whether the percentage of days on which each person took their medications was related to the percentage of doses they took at around the same time each day. Based on clinical advice about a "reasonable" level of day to day consistency, a window of three hours was chosen as the benchmark: people who took their dose sometime in the same three hour block of time each day were considered to have taken their dose in a consistent way. The "right" three hour block was determined for each person by determining the median time of day at which their doses were taken overall, and considering all doses taken within one and a half hours either side of that median. Consideration was also given to using the modal hour of day, however, on examination of the distribution of times for each person, the median time was observed to be a more accurate representation of consistency than the mode.

Calculation of a meaningful median dose time was essential for this measure to be a fair representation of people's medication taking behaviour. While a normal day of 12 midnight to 11:59pm would seem to be the obvious choice, some patients tended to take their daily dose very late at night or after midnight, so that their "day" was skewed by several hours. After examining the distribution of times of all doses taken, the time of day when the least number of doses was taken, was determined to be at around 4am. Calculations of the median time of day and the three hour block around the median were

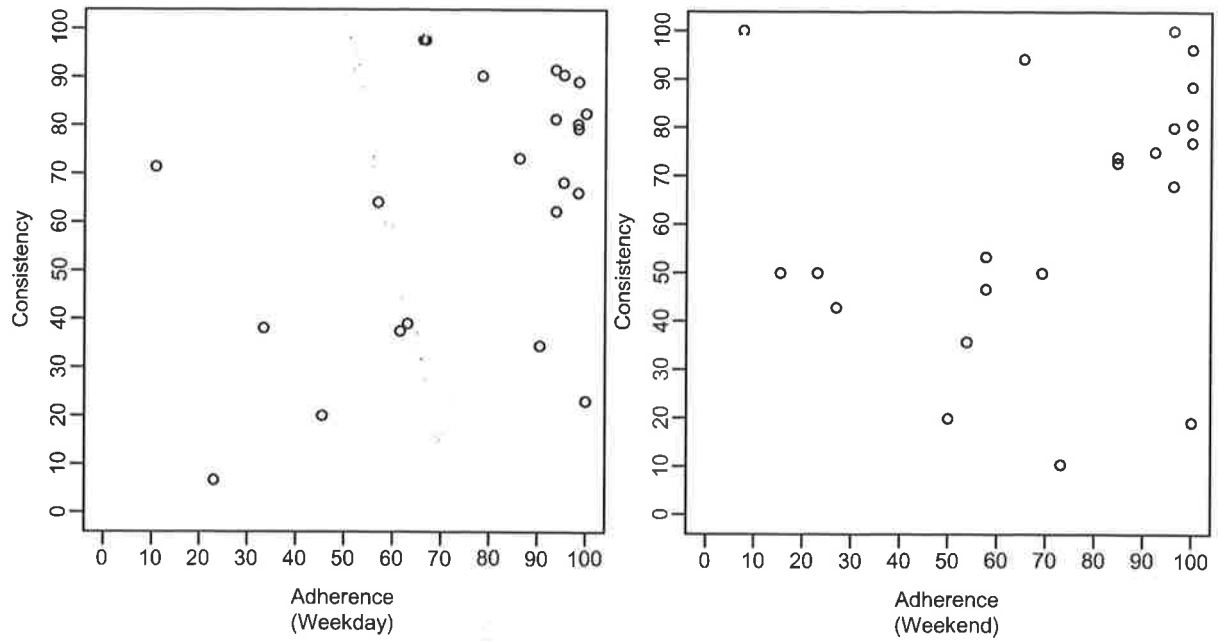

Figure 5.29: Percentage of doses of rhDNase taken (Adherence) versus percentage of those doses taken within an hour and a half of the median time (Consistency).

therefore calculated on days beginning at 4:00am and ending at 3:59am the next day.

Pearson's correlations were performed to examine the relationship between the percentage of days of adherence for each person and the number of doses taken within one and a half hours either side of the median dose time (that is, a three hour block of time) for each person. This statistic was calculated for both weekdays and weekends. For rhDNase, there was a moderate correlation between the percentage of weekday doses taken and the percentage of those doses taken within one and a half hours of the median dose time ($r = .53$, $p = .01$) but the association between percentage of doses taken on weekends and the regularity of dose time was poor ($r = .29$, $p = .18$) (see Figure 5.29).

For vitamin D, there was little association between percentage of days of adherence and percentage of doses taken within one hour either side of median dose time, on either weekdays or weekends (weekday $r = -.11$, $p = .61$ and weekend $r = .30$, $p = .17$) (see Figure 5.30).

Participants did tend to take the two medications at similar times of the day. There was a correlation of $r = .79$ ($p < .001$), for median hour of the day for weekday rhDNase with weekday vitamin D, and a correlation of $r = .48$ ($p < .01$), for median hour of the

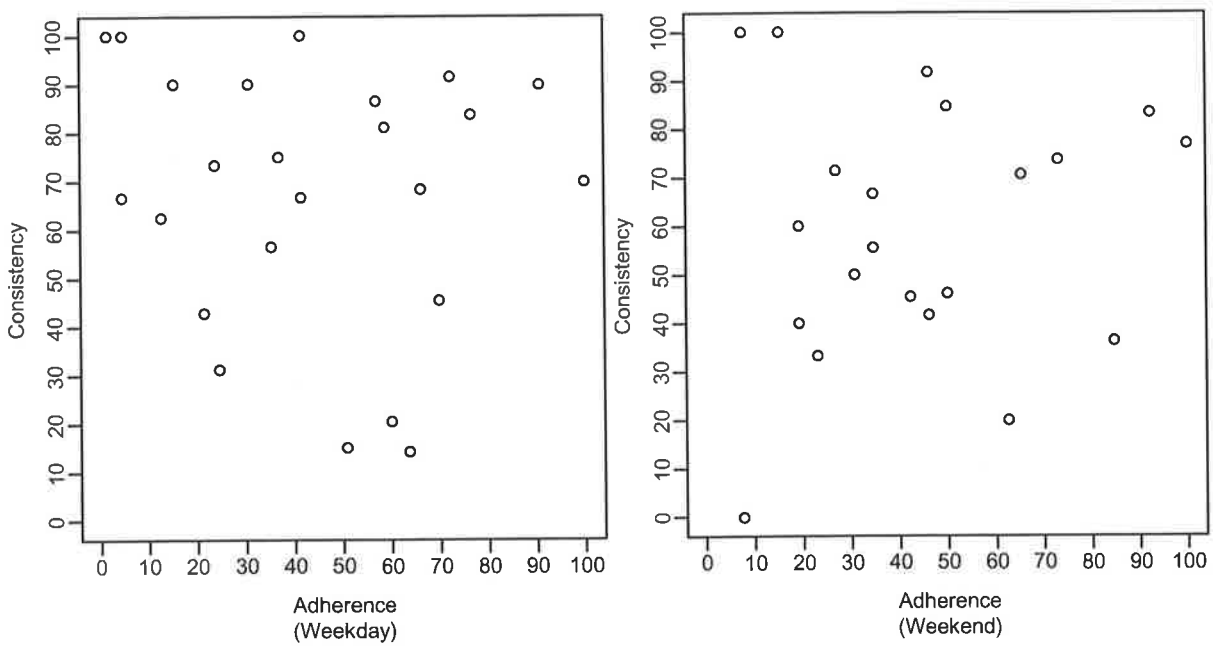

Figure 5.30: Percentage of doses of vitamin D taken (Adherence) versus percentage of those doses taken within an hour and a half of the median time (Consistency).

day for weekend rhDNase with weekend vitamin D (see Figure 5.31).

There was also a strong tendency for people to take their medications at a similar time of day regardless of whether it was a weekday or a weekend (see Figure 5.32).

5.5.6 Hypothesis 5: Adherence to rhDNase and vitamin D before and after hospital admissions

During the data collection period eight of the participants were admitted to hospital for treatment of exacerbations of their CF. This enabled an examination of adherence behaviour pre and post admission to be conducted for those participants. In some of the analyses, only pre or post admission data was available as the person was either admitted to hospital one or two days after recruitment or was discharged from hospital right at the end of the data collection period.

It was hypothesised that adherence to rhDNase and vitamin D would be better in the week following discharge than in the week prior to admission; based on an expectation that poor adherence may lead to greater likelihood of an admission while having just completed

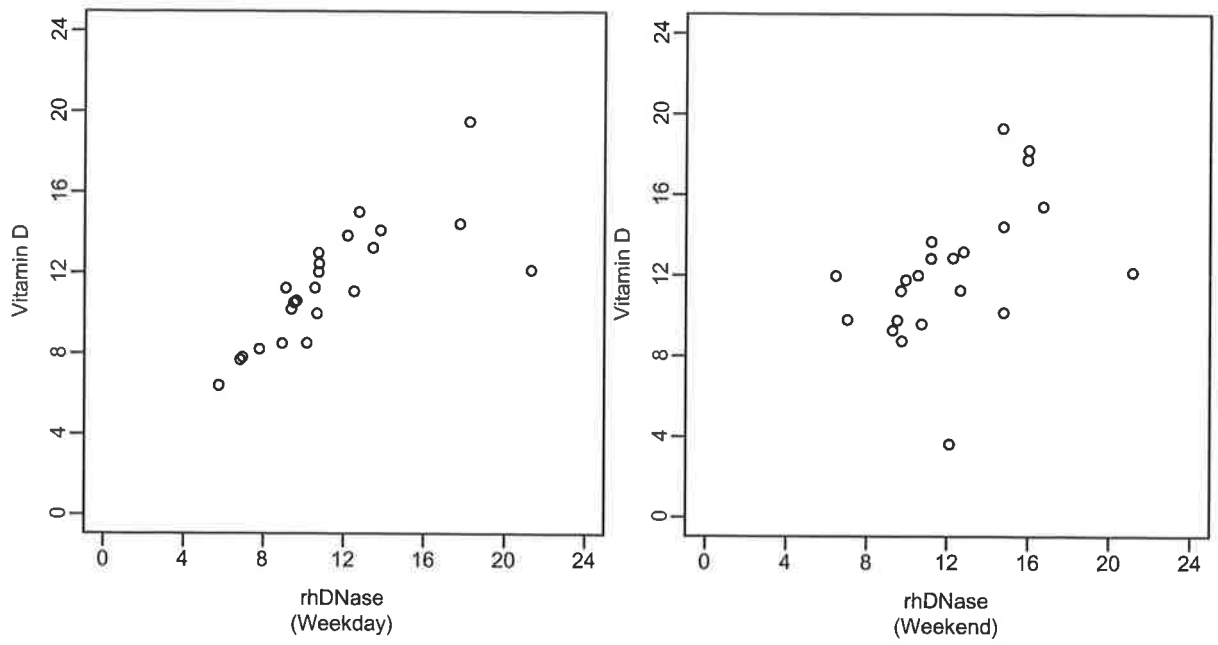

Figure 5.31: Median hour of rhDNase use compared with median hour of vitamin D use.

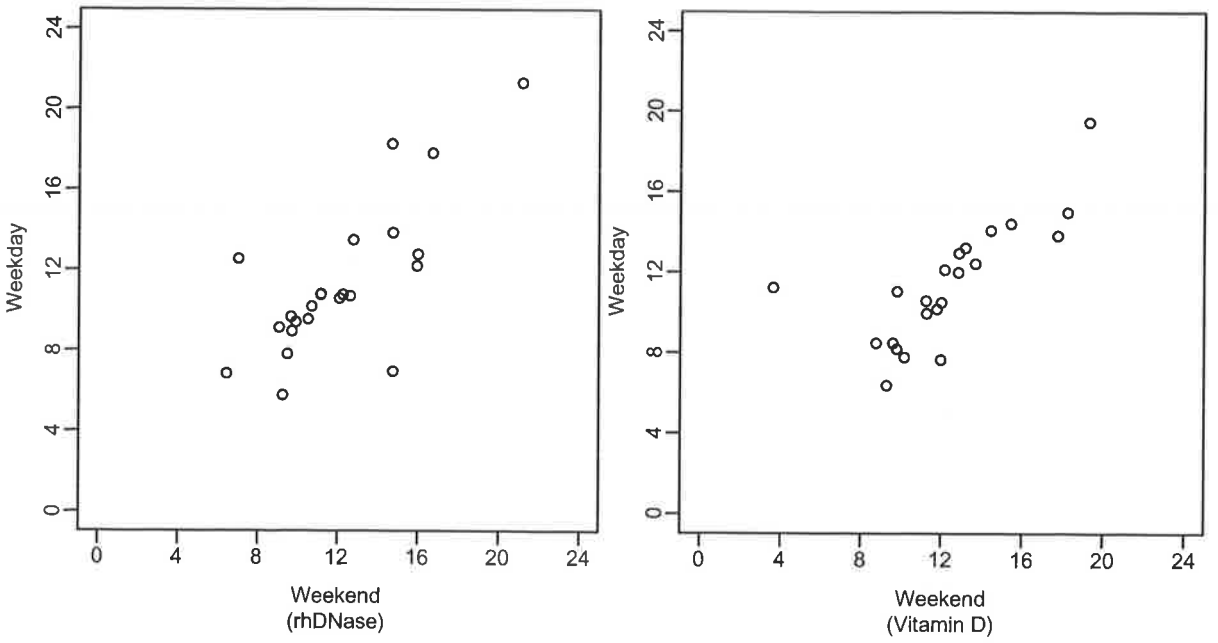

Figure 5.32: Median hour of weekday dose vs median hour of weekend dose ($r = .76$, $p < .001$ for rhDNase and $r = .74$, $p < .001$ for vitamin D).

an admission (and improved their health status) may prompt patients to adhere better to their regular CF treatment for a period of time. Also, from the questionnaire study of beliefs and perceptions in CF ($N = 39$), 55% of participants reported that they kept up better with their usual CF treatments on returning home after a hospital admission and a further 35% were unsure whether they kept up better after a hospital admission or not. In the current study, 64% of the respondents agreed that they kept up better with their usual CF treatments when they got home after a hospital admission.

The electronic monitoring data was used to examine this hypothesis. Paired samples t-tests were conducted to examine differences in adherence to the two treatments before and after admissions. There was no significant difference found in pre and post admission adherence for rhDNase, with the mean adherence in the week prior to an admission being 80% of days and adherence post admission being 77% of days ($t = 0.15$, df $= 4$, $p = .89$). There was a significant difference for vitamin D, however this difference was in the opposite to expected direction. The mean adherence to vitamin D in the week prior to admission was 52% of days and the mean in the week after an admission was 19% of days ($t = 2.91$, df $= 5$, $p = .03$). This post admission drop in adherence to vitamin D was also significantly different to the overall average number of days per week of adherence to vitamin D ($t = 4.47$, df $= 7$, $p = .003$).

5.5.7 Hypothesis 6: Adherence to rhDNase and vitamin D before and after outpatient clinic visits

Most participants had at least one outpatient clinic visit during their data collection period and some participants attended the clinic on more than one occasion. It was hypothesised that participants would take their rhDNase and vitamin D on more days in the week following an outpatient clinic visit than in the week preceding a visit. This hypothesis was based on an expectation that discussions with health professionals about the treatment program would act as a motivating factor by increasing the salience of the prescribed treatment, or by acting as a reminder for adherence after the visit. Outpatient clinic visits are usually also the setting for patients to be given feedback from laboratory

tests or pulmonary function tests.

In the first CFPI study ($N = 39$), 34% of participants reported that they kept up with more of their CF treatment after a regular clinic visit, while a further 47% were unsure whether they kept up more after a clinic visit or not. Further, 65% of participants in that study reported that they kept up better with their CF treatment when they received feedback from laboratory tests that the treatment was working, and 71% reported that they kept up with more of their CF treatment when they received feedback that their lung function was lower than on the previous occasion. In the current study ($N = 24$), 87% of participants reported that they kept up better with their CF treatments when they received news that their lung function had dropped and 52% reported that they kept up better with their treatments after a regular clinic visit.

Paired samples t-tests were conducted to examine adherence before and after clinic visits. The mean number of days adherence to rhDNase before a clinic visit was 80% while the mean number of days adherence in the week following a visit was 85% of days. This difference was not statistically significant, with $t = -0.94$, df $= 25$ and $p = .36$. There was a difference of 10% in mean adherence to vitamin D before ($M = 36\%$) and after clinics ($M = 46\%$), in favour of more days adherence in the week following a clinic visit, and this difference was statistically significant ($t = -2.71$, df $= 25$, $p = .01$). The difference observed in vitamin D adherence pre and post clinic visits was also quite reliable, as demonstrated by the strong correlation between the two ($N = 26$, $r = .84$, $p < .001$).

5.5.8 Hypothesis 7: Relationship between adherence to treatment and reported importance of the treatment

It was hypothesised that patients reporting adherence to a treatment on more days of the week would rate those treatments as more important to their ongoing health. Pearson's correlations were performed to examine the strength of association between reported adherence to each treatment and the importance ratings ascribed to those treatments. The results of this analysis can be seen in Table 5.5

Degree of importance ascribed to the treatment was significantly and quite strongly

Medication	r	p
Antibiotics	.25	0.30
Enzymes	.78	< 0.001
Physiotherapy	.70	< 0.001
Vitamins	.16	> 0.46
Exercise	.43	0.04
Diet	.11	0.63
rhDNase	.60	< 0.001

Table 5.5: Correlation between reported adherence and importance ratings for each treatment.

associated with number of days per week participants reported adhering to pancreatic enzymes and physiotherapy and moderately associated with number of days adhered to rhDNase and exercise. Using this model of self-reported adherence (that is, days of the week rather than a more general estimate such as that used in the first version of the CFPI), importance rating was not significantly associated with adherence to antibiotics, vitamins or diet.

When the relationship between perceived importance for rhDNase and vitamin D and electronically monitored adherence to those treatments was examined, there was a strong correlation found for percentage of days adhered to rhDNase and higher importance ratings ($r = .77$, $p < .001$), and a very poor correlation found for vitamin D ($r = .07$, $p = .77$).

5.5.9 Hypothesis 8: Relationship between electronically monitored adherence and the perceived costs of treatment as measured by the CFPI

Based on the findings of the first CFPI study, where perceived costs of treatment outweighing benefits was associated with poorer adherence to most treatments, it was hypothesised that this relationship would also be found when using electronic monitoring evidence of adherence rather than self-report. Pearson's correlations between percentage of days adhered to either rhDNase or vitamin D and score on the *Cost/Benefit* cluster of CFPI items supported a negative relationship between adherence and perceived cost of

Item	(r)	(p)
I need "time-out" from my CF treatment routine from time-to-time	-.39	.10
Sometimes, the hassles involved with my treatment (e.g., effort/time/expense) outweigh the benefits	-.40	.10

Table 5.6: Correlation between adherence to vitamin D and 2 CFPI items from the *Cost/Benefit* scale.

treatment for rhDNase ($r = -.55$, $p = .02$), but no significant relationship for vitamin D ($r = -.24$, $p > .05$).

As this finding was counter to expectation for vitamin D, further analyses were conducted to investigate the relationship between percentage of days of adherence to vitamin D and responses to the specific items which make up the *Cost/Benefit* cluster. From the seven items, two of the correlations with electronically monitored adherence to vitamin D approached significance (see Table 5.6).

5.5.10 Hypothesis 9: Relationship between belief in the value of treatment as expressed via the CFPI and adherence to rhDNase and vitamin D

It was hypothesised that greater belief in the value of treatment expressed via the CFPI would predict better adherence to rhDNase but not to vitamin D. This hypothesis arose from the findings of the first CFPI study ($N = 39$) where self-reported adherence to rhDNase was moderately correlated with stronger beliefs in the overall value of treatment and the necessity of maintaining good treatment behaviours, but adherence to vitamin D was not associated with beliefs about the positive value of treatment.

Pearson's correlations revealed a moderate association between the percentage of days adhered to rhDNase and a belief in the value of CF treatments ($r = .49$, $p = .02$) and no relationship between percentage of days adhered to vitamin D and belief in the value of treatments ($r = -.07$, $p = .77$).

5.5.11 Relationships between other perceptions and beliefs about CF and its treatment and electronically monitored adherence to treatment

No specific hypotheses were generated about the relationships between other scales of the CFPI and the way they might be associated with electronically monitored adherence, however these relationships were examined and are presented here.

The CFPI scale which reflected keeping up less with treatments as a response to emotional or energy concerns and lifestyle commitments, was examined in relation to percentage of days adherence to both rhDNase and vitamin D. Pearson's product moment correlations revealed a moderate to strong relationship ($r = -.67$, $p = .002$) between a higher score on this scale and poorer adherence to rhDNase, and a smaller trend in the same direction for vitamin D ($r = -.44$, $p = .07$).

Worry about having CF and responsiveness to CF treatment situations or feedback as represented by the CFPI *Attention/Anxiety* scale, was not significantly associated with electronically monitored adherence to either rhDNase or vitamin D (for rhDNase, $r = .01$ and for vitamin D, $r = .34$, [$p > .05$]), however two items from the scale were moderately associated with better adherence to vitamin D (for both, $r = .42$) and these correlations approached significance with $p = .08$: "After a regular clinic visit I keep up with more of my CF treatment." and "When I feel worried about my CF I keep up with more of my CF treatment.".

Participants adopted very different positions from one another about whether they believed that they would beat CF and whether they tried, at times, to forget that they had the disease; however these considerations did not appear to impact on their adherence to either rhDNase or vitamin D (for rhDNase, $r = -.09$, $p = .72$ and for vitamin D, $r = .21$, $p = .40$). Participants' beliefs that they would "beat CF" were associated however with a lower percentage of attended clinic visits ($r = -.41$, $p = .05$) and a higher percentage of missed appointments ($r = .42$, $p = .05$).

It was planned at the outset of this study that the various components of the CFPI would be considered in relation to one another to explore their relative contribution to

adherence in adults with CF as measured by the electronic monitors. Multiple regression analyses would have been employed to assist in this modelling process, however the plan was abandoned due to the small final sample size for this study. The results produced using a multiple regression technique would have been unreliable with this smaller than expected sample size.

5.5.12 Hypothesis 10: Relationship between beliefs about medicines and adherence to CF treatments

It was hypothesised that greater belief in the *necessity* of the medicine as expressed in the BMQ would predict better adherence to rhDNase and vitamin D and that conversely, greater *concerns* about medicines would predict poorer adherence to the two medications. As with earlier analyses, the sample size for this study was too small to adequately examine the predictive strength of any relationships, but it was possible to examine the strength of association between the variables by using correlations. In keeping with the emerging pattern of association between beliefs and adherence to rhDNase and vitamin D, an association was found for rhDNase but not for vitamin D. Beliefs about the *necessity* of medications were not related to the percentage of days of adherence to either rhDNase ($r = .17$, $p = .49$) or vitamin D ($r = -.07$, $p = .77$), but lower levels of *concerns* about medicines were associated with better adherence to rhDNase ($r = .45$, $p = .05$). As indicated above, *concerns* about medicines were not related to adherence to vitamin D ($r = .15$, $p = .51$).

Relationships between self-reported adherence and beliefs about the *necessity* of medications were investigated using Pearson's correlations. Stronger beliefs in the necessity of medications were associated with self-reported adherence to rhDNase ($r = .47$, $p = .03$), and interestingly, to physiotherapy and exercise, two non-medication components of CF treatment (for physiotherapy $r = .49$, $p = .02$ and for exercise $r = .55$, $p = .01$). Lower levels of concern about medicines were related to better reported adherence to rhDNase ($r = .52$, $p = .01$). None of the other relationships between necessity or concerns about medicines and self-reported adherence to treatment reached statistical significance.

At the individual level, the comments of one patient at the bottom of a completed CFPI and BMQ questionnaire set, illustrated thoughts that may accompany a conflict between perceived necessity and concern about treatment. The patient, who reported both a high level of necessity and a high level of concern about treatments, commented that:

> Too many unqualified people know my business, especially newly rotated staff members. There is a threat that staff can take away your treatment if you are not a 'good little patient'. Also, the right to refuse treatment, or 'dignity of risk' is definitely not spoken of.

The same patient reported not being comfortable about discussing treatment difficulties with the doctor and not being certain about what to do with all the different CF treatments.

5.6 Discussion

In this study, electronic monitoring technology was used to examine the adherence of adults with CF to two concurrent treatments over three months. The data obtained about adherence to these two treatments was then used to further the investigation of links between adherence and the perceptions and beliefs that sufferers hold about both CF and its treatment. It was also used to examine variability and patterns in adherence, routine and responses to treatment related events. These investigations have allowed for a consideration of the role that the SRM may play in increasing understanding of adherence behaviour among adults with CF. The examination of adherence to two concurrent treatments using electronic monitoring technology has not been done before with adults who have CF, and, although illness and treatment perceptions have been linked to adherence in several chronic illness groups, these relationships have not been investigated in CF. This combination of new methodology and new theoretical perspective in the area has yielded new information. A discussion of the specific hypotheses examined and issues related to this study follows below. A synthesis of the full program of research will be

presented in Chapter 7.

5.6.1 Relationship between demographic and disease characteristics and both self-reported and electronically monitored adherence

As hypothesised on the basis of previous research findings including those presented earlier in this dissertation, adherence, either self-reported or electronically monitored, was in general poorly associated with demographic variables and with disease characteristics. There were some exceptions to this general finding. Higher BMI was moderately correlated with better adherence to vitamin D as measured using the electronic monitors. This is a finding that makes sense from a clinical perspective. The majority of people with CF are unable to metabolise an adequate supply of essential vitamins and minerals from their dietary intake. Therefore, supplementary vitamin intake is considered an important part of the process of maintaining adequate nutrition. While the effect is mediated by the degree of pancreatic disease, some people with CF who are at risk of poor nutritional status maintain better nutrition levels than others, evident in their higher BMI. While vitamin D is mostly manufactured by the body in response to sun exposure, it is often prescribed in CF as part of a total supplementary nutrition and vitamin program and therefore managed in that context. It seems likely that those people who maintain a higher BMI are more likely to be adhering to nutrition plans prescribed for them and therefore also vitamin supplements prescribed for them.

Married people reported adhering to their physiotherapy on fewer days of the week than single people and students reported adhering to their antibiotics on less days of the week than did people who were employed, looking for work or receiving the disability pension. While both of these outcomes were statistically significant, they occurred in isolation among a large number of small and non-significant relationships. Combined with the fact that neither of the effect sizes was particularly large, this raises doubts about the importance of these findings if not the validity. A clear clinical explanation for these findings was not apparent. For example, there does not seem to be a logical reason

for antibiotic adherence (antibiotics are mostly prescribed as tablets taken twice or three times daily), to be affected for students while not affecting another group that spends large amounts of structured time away from home, such as people who are employed.

In the case of marital status and adherence to physiotherapy, consideration was given to whether there might be a link between either the fact that physiotherapy is time-consuming or that performance of physiotherapy may require the help of another person. Given the relatively small proportion of people with CF who have children however, (which might have accounted for differences in available time), there seemed to be no unique reason why a married person would be more affected by time pressure than a single person. This view seems justified in the absence of any evidence of difference in adherence to physiotherapy resulting from employment status, living situation or age. Further, while a minority of adults with CF at the RAH continue to use physiotherapy techniques such as postural drainage, which require the help of someone else, most perform their physiotherapy independently. Even if it were the case that most of the married adults in this sample required help with their physiotherapy, it seems likely that they would receive help from their spouse.

5.6.2 Contribution of different measures of adherence.

Several different approaches were taken to the measurement of adherence in this study. It has been proposed that multiple methods of measuring adherence offer the best approach to capturing an accurate representation of the way people manage medical treatments (Quittner et al., 2000). To this end, this study made use of pill counts of remaining vitamin D tablets, outpatient clinic attendance records, self-report and electronic monitoring, and analyses were conducted to evaluate the information provided by each method.

Pill counts provided a highly inaccurate measure of adherence (as compared with electronic monitoring) in this study, for all but two participants; the most adherent participant and the least. One participant was 100% adherent to vitamin therapy and, as would be expected, returned the container empty. The least adherent participant returned a matching number of unused vitamins to that expected from the electronic monitoring data. The

participant concerned used the container on only one day and in that instance the pill count was a valuable cross-check mechanism, as it confirmed that the medication had not been taken, rather than that there had been a fault with the monitoring equipment or that the participant had moved the vitamins from the container provided into another dispenser. For other participants there was a particularly poor association between remaining tablets and the number expected from information provided by the monitors. In all cases, pill counts overestimated adherence compared with electronic monitoring.

The reasons for the discrepancies between electronic monitoring data for vitamin D and pill counts were not clear. A number of possibilities could explain the discrepancies and there is no way of determining the correct interpretation from the data. The first possibility is that participants wanted to appear more adherent and removed more tablets than they had actually taken, before returning the dispenser. This seems probable for those participants who removed more tablets than indicated by the electronic monitoring data, but left some tablets in the dispenser at the end of the study. Another possibility is that patients did take the vitamins, but failed to follow the study instructions; removing several doses at one time and placing them in a weekly tablet organiser. This is a common practice in CF, but the importance of using only the special tablet dispenser and only at the time the dose was to be taken, had been stressed with all participants at the beginning of the study. Further, there would perhaps be an expectation that for people using a weekly tablet organiser, there would be a regular pattern to their use of the electronic monitor to coincide with refilling the organiser. This was not evident from the data, as can be seen in Figures 5.4 to 5.27.

More than half of the participants returned the dispenser empty, when the electronic monitoring data indicated that they had not used the dispenser on enough occasions to have used all of the tablets. A possible explanation for this is that participants forgot that they were to return unused tablets at the end of the study and had already removed any extras to keep for later use. A further possibility for all cases when there was a difference between pill count and the electronic data is that the electronic monitors were malfunctioning. This is highly unlikely, as all monitors were carefully tested before and after use by each participant. All were found to be working reliably.

Regardless of the reasons for the poor association between pill counts and electronic monitoring, it seems clear that in this instance, electronic monitoring was the more accurate measurement approach.

The relationship between attendance at routine outpatient clinic visits and both electronically monitored and self-reported adherence to treatments was examined. On the basis of the electronic monitoring data (and to a lesser degree, self-report) an increased percentage of attended clinic visits was associated with adherence to rhDNase on a higher percentage of days. This finding was also observed for self-reported adherence to exercise plans. Conversely, a lower level of self-reported adherence to physiotherapy or electronically monitored adherence to rhDNase was related to a higher percentage of cancelled visits. Poorer reported adherence to enzymes and dietary plans was associated with a higher percentage of missed appointments. Adherence to vitamins and antibiotics did not appear to have an association with clinic attendance. Adults with CF who were aged 25 years or more attended a higher percentage of their clinic appointments and missed fewer than did younger adults.

It is not clear why some treatments were associated with clinic attendance habits but not all. The fact that the relationships did *not* emerge for all treatments and the associations observed were of only moderate size, is important. This finding that adherence to CF treatments is differential, even in its association with clinic attendance, demonstrates that adherence to treatments at home can not be predicted accurately on the basis of whether or not patients attend clinic. This is further highlighted by the fact that while older adults appear to be more reliable about attending their outpatient clinic appointments, adherence to treatments at home is not associated with age. Those relationships observed however, are all in a logical direction and fit with the clinical perception that often, those people who either fail to attend scheduled appointments or repeatedly cancel appointments are also less adherent to their home-care treatment routines compared with those who attend reliably. It is not difficult to see why the perceived link between home care adherence and attendance at scheduled appointments persists in the clinical setting. It may be important in the planning of future management approaches to maximising adherence, that information about this kind of treatment specific effect be made clear to

clinic staff, so that assumptions are not made unreasonably about patients' levels of home care adherence.

A comparison was made between self-reported adherence and electronically monitored adherence to rhDNase and vitamin D. It emerged that while self-report of adherence to rhDNase did not differ significantly from electronically monitored adherence, self-reported adherence to vitamin D significantly overestimated adherence as recorded by the electronic monitors. While the finding for vitamin D is important and highlighted what is likely to be a real discrepancy between self-report and electronic monitoring for this medication, the analysis itself revealed important limitations in the scale used to measure self-reported adherence in the CFPI.

The CFPI adherence scale breaks a week into four groups of two possible days, rather than (for example), having eight categories: one for each day of the week and an extra category to indicate if the treatment was not used at all. This degree of added accuracy would probably have been sufficient for a more accurate comparison of self-report with electronic monitoring for rhDNase as it is only ever prescribed as a once-daily treatment. This may not have been enough to improve the scale for vitamin D, as the CFPI asks about vitamins in general, grouping vitamin D with other vitamin treatments which may be adhered to differently. Difficulties emerge with the CFPI self-report scale for other medications as well. For example, medications used more often or less often than once daily can at best be only crudely represented on the current CFPI adherence scale. It may be that the most accurate way to measure self-reported adherence in CF, while still using a written questionnaire format, is to have a treatment specific set of choices for people to use when reporting their use of different treatments. This then raises the further problem of how much adherence to one treatment is proportionally equivalent to adherence to another treatment. Proportional equality is important if adherence to different treatments is to be compared in a meaningful way.

The other comparison made between self-report and electronic monitoring was one between self-rated severity of lung disease (mild, moderate, severe) and a rating of lung disease (into the same categories) made according to widely accepted clinical guidelines on the basis of FEV1%. Contrary to previous research that found adults with CF to be

poor judges of their own disease status (Abbott et al., 1996), in this study participants were quite accurate in their self-rating of lung disease severity. This difference might reflect differences in clinical practice. Certainly in both the RAH and Alfred CF clinics, personal lung function information is routinely discussed with patients, so some level of awareness of the severity of lung disease might be expected for these patients. It was not clear from the paper by Abbott et al. (1996) whether patients were routinely made aware of their lung function scores.

In summary, electronic monitoring was demonstrated to be a very useful and substantially more detailed and accurate method for measuring adherence than the other methods employed. As discussed in Chapter 1 however, there are obvious limitations to this approach to measurement, several of which were clearly demonstrated in this study. When people don't use the dispenser, any interpretation of why that was so can only be speculative. It is not possible to be certain that the person failed to use the medication on that occasion. They may have forgotten to use the correct dispenser (i.e., used their own usual nebuliser pump or an unfinished, previously dispensed bottle of vitamins), or may have (in the case of tablets) dispensed more than the required dose at some time, putting extra doses into another dispenser. It is almost as difficult to be confident that treatment has taken place, even if the monitors indicate that the dispenser has been used. It is possible that participants have opened their tablet dispenser but not removed a tablet, and possible that they have turned on the nebuliser pump for the expected length of time but not nebulised the medication. As noted earlier though, these kinds of effects are usually of fairly short duration and deceptive behaviour of this kind is rarely sustained over a long period of time (Rand et al., 1992).

In this study, the addition of self-report, admission and attendance records and pill counts, despite the significant problems with those methods, was very useful as a means of cross-checking electronic monitoring data. In instances when there was very little data recorded by the monitors, these other methods were helpful in piecing together the accuracy of the information. Hospital admission records, for example, were crucial to the recognition that participant eight had failed to use the monitoring equipment while in hospital, but that this lack of use did not necessarily mean that he had been non-adherent

to those treatments while in hospital.

At least some of the participants appeared to respond either to the knowledge that their behaviour would be monitored, or to the motivating effect of a clinic attendance (or both), by adhering to treatment better in the first (and sometimes last) few days of the recording period than at any other time in the three months (e.g., person 1, person 20 and person 24). For the majority of participants though, the substantial variability in use of the monitors throughout seems indicative of legitimate and probably typical use of the treatments, and the data from the monitors has therefore been assumed (with the known exceptions discussed previously, for example, person 8) to represent an accurate picture of the participants' adherence to the two treatments for the duration of the study.

5.6.3 Difference in adherence to and variability in use of rhDNase and vitamin D.

The hypothesis that adherence to rhDNase would be better than adherence to vitamin D was strongly supported in this study, as shown by data from the electronic monitors. As discussed earlier in this chapter, there were a number of reasons for hypothesising that this would be the case, including:

- the need to pass a clinical trial of effectiveness before being prescribed rhDNase
- a difference in the immediacy of any perceived benefit from the treatment
- perceived value or importance due to relative costs of the medications and,
- previous research findings about levels of adherence to these treatments.

What was unexpected was that there would be such a substantial difference in adherence between the two. Studies 1 and 2, for example, had shown quite similar levels of reported adherence for rhDNase and vitamin D.

It was also noteworthy that there was a very substantial variation between participants, in the average number of days of adherence to each medication. For both medications, this varied between less than 5% and up to 100% of days in the study period. However, only

two of the participants were very poorly adherent to both medications (less than 10% of days) and conversely, only two were very adherent to both (more than 90% of days). Only one participant (person 1) was appreciably more adherent to vitamin D than to rhDNase and his CFPI reports of the relative importance of the two medications indicated that he believed vitamin D to be more important to his ongoing health than rhDNase.

In combination, these findings provide evidence that adherence is unlikely to be a personality or trait linked phenomenon, at least in most people. In turn, this highlights the risk of making significant misjudgements about people by describing them as adherent or non-adherent in a general fashion. In this sample, many of the same people who were extremely reliable in their management of rhDNase were very poor managers of vitamin D. Even without giving closer consideration to the cognitions of patients, this adherence discrepancy is consistent with the SRM which proposes that people modulate their decisions with appraisals about the benefit of particular courses of action over others and that this is a dynamic and ongoing process.

5.6.4 Relationship between adherence to treatment and management routine

Routines were much more evident in the management of rhDNase than vitamin D, with both a higher percentage of days of adherence and more consistent dose times observed for rhDNase for the majority of participants in this study. Further, adherence to rhDNase appears to be more robust and impervious to influence by concerns about treatment events such as hospital admissions and clinic visits, as there were no significant differences in adherence observed before and after these events, while there were differences observed for vitamin D. These findings raise the question of whether the establishment of routine is responsible for better adherence to treatment or whether the decision and motivation to adhere to treatment is responsible for the establishment of routines to facilitate that. It is feasible that the two may have an interactive relationship in which a belief in the value of the treatment (discussed below) acts as a motivating factor in the establishment of a routine to manage the treatment, and subsequently the presence of the routine assists in

the ongoing maintenance of both the motivation to adhere and the actual adherence to the treatment.

It is of considerable interest that it was the more complex, demanding and symptomatically unpleasant of the two treatments which was managed better and with a more consistent routine. Although there were many reasons why it was predicted that people would adhere better to rhDNase than to vitamin D, these do not detract from the fact that the finding is contrary to the generally accepted belief that people adhere better to treatments which are less complex and time-consuming. Without doubt, a considerable amount of funding and research effort is expended annually worldwide in conducting clinical trials of treatments to discover the most efficient way to achieve the maximum treatment effect, with exactly this principle in mind. If a patient is faced with a choice between taking a tablet 3 times per day to achieve an effect, when an equivalent but different tablet will achieve the same outcome if taken once per day, it is only common sense that the latter will be preferred, and probably adhered to better.

When the comparison is between treatments with different modalities acting to affect different aspects of the disease process, the consideration of complexity and time becomes a more complex issue. It may be only in the presence of multiple treatments and in chronic illness that more abstract concepts such as treatment and illness perceptions play a role in the planning and execution of treatment related behaviours, helping to explain the apparent anomaly of better adherence to more complex and difficult treatments. It could also be true that the establishment of good routines may be considered more important for the management of a more complex and time consuming treatment such as rhDNase than for a once-daily tablet such as vitamin D, which takes only moments to perform. From the findings of this study, where adherence to rhDNase was overall, either very good or very bad, it can be argued that for a time-consuming treatment, routine may be a necessary but not sufficient condition for adherence. The fact that poor adherence to vitamin D was associated with participants reporting that at times, they forgot some of their CF treatments (CFPI item 16), and that this relationship did not hold true for rhDNase, lends further credence to the position that routines are important in maximising adherence to treatment.

5.6.5 Relationship between self-reported adherence and electronically monitored adherence to treatment, and ascribed importance of the treatment

As in the other studies presented in this dissertation, the relationship between self-reported adherence to treatment and the importance ratings that participants gave to the various CF treatments was examined. The findings in this study were similar to those in the first CFPI study, where relatively strong relationships between perceived importance and adherence were found for enzyme replacement therapy and physiotherapy, moderate relationships found for rhDNase and exercise, and weaker relationships evident for the other treatments. The similarity of the findings between studies, particularly in light of the fact that the scale for the measurement of self-reported adherence was changed between the studies, is encouraging. Given that the size of the relationships relative to one another appears to have been similar between studies, it seems probable that these findings represent real differences in the way that perceived importance of treatments may impact on adherence; that is, a lot for some treatments and not very much or not at all for others.

In light of the difficulties observed earlier with the CFPI self-reported adherence scale however, there are some points about the findings of both strong and poor relationships between self-reported adherence and importance that must be made. It is possible that participants could be reporting quite accurately that they perform their physiotherapy and take their enzymes every day and still be overestimating their adherence if they do not do those treatments the number of times prescribed within each day. In this instance, the CFPI may or may not be inflating the relationship between these treatments and perceived importance, but participants are not able to report more accurately about their behaviour.

Similarly, the relationship between exercise and importance may not be well represented by the CFPI data. When analysing data from the CFPI self-report adherence scale, an assumption is made that performing the treatment on more days of the week is better than performing it on less days of the week. In fact, a participant may only

be prescribed an exercise plan to be carried out on three days per week. In that case, when a participant chooses the box that reports that exercise was adhered to on three or two days of the week, correlations will underestimate the link between good adherence and higher ratings of importance. The CFPI also forces people to generalise about their vitamin use rather than be specific about different vitamin supplements, as all vitamin replacement therapy is grouped in one category on the measure. The similar difficulty with the *importance* rating scale in that particular case, means that there is a further reduced ability for any link which might be present between adherence and perceived importance to be demonstrated adequately by the measure. There are limitations such as insufficient accuracy with the CFPI adherence scale for the remaining treatments also.

When the relationship between perceived importance and adherence was examined for rhDNase and vitamin D using data from the electronic monitors, correlations of a similar effect size as those found using self-report were found for both medications. Perceived importance appears to have an association with adherence to rhDNase but not adherence to vitamin D. The fact that such similar relationships emerged when using self-report or electronic monitoring data, lends support to the validity of the finding and indicates that while it should be addressed, the difficulty with the *adherence* scale in the CFPI may not have a particularly large bearing on the outcome, at least for these two treatments. Of course, the difficulty remains with the lack of specificity of the *importance* rating for vitamins. If people are responding to this scale for vitamins in general, when their beliefs about vitamin D differ from that general belief, it is possible that there is a relationship between adherence and perceived importance for vitamin D and the apparent lack of association is incorrect.

Returning briefly to the link between self-reported adherence and perceived importance of CF treatments, it is interesting to note that not withstanding the difficulties described above with the CFPI scale, the relationships were generally strongest for the most time-consuming and difficult medications and treatments to maintain. In order, from strongest link to weakest, the treatments were ranked:

- Enzymes

- Physiotherapy
- RhDNase
- Exercise
- Antibiotics
- Vitamins
- Diet

5.6.6 Relationship between adherence and the perceived costs of treatment as measured by the CFPI.

As predicted based on the first study completed using the CFPI, electronically monitored adherence to rhDNase and vitamin D was negatively associated with beliefs and perceptions that the various costs (e.g., time, effort and money), outweigh the benefits of treatment. The effect was stronger for rhDNase than for vitamin D, which makes good clinical sense given the relatively high costs involved in managing rhDNase compared with vitamin D. The fact that this kind of cognitive appraisal was both reported to occur and that it was also related to adherence, lends support to the SRM position that decisions about treatment adherence are made on the basis of a dynamic set of ongoing appraisals about the value of adhering to the treatment versus the risks, costs and difficulties associated with doing so. In this particular case it seems likely that the consideration is between a recognition of the consequences of non-adherence and the potential degree of control to be gained over the disease or symptom process if adherence to the relevant treatment is maintained.

5.6.7 Relationship between belief in the value of treatment as expressed via the CFPI and adherence to rhDNase and vitamin D

As for the cost versus benefit appraisal, a significant relationship was observed between adherence to rhDNase and an overall belief in the value and effectiveness of the treatment program along with a belief in the importance of managing treatments as prescribed. The relationship was not present for vitamin D. For both medications the observed relationships fit consistently with the developing picture of differential adherence to the two treatments. Again, it was with the more complex of the medications that specific cognitions and beliefs about treatment were shown to be linked with the way that the treatment was managed, while cognitions and beliefs appear to have a much weaker effect on adherence to more simple treatments.

5.6.8 Relationship between other aspects of the CFPI and electronically monitored adherence to treatment.

Where participants reported that they were less likely to keep up with treatments when they were tired, emotionally troubled or busy, they were also more likely to demonstrate poorer adherence to both rhDNase and vitamin D. Agreement with the statements in this scale seems to reflect a less robust maintenance of routine in response to common but not daily events, such as feeling emotionally or physically drained or being involved in a social activity. Scores for this scale co-varied quite reliably with those on the *cost/benefit* scale, and it seems that the scales may both reflect a greater susceptibility in patients to be influenced by the difficulties of treatment rather than being bolstered by a conviction about the value of treatment.

While participants expressed definite beliefs about whether they believed that they would "beat" CF, this belief did not appear to predict home-care behaviour but did appear to be related to poorer attendance at clinic appointments. There are two equally reasonable explanations for this finding. The first is that those people who believe that

they will win the fight against the disease may also believe themselves to be doing well in the fight at home and less in need of consultations to monitor their health. The other possibility is that people who believe that they will beat the disease are at some level denying the seriousness of the condition; so avoiding outpatient appointments where their health status will be discussed, allows them to avoid a contradiction between their belief and the reality presented to them in the clinic. Either good adherence (which is effectively maintaining health) or poor adherence (in the absence of rapidly declining health) may allow a person to maintain the illusion of their disease being less serious and more "beatable" than it might be in reality.

5.6.9 Relationship between beliefs about medicines and adherence to CF treatments

On the basis of previous research in chronic illness conducted using the BMQ (Horne et al., 1998; Horne & Weinman, 1999), it was hypothesised that greater belief in the *necessity* of medicines would be associated with better electronically monitored adherence to treatments and that higher levels of *concerns* about medicines would be associated with poorer adherence. In this study, only the *concerns* dimension was found to be associated with adherence and only for rhDNase. This result was consistent with the findings from the subscales of the CFPI, where all of the outcomes for rhDNase were more substantial than those for vitamin D, and where a belief that treatments were more costly than beneficial, had a stronger relationship with poorer adherence than did a belief in higher value of treatments, with better adherence.

As indicated at the beginning of this chapter, the main reason that this questionnaire was not chosen as a primary measure for the study was that it generalised too much and did not allow people to respond with reference to specific treatments. It may be that this factor influenced the results of this study, so that the generalisation between treatments on the BMQ underestimated true relationships between adherence and beliefs about the necessity of specific medications or concerns about taking them. If this is true, it makes the finding from the BMQ relating to the CFPI self-reported adherence

data particularly interesting. Those data showed an association between a belief in the necessity of medications and better adherence to some NON-medication treatments, as well as to rhDNase. These findings add to the case for the importance of perceptions and beliefs in influencing adherence behaviours in adults with CF, especially for more difficult or complex CF treatments.

5.6.10 Summary

The cumulative information gathered in this study about rhDNase and vitamin D indicates that adults with CF:

- are more accurate in self-reporting their adherence to rhDNase than to vitamin D.
- are more adherent to rhDNase than to vitamin D.
- use better routines to manage rhDNase than vitamin D.
- have their adherence to vitamin D more affected by outpatient visits and hospital admissions than their adherence to rhDNase.
- are more likely to attend outpatient clinic appointments if they also adhere to their rhDNase, regardless of adherence to vitamin D.
- demonstrate a link between forgetting to do treatments and adherence to vitamin D, that is not present for rhDNase.
- demonstrate a link between the perceived importance of rhDNase and adherence to it, that is not present for vitamin D.
- adhere less to both rhDNase and vitamin D if they believe that the costs associated with treatments outweigh the benefits.
- adhere better to rhDNase if they hold a belief in the overall value of treatments.
- adhere less to rhDNase if they report responding more to the difficulties of maintaining treatment when busy or tired.

- adhere better to rhDNase when they have fewer concerns about their medicines.

In combination, these findings lead me to posit that adults with CF think about their rhDNase treatment and plan a behavioural response for it in a way that does not happen for vitamin D. To be adherent or not to vitamin D does not require much from people and does not have an immediate impact, in terms of time, money, social effect or symptomatic benefit. Therefore, perhaps with the exception of a few people who might include vitamin D management in a very closely structured daily routine for all CF treatments regardless of their opinions about different treatments, it may be that people remember their vitamin D treatment from time to time and are pleased when they do, but not particularly concerned about taking it in a reliable way. People may be reminded to adhere better to it after an outpatient clinic visit, particularly if the visit includes feedback about low vitamin D levels in the blood or poor bone density, and they may conversely decide to take a break and leave it out of the treatment program after a hospital admission, when they are feeling much better than before the admission and have been burdened with extra treatments each day while in hospital.

In contrast, rhDNase is only prescribed if it has been demonstrated to have had an impact on lung function. It requires time and possible social inconvenience to adhere to it. It is known to be very expensive, even if the cost is not borne fully by the recipient. A treatment such as rhDNase requires more planning and decision making on a day to day basis in order to adhere to it and a decision to adhere is likely to have costs associated with it. This kind of treatment requires a more substantial cognitive response and a consideration of the practical implications of adherence versus non-adherence to be dealt with. It is likely that it is in this context in a chronic illness such as CF, that perceptions of health and beliefs about treatment are most likely to influence the decisions people make about treatment.

Chapter 6

Practical concerns and research limitations

There were a number of practical and technical issues dealt with in the course of this research that warrant some further description and comment. Some of these issues were related directly to important limitations in the research, and it was considered appropriate therefore to discuss both topics in this chapter. Technical and practical matters are discussed first, followed by the description and consideration of limitations in the research.

6.1 Technical and practical matters

Most of the substantive technical and practical matters that impinged on this program of research were associated with Study 3. Several significant barriers to the successful progress and completion of that study were encountered. It is important that others considering research in this area are aware of the challenges associated with it.

6.1.1 Equipment

The first challenge in Study 3 was to determine from where and at what cost and availability the required monitoring equipment could be obtained. No previous research of this kind had been undertaken within the University of Adelaide department or faculty in which I was enrolled, so it was necessary to explore external sources for the equipment.

While there were at least two or three commercial companies, such as AARDEX Limited, that produced tablet monitoring devices and the requisite software, no commercial source could be found for electronic monitoring devices for a nebuliser pump. Further, largely as a result of the unfavourable exchange rate of the Australian dollar with major foreign currencies, commercial tablet monitors were difficult to afford at about $130 per unit. A considerable amount of time was spent in investigating the feasibility of engaging an engineering group to design and make a suitable nebuliser monitoring device, however both the costs and the lead time for design and testing were considered by both myself and my supervisory team to be prohibitive within the context of PhD research. The monitors eventually used in the study were considerably more expensive again at $500 per unit, however, they had been funded for another research project and the purchase cost of the equipment was not sustained by this project.

The establishment of a collaborative link with the research group already using such devices at the Royal Children's Hospital in Melbourne was crucial to the eventual success of this study, although the arrangement was not without its own difficulties. There was a long lead time until the equipment became available, and then fewer devices were made available than had been anticipated. This meant that data had to be collected in several rounds, calculated to take a minimum of one year in total. In reality, the practicalities of participant recruitment in busy CF clinics and in some cases, long delays in the return of equipment after the study, resulted in a data collection period in excess of 18 months for the first half of the sample. Some rural participants were unable to return their equipment until several weeks after the end of the monitoring period and on occasion, other participants needed several reminders before they returned their equipment to the clinic. This late return of equipment resulted in further delays in re-distribution of the equipment.

When the equipment was first made available from Melbourne, many of the units were not able to be read properly by the software and the tablet monitors in particular were very dirty. Most devices had flat batteries and many had loose internal electrical connections which meant that their performance was unreliable. After unsuccessful attempts to remove old labels from the tablet monitors, I decided to remove the monitoring components from

their containers and to replace the container. New containers were obtained and the monitoring devices repaired, tested, fitted with new batteries then cleaned and sterilised with alcohol before being fitted to their new containers. Each unit was then re-sterilised before being distributed to participants.

The nebuliser pumps were far too valuable to be replaced and all were in excellent working order, but required a substantial amount of cleaning and thorough disinfecting before they could be used. This process of repair, maintenance, cleaning and sanitisation required up to a few hours per unit and was thus very time-consuming. The high cost of these units prohibits using them as disposable items, so it is important to bear these substantial maintenance requirements in mind in the planning of future research employing electronic monitoring devices.

6.1.2 Funding

The next and most important barrier was in the acquisition of sufficient funding to complete the study. As described in Chapter 5, three separate applications were made for grant funding to purchase the necessary monitoring equipment and software. One of these applications was successful as described in Chapter 5, and central to the project going ahead. The funding awarded however, was considerably less than that applied for and did not allow for the purchase of additional equipment. Timely funding for equipment would have made a substantial difference to the amount of data that could be collected in the time available. That in turn would have made it possible to explore any contextual influences on adherence behaviour within the whole sample, such as holidays over Christmas or behavioural responses to events such as the death of someone with CF who was known to the participant.

The challenges of this study in regards to competing successfully for research money are in no way unique and I was indeed fortunate to obtain grant funding. The application process however, highlighted inherent difficulties in competing successfully for research on adherence in CF, when most proposals are for trials of new treatments or involve basic science investigations. A perusal of lists for the past ten years of successful applications in

the annual round of funding by the CF Research Trust in Australia revealed that almost all funded projects were directed at increasing understanding of the disease process or were for specific new treatments. None of the funded projects were concerned with management of existing treatment protocols and less than 10% of funded projects involved any aspect of psychosocial investigation. No studies on adherence have been funded by this research trust during this period of time. Interestingly, the relatively modest budget for and proposed scope of the project may have disadvantaged the application. Almost all of the successful project applications were for projects funded in excess of $50,000: more than three times the amount requested for this project. Despite the difficulties of competing in that environment the CF Research Trust remains the most suitable funding body to approach for CF related projects in Australia.

It may be that as more research such as that conducted in Study 3 is published, and the research begins to yield clinical (and possibly economic) results, its value will be clearer to research funding bodies and it will prove less difficult to compete for funding. Psychological studies with a more obvious direct link to patient outcomes and randomised controlled trials of interventions for adherence by adults with CF, if well designed and based on sound theoretical foundations, may prove to be a more attractive proposition for funding organisations.

6.1.3 Multi-centre research

The low incidence of CF in the Australian community means that there are relatively small populations of people with CF in each Australian state. Research involving people with CF in Australia therefore often involves more than one research centre, in order to recruit research groups of adequate size without placing an undue burden of research pressure on any one state community. A multi-centre design, while effective in ensuring that research can take place, can be complex and time-consuming to administer, particularly when research budgets are small. While operating on similar models of care, each centre has its own unique practices and these can all influence the process of negotiation about research questions, data collection and resource allocation as well as the choice of treatment to

study

Before any project can commence, ethical approval must be obtained from each institution involved in the project and this requires a separate and institution specific application process at each place. While many aspects of the applications are necessarily similar, each institution requires a unique consideration of resource allocation and costing as well as different patient information and consent forms. Revelations in recent years of unethical or questionable research practices in some Australian hospitals have resulted in well justified increases in the level of information required and scrutiny given to research proposals. Any modifications to an approved protocol must be considered by the relevant ethics committees before they can be adopted and all of these processes take at least several weeks to complete.

Several specific challenges arose in relation to the multi-centre aspect of this research. The most significant of these was a lack of resources for this research at the second centre, making it very difficult to determine the eligible patients and plan the strategy for recruitment. Additional difficulties arose when it became clear that the routine data collected about patients differed in the two centres involved and information that was readily available in the first centre would be hard to obtain in the second. Differences in prescribing practices then resulted in a much lower than anticipated number of eligible patients in the second centre relative to the first. It is anticipated that this problem is likely to occur between centres in the continued absence of agreed international treatment protocols for CF.

Perhaps the most significant issue however, was that of adequate resourcing to manage the "on the ground" work in the second centre. Local knowledge and an active presence is essential to the efficient running of a research project in any particular institution. Many of the delays experienced in this project were the result of attempting to manage the project from one site in South Australia, with occasional visits to the second site in Victoria. While email contact and phone calls meant that it was possible to conduct a lot of the business without face-to-face contact, research is often placed lowest on the list of priorities in a clinical setting. With no-one in the Melbourne CF team having time to dedicate to the research process, developments and negotiations were extremely slow.

Within the past few weeks a small amount of new funding was made available by the Alfred for a suitable member of staff to co-ordinate the collection of additional data to improve the statistical power of Study 3 and to further test the validity of the CFPI. The involvement of that person has made a significant difference to the feasibility of continuing the study and has had a dramatic impact on the speed at which organisation of the study has progressed. Further, while difficult to establish, the collaborative link developed for this research with the Alfred is now in place and is expected to generate follow on work beyond the scope of this initial research.

6.2 Limitations of this research

6.2.1 Size of the study samples

The reasons for the small study sample in Study 3 are described above, however their implications have not yet been discussed in detail. Small numbers of participants for Study 2 were also limiting, however in that case a decision was taken to recruit fewer participants to allow the best chance of recruiting an adequate sample size for Study 3. Small sample sizes were considered to be the most significant limitation for these studies.

A small sample size results in a low statistical power compared with that from a larger data set (Pagano, 1986). In the analyses for both studies there were a number of smaller correlations, with effect sizes of between 0.25 and 0.40, that appeared to be consistent with the hypothesised relationships, and did not appear to be due to outliers in the data set or other artifacts, but did not reach the minimum level of statistical significance of 0.05. It was not possible to report on these associations with confidence, although taking account of effect sizes has been helpful in interpreting their probable significance. Many of these smaller relationships warrant further investigation.

Another aspect of this problem was the limitation in statistical techniques that could be applied to the data in order to test the hypothesised relationships. This was evident in the exploration of the Cystic Fibrosis Perceptions Inventory, where principal components factor analysis could not be performed as the ratio of variables to participants was too

high. The clustering technique employed gave a satisfactory result, however it would have been valuable to determine whether a pricipal components solution supported the derived structure of the measure.

The clusters which emerged from the analysis technique applied were also somewhat difficult to name in such a way as to capture the central theme of the clustered items. While the names applied to the derived clusters are helpful in conceptualising the findings with the measure and do, in my opinion, reflect the thematic content of the clusters, these "first names" remain open to further consideration and possible re-interpretation. New and larger studies have commenced in order to address the problems with the questionnaire development.

The contribution of this research was also limited by the fact that predictive regression models could not be employed to explore the relative contribution of the different aspects of illness and treatment perception to adherence. There was no way in this sample to investigate adequately to what extent the different aspects of perception were independent contributors to patient behaviour.

6.2.2 Sample biases

Largely as a result of the small pool of eligible participants, no attempts were made to randomise the study samples. While most people who attended outpatient clinics during the data collection period agreed to take part in Study 2, there is a risk that the sample under-represents people with the mildest CF and those who have the poorest record of reliable clinic attendance. Some people with very mild symptoms attend far less frequently than the usual interval of every two or three months for outpatient reviews of their health. Particularly if they live a long distance from the clinic, patients with mild disease may attend their local general practitioner for prescriptions and general health maintenance, and visit the specialist CF centre only for an annual review or for treatment of respiratory exacerbations. An examination of the spread of demographic and disease parameters within the sample of participants however, did not indicate any bias towards data collection only from those with more moderate or severe disease. As

was demonstrated in Study 3, while patterns of clinic attendance may be associated with adherence to some treatments and are an important aspect of adherence in their own right, poor clinic attendance cannot be equated with poor adherence overall.

As described in Chapter 5, there was also a bias in the sample for Study 3 resulting from the choice of treatments monitored. In Australia, rhDNase cannot be prescribed unless the patient completes a successful one month trial of efficacy. This means that to some extent, the patients prescribed rhDNase in an ongoing way are a self-selected sample in whom the drug is known to be effective. Whether people continued to manage the drug in the same way after they had completed the trial is not known for this sample, although it has been demonstrated that improvements in lung function experienced as a result of using rhDNase decline quickly if the drug is stopped (Eisenberg et al., 1997). While there was initially some concern that this factor may skew the sample to highly adherent individuals, it may in fact have helped to highlight the differential adherence to treatments by individuals. Lack of randomisation in the sample for Study 3 was not considered to be a problem, as almost all of the eligible patients participated in the study.

One further bias associated with the samples in these studies was the issue of participant overlap between studies. Three people participated in all three studies, over a time period of almost three years. Another seven who had participated in the pilot study went on to participate in the second study and 10 new participants from study two also participated in study 3. This problem is clearly linked to the small pool of eligible subjects—if previous participants had been excluded from participation in the final study, the resulting research sample would have been unviable. In further defense of this overlap, the findings in Chapter 3 did indicate that opinions and perceptions about treatments are somewhat dynamic over time, as is adherence and it seems unlikely, particularly given the intervals between studies, that this overlap between samples made a significant impact on the research findings.

6.2.3 Inherent limitations of electronic monitoring

While electronic monitoring currently represents the best available method for objective ongoing measurement of adherence, it is important to remember the limitations of this form of measurement. As discussed in Chapter 1, electronic monitors measure use of a dispenser, not whether a medication was actually taken or treatment performed. Careful consideration must be given to data handling for information gathered with electronic monitors, so that non-standard use of the dispenser (such as using the nebuliser pump for a few seconds only), is accounted for in a meaningful way. There is potential for inadvertent mis-use of the equipment, such as occurred with Person 26 in Study 3, who apparently used the nebuliser monitor for all nebulised treatments rather than rhDNase alone, and for Person 8, who did not take the equipment to hospital when admitted for inpatient treatment. Another risk with electronic monitors is technical failure of the equipment. While no difficulties with data recording or retrieval occurred in Study 3, the monitors did require repair as well as routine maintenance before they could be used for that study.

6.2.4 Number of treatments monitored

Funding and equipment shortages meant that it was not possible to monitor more than two treatments electronically in Study 3. The study would no doubt have been strengthened if more treatments, requiring different routines, could have been monitored alongside rhDNase and vitamin D. While it was possible to compare treatments on the basis of self-report, the electronic monitors provided much more detailed information and, in the case of vitamins, more accurate information. It must be noted however, that treatments such as dietary management are not amenable to electronic monitoring, and the technology for monitoring several others is not available.

6.2.5 Family environment and adherence

The examination of family variables and their impact on adherence in this study added little to the understanding of adherence. The investigation was unsuccessful for a number

of reasons, some of which were described in the relevant section in Chapter 4 and are discussed further in Chapter 7.

Part of the difficulty arose from a lack of sufficient information given to patients participating in the study. While the information sheet did make it clear that participants would be asked questions about their family, many participants seemed surprised about the nature of the questions and some were not happy to answer them. It may be that people were expecting questions about their family composition rather than about the way members of their family interacted with one another. Perhaps because of the unexpected nature of the questions and their perceived intrusiveness to participants, it seemed likely that that the high levels of cohesiveness and low levels of conflict reflected some social desirability in responding and limited the validity of the information. Some people had difficulty understanding the meaning of some questions, possibly because of slightly dated and culturally biased aspects of the language in the measure. It was clearly derived in a 1970's United States culture and did not appear to translate as well as anticipated to the context of 21st century research in Australia. Recommendations for future research about family variables are accordingly that:

- patients are given suitable preparation for supplying information about family relationships and
- measures are tested in the target population before use.

Another issue related to the choice of measure was that some people found it hard to answer the questions as they do not live with family members. The focus of the Family Environment Scale is home life, which meant people who live apart from their family were either unable to answer some questions or tried to answer them with respect to the people they were living with, again reducing the validity of the responses. Future investigations of the impact of family variables on adherence in adults with CF will need clearer definitions of what constitutes family, and may benefit from employing a combination of measures to account for the different living arrangements of people with CF.

6.2.6 Longitudinal measurement

Study 3 in this research program involved the longitudinal collection of data and the results yielded new insights into the treatment management behaviour of adults with CF. In the context of a chronic illness such as CF however, three months is not very long. This means that despite using a longitudinal approach, it is somewhat difficult to estimate the degree to which the adherence findings for each person would generalise to their behaviour over longer periods of time such as one or two years. Further, a relatively short period of time such as three months did not allow for a very thorough investigation of the impact of clinic visits and hospital admissions on adherence, as there were numerous participants who did not require either a hospital admission or outpatient appointment during the monitoring period. This may have biased the findings to some degree as people who did attend the clinic more often and who were hospitalised during the study period were at least temporarily in poorer health than other participants. Longer monitoring periods could reveal the significance of this potential bias, and would be desirable in larger future studies.

Chapter 7

Synthesis and conclusions

7.1 Introductory remarks

Concern about the way that people respond to prescriptions for medical treatment is far from new and has been written about extensively in the medical and to a lesser extent, the psychological literature (Meichenbaum & Turk, 1987). More than 2500 years ago Hippocrates, as mentioned in Chapter 1, warned his students of medicine about the problem of patients failing to follow prescriptions. Recently Pendleton & David (2000, pg. 9) commented regarding the issue of poor adherence that "no condition is immune from its effects". Despite the long-standing and widespread recognition of the issue, understanding of the extent of non-adherence remains limited for most medical conditions (Epstein & Cluss, 1982). Further, despite ongoing research efforts, effective and reliable solutions to the problem continue to elude the medical and psychological community (Haynes et al., 1996).

Cystic Fibrosis, with its complex medical presentation, extensive and ongoing treatment expectations and inexorable disease progression, presents health practitioners and patients with a particularly difficult management task. While a considerable amount of research on adherence has now been done with children and adolescents with CF, an examination of the literature identified very few studies devoted specifically to the behaviour of adults with this disease. The studies of adults were all conducted within the last 15 years, reflecting the recency of substantial breakthroughs in the effective treatment

of CF, and the consequent improvement in patients' life expectancy. These few studies have built on the knowledge base of findings about adherence in children with CF and adults with other chronic diseases and have begun to elucidate factors that contribute to non-adherence (Abbott & Gee, 1998). None of the studies however, have been able to support a cohesive theoretical explanation for the findings.

Models of self-efficacy and health belief have been effective in explaining some of the variance in adherence but the links have been weaker than anticipated (Abbott et al., 1996; Parcel et al., 1994). Despite the lack of a good theoretical basis for the findings, many of the individual factors identified as contributing to non-adherence are consistent with both clinical and common sense (Conway et al., 1996). If a cohesive basis for understanding the collective influences on adherence behaviour can be identified, it seems likely that more effective interventions or management strategies may be found for the problem.

Leventhal et al. (1992) described a comprehensive model called the Self-Regulatory Model (SRM) that integrates many aspects of adherence findings previously thought to be independent or disjointed. The model may have significant implications for understanding adherence in CF but has not been employed in this context until now. The SRM advocates a "common-sense" approach to understanding adherence and is systemic, incorporating emotional and cognitive processes, as well as environmental and social influences on behaviour. Rather than dismissing other models such as the Health Belief Model, concepts of self-efficacy and aspects of health locus of control, the SRM draws them together into an interconnected system.

Expanding on that model, Horne (2000) has considered the concept of treatment representations, that is, the beliefs and perceptions that people hold about the treatments (in particular, the medicines), prescribed for them.

7.2 Aims and approach

Several aims were developed for this program of research, with a view to contributing new knowledge to the understanding of adherence in adults with CF. On the basis of the literature as presented in Chapter 1 and above, the aims for this research were:

1. To investigate rates and patterns of adherence to treatment in Australian adults with CF.

2. To consider the role of demographic and disease characteristics on treatment adherence in adults with CF.

3. To explore the beliefs and perceptions of adults with CF in relation to a variety of CF treatments.

4. To investigate the role of family environment in adherence to treatment by adults with CF.

5. To conduct a longitudinal examination of adherence to concurrent treatments in CF.

6. To investigate the associations between illness and treatment perceptions and adherence to CF treatments, using multiple methods of measurement.

7. To apply the SRM to a consideration of adherence to treatment in adults with CF.

To meet these aims, three studies were conducted. The first of these was a pilot study. It was designed to assist in the development of specific hypotheses for the remainder of the research and to guide decision making for appropriate measurement instruments.

The second study used a cross-sectional, repeated measures design to investigate the illness and treatment perceptions of adults with CF, and then the association between the perceptions and reported adherence to treatments. This investigation was combined with an examination of self-reported adherence and its relationship with aspects of family environment. This study allowed for the first substantive consideration of the influence which the SRM may have on understanding adherence behaviour in adults with CF. The Cystic Fibrosis Perceptions Inventory (CFPI) was designed and used for the first time in the study, to measure illness and treatment perceptions hypothesised to be influential in CF.

The third study used a longitudinal, repeated measures design, with multiple methods of measurement for adherence, to further investigate emerging links between illness and

treatment perceptions and adherence in adults with CF. Electronic monitoring technology was employed, along with pill counts, self-report and outpatient attendance records in this examination of two concurrent treatments over three months. Substantial practical, financial and time delays resulted in the collection of less data for the third study than had been originally planned and at the time of writing, extra data for the third study was still being collected and will be examined later. Despite these difficulties, the original aims for the research were able to be addressed and the data was sufficient to test the research hypotheses.

7.3 Key results

Multiple methods of measurement provided confirmatory evidence of differential adherence to treatments by adults with CF. Contrary to previous observations (Rapoff, 1999), there was evidence that time-consuming, complex treatments can be managed better than less demanding treatments. Significant links between adherence and both the treatment and illness perceptions of adults with CF have been demonstrated for the first time in this research. Preliminary psychometric evaluation supported the validity and reliability of the CFPI as a measure of illness and treatment perceptions for adults (and possibly adolescents) with CF. Evidence of differential adherence to treatments combined with emergent links between adherence and perceptions, supported the SRM as a better explanatory model for adherence in adults with CF than has been identified before. There was also sufficient evidence to postulate that in chronic illness, with multiple treatments, the most simple treatments may be less affected or influenced by a self-regulatory cognitive and emotional process than are more complex treatments.

The findings from the three studies are reviewed below in relation to the overall research aims. Links and disparities between elements of the different studies are considered, along with the implications of the findings.

7.4 Aim 1: To investigate rates and patterns of adherence to treatment in Australian adults with CF

The small body of self-report research about adherence rates among adults with CF has found different levels of adherence for different treatments (Abbott et al., 1994; Conway et al., 1996). There is also some evidence of links between ease of treatment delivery, likelihood of short-term benefit and better adherence. Methodologically, the studies to date have all re-interpreted patients' responses on self-report measures, categorising people into three groups: good compliers, moderate or partial compliers and poor compliers. For the studies in this program of research however, a decision was made not to re-interpret responses, but simply to report findings based on the response categories or raw information from the measures used. The exception to this was in Study 1, where the Manchester Cystic Fibrosis Compliance Questionnaire (MCFC) was used. In that instance it was considered more appropriate to interpret responses in the same way as had been outlined by the authors of the measure.

This decision meant that adherence data obtained from the electronic monitors and pill counts in Study 3, reflected the proportion of doses taken, with no judgements made about whether the adherence was good or poor.

In Study 1, reported adherence varied between the four treatments examined, with rates of adherence as measured by the MCFC being similar in this small sample to those found using the same criteria on the same measure, for a sample of adults with CF in Britain (Abbott et al., 1994). Using the British criteria, 55% of people in Study 1 were considered compliant with physiotherapy treatment, 90% with exercise regimens, 70% with vitamin therapy and 80% with pancreatic enzymes.

In Study 2, the CFPI was used to measure self-reported adherence to seven different CF treatments. On the basis of this self-report, adherence again differed significantly between treatments, with 74% of participants reporting that they always took their enzymes compared with 18% of participants who reported always doing their physiotherapy. Ad-

herence to the other five treatments varied between these two extremes, with around 30% reporting that they always adhered to their antibiotics and their dietary plans, just under half reporting that they always adhered to their rhDNase and just over half reporting always adhering to vitamin therapy. Around 25% reported ideal adherence to exercise regimens. For most treatments, the largest number of people reported that they mostly or sometimes adhered to their treatments. Due to the different categorisation of adherence between the studies it was difficult to compare the findings, however the relative positions of the treatments, from most adhered to least adhered was consistent, with the exception of exercise.

The approach to self-report measurement of adherence was changed in the CFPI for Study 3 and the measure yielded quite different results. Higher levels of adherence were reported for most treatments using the different style of measurement, especially for antibiotics and dietary plans, with 90% and 64% reporting adherence on 7 or 6 days per week respectively. As was discussed in Chapter 3, a change from reporting a qualitative estimate of adherence to reporting a quantitative estimate may have inflated the self-report for treatments done more than once daily. It may also have underestimated adherence to treatments such as exercise, that are not expected to be done every day.

Study 3 also employed electronic monitoring of two treatments, rhDNase and vitamin D. A significant difference in adherence was found between the two, in favour of rhDNase. The effect size and statistical significance for this difference were stronger than the correlation for adherence between the two treatments. Further, participants in the study had much better routines associated with their management of rhDNase compared with vitamin D. Participants tended to take their rhDNase at the same time of day as their vitamin D, however they were much more likely to omit their vitamin D. Adherence to rhDNase did not appear to be influenced by events such as attendance at outpatient clinics or by hospital admissions, with routines continuing as usual around these events. Adherence to vitamin D however, improved after clinic visits relative to the week prior to the visit, and decreased after hospital admissions relative to the week prior to admission.

Above all and even taking into account the differences in approach to measurement it now seems beyond doubt that adults with CF adhere differently to different treatments.

It also seems increasingly likely based on the trends observed in this research and earlier studies, that adults in different clinics and different countries will be shown to have similar patterns of adherence to the different treatments. More studies will need to be conducted using comparable criteria and measures for adherence in order to be able to demonstrate this similarity. If such a similarity can be demonstrated, it may prove highly desirable in future to develop adherence interventions that are aimed at specific treatments rather than targeted at specific individuals.

7.5 Aim 2: To consider the role of demographic and disease characteristics on treatment adherence in adults with CF

Previous research has identified a very limited role for demographic differences and disease characteristics in the prediction of adherence in CF. Poorer adherence with increasing age is one of the few consistent findings (Abbott & Gee, 1998), however the mix of adolescents and adults in the research samples cast some doubt about whether this finding would hold true with samples of adults only.

The role of demographic and disease characteristics in adherence was considered in Studies 2 and 3 in this research. Both of these studies included only people aged 18 years or over, with a median age of 24 to 25 years. Further, in both studies there was a relatively even ratio of males to females and a broad spectrum of both nutritional and respiratory health. Aspects of lifestyle such as marital status, employment status and country versus metropolitan living were also considered.

In Study 2, three statistically significant associations were found between disease or demographic characteristics and reported adherence. People with better lung function reported adhering better to their pancreatic enzymes, women reported themselves to be less adherent to antibiotics than men and people who lived in the country reported poorer adherence to exercise regimens.

In Study 3, few demographic differences differentiated between people in terms of

their adherence. There was, however, an association between higher Body Mass Index and better adherence (electronically monitored) to vitamin D. In addition, married people reported adhering less to their physiotherapy and students reported adhering less to antibiotics than did people in other categories of employment.

Inconsistent findings were obtained between the studies conducted with regard to the contribution of demographic or disease characteristics to differences in adherence. Across the studies, findings of links between demographic or disease characteristics and adherence had small to moderate effect sizes and were isolated to separate aspects of the treatment regimen. The fact that none of the links were found in both of the major studies seems to indicate any of three possibilities. Firstly, it is possible that the findings are valid but were local to the specific combination of individuals in each study sample and can not be considered likely to generalise to the general population of adults with CF. Secondly, as would fit with the SRM position on appraisals of illness and its treatment, it may be that relationships between these social and personal factors are associated with adherence in the same dynamic way that beliefs and perceptions appear to be. If this is the case, it would make sense for the contribution of these factors to be higher for individuals at some points in time than others, and the relationships may therefore be present sometimes but not always within the general CF community or in any particular sample of adults with CF. Thirdly, there is also the possibility that the results were artifacts of the measurement process, however the relationships did appear to make clinical sense in most instances, so this possibility is considered unlikely.

Overall however, and regardless of the explanation for these results, it emerged as in previous research in this area, that neither demographic differences or disease characteristics were reliably or strongly associated with adherence.

7.6 Aim 3: To explore the beliefs and perceptions of adults with CF in relation to a variety of CF treatments

Previous studies have identified that the illness and treatment perceptions of people with chronic illness may be predictive of adherence to treatments (Horne & Weinman, 1999; Weinman et al., 1996). Such perceptions have not previously been investigated in CF, although the implications of taking patient perceptions into account within the medical consultation in CF have been discussed by Pendleton & David (2000). Although a decision had already been made to investigate illness and treatment perceptions in CF in this research, Study 1 provided an opportunity to explore patients' beliefs and perceptions through open questioning before finalising the approach to be taken with the examination in later studies.

In interviews in Study 1, patients reported that factors such as having a positive attitude, receiving good social support, having a desire to avoid the consequences of poor adherence and being in a good routine motivated them to adhere to CF treatments. Conversely, factors such as making a cost versus benefit choice, tiredness and time constraints were implicated as interfering with adherence to treatment.

Ratings of importance to health ascribed to a number of different CF treatments were very varied in this small sample. While no statistical analysis was attempted due to the very small size of the sample, it did appear from this small group that the treatments that most people rated to be important were also the ones that most people reported adhering to well. Conversely, low levels of ascribed importance appeared to be linked with lower levels of adherence to those treatments.

These observations, in combination with the collection of previous findings from more than seven other chronic illness groups surveyed about their illness and treatment perceptions (Horne et al., 1998; Horne & Weinman, 1999; Petrie & Weinman, 1997) were used to develop a new disease specific perceptions and adherence questionnaire for CF.

7.6.1 Cystic Fibrosis Perceptions Inventory (CFPI)

The CFPI was developed in response to the perceived lack of an appropriate measurement tool for adherence, illness perceptions and treatment perceptions in CF. The MCFC did not address elements of the SRM that were of interest in this research. Further, the measure was poorly received by members of the target audience who completed it in the pilot study. Existing validated measures of illness perception (the Illness Perceptions Questionnaire [IPQ]) and treatment perceptions (the Beliefs about Medicines Questionnaire [BMQ]) did not take into account unique characteristics of CF. For example not all of the five themes of illness representation in the IPQ were thought likely to differentiate between people with CF in terms of adherence. Similarly, questions in the BMQ (even on the Specific form), are asked with reference to all medicines that a person is prescribed, while in CF, it was expected that responses to the questions may be specific to different components of the treatment regimen. The CFPI was developed therefore, with the aim of incorporating relevant aspects of the existing measures and building on the existing knowledge base about adherence in adults with CF.

The CFPI is divided into three sections: a series of statements about CF and its management that incorporates aspects of illness and treatment perceptions; a section for self-report of adherence to seven different commonly prescribed CF treatments and a section in which ratings are made of the relative importance of the seven treatments to ongoing health. The two studies described in Chapters 4 and 5 provided opportunities to investigate aspects of the validity and reliability of the measure. An examination of the variability in beliefs and perceptions about CF and its treatment was also conducted.

Using a cluster analysis technique, the beliefs section of the measure revealed five conceptually meaningful sub-scales, with acceptable to good levels of internal reliability and good item-to-scale discriminant validity in the three separate groups of patients in which it was tested. In particular, it was encouraging that support for the same internal structure was found in two groups of Australian adults and in data collected from a sample of adolescents from another country. The emergent scales fit quite well with the concepts central to the SRM, although they were somewhat different to those originally

conceptualised in the item development phase for the measure. The sub-scales for the beliefs and perceptions section of the measure were labelled *Treatment value*, *Cost versus benefits*, *Denial*, *Attention/Concerns* and *Lifestyle/Energy*.

Specific items from the CFPI as used in Study 2 yielded some noteworthy information. For example, about half of the participants agreed that they forget aspects of their treatment from time to time and just over half felt that they needed "time-out" from their treatment routine from time to time. Almost 70% felt that they kept up more with their treatment when their lung function was lower, while just over half of the participants believed that their treatment worked well overall. It was clear from an examination of the spread of responses to the CFPI, that patient opinion varied quite substantially about some aspects of CF and its treatment, while for other aspects there was a considerable level of agreement in the population.

7.7 Aim 4: To investigate the role of family environment in adherence to treatment by adults with CF

Elements of family environment have been linked to adherence in CF, diabetes and phenylketonuria (Moos & Moos, 1994) and have been found to have an association with pulmonary health trends for children with CF (e.g., Patterson et al., 1993). Although the circumstances of adulthood were considered likely to alter the impact of family variables on health, many young adults with CF continue to live with their parents and a decision was made to investigate the relationship between family variables and adherence in adults. The Moos Family Environment Scales were used to accomplish this aim in Study 2.

Unfortunately, exploration of the role of family functioning on adherence was not very successful in this study. Difficulties were encountered with the Family Environment Scale, including what seemed to be inflated levels of reported cohesiveness and expressiveness in families and lower than anticipated levels of reported conflict. This raised concerns that the scores reflected socially desirable responding rather than a true reflection of family

functioning at least for some participants. Other participants opted not to complete the family questions at all or responded only to some of the questions, making it impossible to derive a valid scale score. Bearing the limitations of measurement in mind, an association was found between higher levels of family cohesiveness and adherence to physiotherapy, while higher levels of family conflict appeared to be related to lower levels of adherence to physiotherapy. None of the other possible relationships examined reached statistical significance. As discussed in Chapter 4 these limited findings clearly do not do justice to the original question of whether family variables play a significant role in adherence behaviour in adults with CF and further examinations, using different measures are indicated.

Another way of thinking about the outcome of this examination however, is to consider that in Study 1, participants identified social support more generally (i.e., from friends as well as family), as an important motivator for adherence. If this is the case then a wider examination of the social context of CF may also provide valuable insight into the systemic foundations of adherence decision making in CF. With this possibility in mind, some elements of contextual influence on patients' conceptualisation of their illness will now be discussed.

7.7.1 Treatment choices in the social context of CF

An issue which may contribute to appraisals about treatment is the question of "the cure" for CF. Since the initial discovery of the genetic defect responsible for CF, research into the development of effective gene therapy has been taking place in numerous countries worldwide, including the United States of America, Britain, France, Sweden, Italy and Australia, as evidenced by the proliferation of conference posters and presentations originating from research groups in those countries at recent international CF conferences. The prospect of a cure for CF is an increasingly realistic possibility so that a high level of optimism for the future is present in the community affected by CF. Many adults with CF, as demonstrated by responses to the item asking about this in the CFPI, believe that they will "beat CF" if they can maintain their health until a cure is found. What is much less clear is the extent to which adults with CF recognise that the damage already

done by the disease to their lungs cannot be undone by gene therapy, even if further deterioration of their health might be prevented. Further, effective gene therapy may not change the demands of CF treatment regimens at all for many people, who may continue to need substantial home care treatment to manage the earlier impact of the disease on their health.

The optimism or enthusiasm for the future promoted by the possibility of a cure is to some extent countered by the loss of a sense of "community" in the population of people with CF (Geddes, 2002). This loss is a relatively recent phenomenon in a population in which a "united front" against the illness has traditionally been present as evidenced by the prevalence of CF association gatherings, fund-raising activities, youth camps and lifelong friendships between many people affected by the disease. The change in this community ethos is largely due to the recent introduction of strict infection control guidelines in most countries where CF is prevalent. These guidelines call for very careful procedures in both medical clinics and social settings to minimise the risk of spreading bacteria common in CF infection.

As such guidelines have only been developed in the past few years, it is perhaps too soon to determine what impact they may have on the perceptions of CF and its treatment. It is reasonable to predict that heightened awareness about infection and increased sanctions against social interaction between people with CF may serve both to limit avenues of social support and heighten the perceived threat of CF for some patients. Together these factors may play a significant role in the self-regulatory process described in more detail below, with Aim 7.

7.8 Aim 5: To conduct a longitudinal examination of adherence to concurrent treatments in CF

The value of longitudinal studies in increasing understanding of adherence behaviour has been admirably demonstrated by Rand et al. (1992) and Rand & Wise (1994) in their studies of asthma. There are obvious advantages to be gained by conducting longitudinal

studies, including more detailed information and the ability to better understand typical behaviour. The disadvantage however, is the additional research cost in time and resources as well as potential additional inconvenience for research participants.

The value of a longitudinal study in this research was present at several levels. Firstly, as discussed in Chapter 1, adherence research has been plagued by difficulties of definition and the recognised inadequacies of many available measurement techniques. A longitudinal study provided daily information, allowing a more direct quantitative report on behaviour to be made, rather than a secondary interpretation of estimates as is most common when self-report is used. Secondly, if adherence is a dynamic process, as hypothesised and discussed in this thesis, then cross-sectional studies risk missing valuable information from their "snap-shot" approach. With daily information over time, changes in behaviour were able to be observed. A further advantage of this technique was that it allowed the stability of participants' perceptions about illness and treatment to be examined with the CFPI.

To address the last point first: the test-re-test reliability of the CFPI was moderate but not high for most elements of the measure, and stronger over two weeks than over three months. This finding indicated that people's perceptions are subject to change over time, but that the change is more likely to be subtle than radical.

Study 3 then, was a longitudinal examination of adherence to treatment in 25 adults with CF, using self-report, clinic attendance records, pill counts and electronic monitoring to measure adherence. This was the first study of its kind measuring concurrent adherence to two different elements of the treatment regimen in adults with CF. Lengthy delays and a much smaller than expected group of eligible patients at the second of two research sites for this study, resulted in only half of the expected number of study participants being recruited. Despite the limitations of its sample size, this intensive examination of adherence over three months provided an excellent opportunity to examine the influence of beliefs and perceptions about CF and CF treatment on adherence. The validated version of the CFPI, and the Beliefs about Medicines Questionnaire were used to examine these relationships.

While most of the findings from this study are discussed under the headings of Aim 4

and Aim 6, the form of this study provided an opportunity to investigate the relative contribution of different measurement techniques to understanding aspects of adherence in CF and allowed for test-retest reliability analyses to be conducted for the CFPI. This longitudinal approach also allowed an examination of the influence of outpatient clinic visits and hospital admissions on adherence to the two continuously measured treatments. Those findings were discussed earlier with Aim 1.

7.8.1 The influence of measurement

Electronic monitoring provided a technically reliable, easily administered and detailed record of medication management behaviour for the two CF treatments examined in Study 3. Its association with other measures of adherence was varied, providing qualitatively different information from clinic attendance data, much better information than pill counts and more detailed information than self-report. In the case of adherence to vitamins, the electronic monitors provided a more accurate record of adherence behaviour than did self-report. Participants substantially overestimated their adherence to vitamin D relative to data collected electronically, although it is possible that the electronic monitors may have under-estimated adherence to that medication to some degree (see Chapter 5).

Pill counts also substantially overestimated adherence to vitamin D, but did provide confirmatory evidence of poor adherence for the least adherent study participant. Using a relatively broad measure, self-reported adherence to rhDNase did not differ significantly from electronically monitored adherence. Greater reliability of attendance at outpatient clinic appointments was associated with both better electronically monitored adherence to rhDNase and better self-reported adherence to exercise plans. Conversely, lower electronically monitored adherence to rhDNase and lower self-reported adherence to physiotherapy was related to a higher proportion of cancelled visits. Poorer reported adherence to enzymes and dietary plans was associated with a higher percentage of missed appointments.

This study and Study 2 contributed additional information to the issue of adherence

measurement in CF. It now seems beyond question that irrespective of measurement technique, there are real and important differences in adherence between treatments for adults with CF. Further, it seems that these differences are in most cases, likely to be more substantial than differences between individuals in terms of adherence. The studies have also highlighted the importance of minor changes in measurement approach, even within the same style of measurement. For example, the change in the way self-reported adherence was measured between Study 2 and 3, from a general conceptual question to a question about days of the week, may have had an important influence on the information which participants reported.

There is unfortunately no way to tell definitively from these studies which approach to self-report yielded the most useful information. It does seem probable however, that the attempt to increase the specificity of the information provided may have made the task of giving accurate relative comparisons more difficult for participants and yielded less meaningful information. The fact that similar but overall, smaller statistical associations were found between elements of the CFPI and self-reported adherence for the second version of the measure, seems to lend support to this concern.

Considerable advantages in reliability and richness of information were gained in Study 3 by using more than one method of measurement and in particular as a result of using electronic monitors to measure adherence. This result is consistent with previous literature advocating the advantages of multiple methods of measurement (Quittner et al., 2000). Concurrent measurement of two different treatments provided independent confirmatory evidence of the discrepancies in adherence between treatments which have been observed in questionnaire studies previously (e.g., Abbott et al., 1994, 1996; Conway et al., 1996). The high response rate for the study and low drop out rate are both consistent with the idea that electronic monitoring was perceived by participants to be an acceptable method for developing a better understanding of their day to day medication management.

7.9 Aim 6: To investigate the associations between illness and treatment perceptions and adherence to CF treatments, using multiple methods of measurement

A growing body of research has identified that both illness and treatment perceptions can predict a significant portion of the variance in adherence to treatments in many chronic illnesses including heart disease and asthma (e.g., Weinman et al., 1996; Petrie & Weinman, 1997; Horne & Weinman, 2002). The relationship has not been investigated previously in CF. In the absence of satisfactory explanatory models for adherence among adults with this disease, the examination of associations between adherence and patients' perceptions of illness and treatment offered a new and promising direction for research. Links between different perceptions and a range of CF treatments were examined in Studies 2 and 3, confirming a substantial number of statistically significant relationships.

7.9.1 Study 2

In Study 2 participants' ratings of the importance of the CF treatments to their health varied considerably between treatments. Further, the rating for each treatment was significantly and positively associated with the reported adherence to that treatment. Contrary to previous findings (Rapoff, 1999), the relationship was strongest in general for the treatments which required the most effort and time for patients to perform.

Based on the sub-scales derived from the CFPI beliefs section, relationships were examined between adherence and illness perceptions and beliefs. Poorer adherence to almost all treatments was associated with a belief that the costs associated with treatment (such as time, effort and expense) were not justified by the perceived benefits. Comparatively, a belief in the overall effectiveness or value of the treatment program was associated with better adherence to physiotherapy, dietary management, exercise and rhDNase. Denial of the disease process was associated with poorer adherence to antibiotics, while a busy

lifestyle or lack of energy was associated with poorer adherence to vitamins. Anxiety about or attention to the disease process or medical management of it was positively associated with better adherence to physiotherapy, exercise, dietary management and rhDNase.

7.9.2 Study 3

Beliefs and perceptions were significantly associated with both self-reported and electronically monitored adherence to some but not all treatments in Study 3. Perceived importance was significantly correlated with self-reported adherence for four of the seven CF treatments examined in the study and was significantly associated with electronically monitored adherence to rhDNase but not to vitamin D. As discussed in Aim 5, it is not yet clear whether the smaller relationships found in this study reflected a real difference in the relationships between the two studies or whether they were in fact a reflection of the different approach to measurement. The pattern of relationships however, favoured the latter explanation for the difference.

Using electronic monitoring information, adherence to rhDNase on more days of the week was associated with a higher level of belief in the overall value of treatments and a lower level of belief in the idea that the costs of treatments outweigh the benefits. Better adherence to rhDNase was also associated with a lower level of reported influence of lifestyle or energy concerns. Adherence to vitamin D was not significantly associated with beliefs and perceptions about treatments, however there was a non-significant trend for better adherence to vitamin D to be associated with worry about CF and responsiveness to outpatient clinic visits.

The BMQ was chosen as a comparison measure, to assist in an examination of concurrent and discriminant validity for the CFPI. The relationships between elements of the CFPI and the BMQ were consistent with the CFPI having both concurrent and discriminant validity. Moderate levels of association in expected directions were found between items and scales on the two measures, lending support to the idea that there were conceptual similarities between the two measures as intended. The fact that the associations

were moderate rather than strong however, suggests that the two measures each make an independent contribution.

Electronically monitored adherence to rhDNase and vitamin D was associated with a lower level of *concerns* about medicines, but was not significantly associated with reported beliefs about the *necessity* of medicines. Higher self-reported adherence to rhDNase, physiotherapy and exercise was associated with higher belief in the *necessity* of medicines, while lower self-reported adherence to rhDNase was associated with higher levels of concerns about medicines.

While relationships between adherence and patients perceptions had been predicted, the relative strength of these relationships for more complex treatments compared with simple treatments was not anticipated. A hypothesis about the role of cognitions was put forward in Chapter 5 to address this finding. One study however, is clearly insufficient to determine whether the finding will generalise to other settings. It may be of interest to test this finding in other illnesses where complex regimens are required, particularly those which use a mix of simple and complex treatments.

7.10 Aim 7: To apply the SRM to a consideration of adherence to treatment in adults with CF

As prefaced at the beginning of this chapter, no theoretical model has previously been demonstrated to account for substantial amounts of the variance in adherence among adults with CF (Abbott & Gee, 1998). Previously tested models including the Health Belief Model and examinations of self-efficacy have received only partial support (Abbott et al., 1996; Parcel et al., 1994). The SRM was applied to the findings from Studies 2 and 3. The outcomes from these studies support the idea that a self-regulatory process is occurring within adults with CF in relation to their management of treatment regimens.

In Study 3, adults with CF adhered more often and with a better daily routine to a treatment which was more complex, more time-consuming and more expensive; thus ease of adherence was clearly an inadequate explanation for the behaviour. As described

under Aim 6, specific appraisals regarding the value of treatments and the costs in time, money and effort involved in maintaining them at prescribed levels had a more substantial influence on adherence. Concern and attention given to either the disease or the help seeking process were also found to be relevant to the management of treatments in both of the studies. A general perception of the importance of the treatments to ongoing health contributed further to this developing web of interconnections. In Study 2, statistically significant links emerged between adherence to all of the treatments and the degree of importance ascribed to the treatment. The strongest links were for the two treatments at the extremes of the self-reported adherence continuum: enzymes, which most people perceived as being important and reported adhering to well, and physiotherapy, which most people perceived as less important and reported adhering to poorly.

The pattern of these relationships among different treatments led me to hypothesise in Chapter 5, that more conscious cognitive and emotional appraisal processes are performed for treatments that require a more substantial input from patients. This appraisal process may lead to a decision that the treatment warrants the personal expenditure to adhere to well, such as for enzymes and rhDNase. Conversely, the benefits may be perceived as insufficient for the investment of time or effort to adhere well to the treatment, such as appeared to be the case for physiotherapy. Simple treatments on the other hand, especially if patients experience little obvious benefit from adhering to them, were hypothesised not to receive the same level of cognitive or emotional consideration. Links between illness or treatment perceptions and adherence for simpler treatments with little immediate benefit, are consequently observed to be weaker.

7.10.1 Application to other CF treatments

Based on the findings from this research, and their conceptualisation in the framework of the SRM, predictions can be made about the way that different patients will adhere to particular CF treatments. The case of pancreatic enzymes illustrates this point.

The management of pancreatic insufficiency in CF usually requires patients to take multiple capsules of digestive enzymes with every meal and snack (Anthony et al., 1999).

Due to the high frequency of treatment and the considerable inconvenience of taking many capsules each time, it might be predicted that adherence to pancreatic enzymes would be poor. The evidence to date from patient reports of adherence however, does not support this prediction. High levels of adherence to this treatment are reported by the majority of people with pancreatic insufficiency. Consideration of some inter-related observations help to clarify the basis for good adherence to this treatment.

It was hypothesised in Chapter 5 that more complex treatments are afforded greater cognitive consideration by patients. As enzyme replacement therapy requires both time and considerable inconvenience, it is anticipated that patients will make substantial cognitive and emotional appraisals about it. Based on the tenets of the SRM, the proximal and reliable link between use of the treatment and either relief from or avoidance of symptoms, is of critical importance to understanding adherence to enzymes. The short-term symptomatic benefit is likely to be a significant motivation for ongoing adherence regardless of less immediately obvious nutritional benefits of adherence to enzymes. Further, in contrast to some other elements of CF treatment, enzymes have relatively few side effects (Anthony et al., 1999) that might impinge on perceptions of their effectiveness or that could lead to a perception that the treatment was making the person sick.

As digestive enzymes have a very short term action (Stapleton, Anthony, Collins, Powell & King, 1999), the link between the action of using the treatment and the perceived benefit is likely to have been reinforced several times each day, over many years. For the same reason, the link will be just as strongly reinforced either by use of the treatment or by failure to take it, as the effect of either action will be noticed promptly and fed back into the appraisal loop before the next treatment time. Adherence to enzyme replacement therapy, perhaps more than for any other CF treatment, is likely to result in a high level of coherence in the self-regulatory process of appraisal, interpretation of the problem and the effectiveness of the coping strategy employed to manage it. Enzymes offer a relatively direct and high level of control over the gastro-intestinal disease process for many patients.

The situation however, is clearly not as simple as just described and it is inevitable that adherence will be influenced by more subtle aspects of the health of the individuals concerned and their ongoing appraisals of their disease. In particular, adherence to

enzymes is predicted to be highest for those people who have the greatest experience of control over their gastro-intestinal health and nutritional status as a result of enzyme use and for those people who appraise their symptoms as most indicative of CF related illness. For example, a person with CF who misinterpreted gastro-intestinal symptoms as being related to food poisoning or stress, would be unlikely to consider better adherence to enzyme replacements to be an appropriate coping response, based on their representation of the illness. Similarly, people with the most severe pancreatic disease may be at increased risk of poor adherence to enzymes. For them, enzyme use may not be perceived to have sufficient benefit for the considerable inconvenience and high level of organisation required to maintain treatment as prescribed. In addition, people with severe gastro-intestinal symptoms are unlikely to feel well enough to eat as much or as often as recommended and may consequently use less enzymes.

The fast and brief action of enzymes, combined with the relatively benign and predictable (if unpleasant) short-term symptoms associated with insufficient treatment, lead me to hypothesise that patients will engage in substantial dose manipulations. As enzyme effectiveness is at least in part dependent on the specific food consumed, dose manipulation is necessary and expected to some degree (Anthony et al., 1999). The hypothesis however, is that dose manipulation is considerably more extensive than required and may be performed for a variety of reasons. In an attempt to reduce the overall burden of treatment, people may experiment with the minimum dose required to avoid an increase in unpleasant symptoms, regardless of whether the dose is sufficient to meet nutritional goals as well. Further, as mentioned in Chapter 4, people may intentionally under-use the treatment in an attempt to maintain a fashionable but low body weight. The counterpoint to this is the idea of over-using enzymes in an attempt to limit the amount of food required for the same nutritional gain.

The prediction of the adherence behaviour of any particular individual may require a relatively detailed evaluation of their cognitive and emotional schema relative to different treatments. Even a treatment which appears most likely to produce a simple and positive self-regulatory model for behaviour, may be influenced by a complex set of perceptions.

7.10.2 Relevance to the clinical context

If the links between adherence and illness and treatment perceptions described in Studies 2 and 3 are to be understood in the proposed way within the framework of the SRM, this must have implications for approaches to clinical management with adults who have CF. Of paramount importance is recognition within the clinical setting that adult patients are active decision makers about their adherence to treatments. Further, their decisions are likely to be driven by a combination of inter-related and rarely spoken about factors associated with their CF. Patients' day to day perception of the coherence between their cognitive and emotional representation of the disease is likely to change. This may often result in changes in their approach to management of different treatments, particularly for treatments which are more complex or time-consuming. If an adult patient experiences a significant change for the better or worse in health status, this can be expected to lead to a shift in their perception of the value of some aspects of the treatment program. A simplistic view that poor adherence to one treatment implies poor adherence to others is highly unlikely to be accurate. The probability that a self-regulatory appraisal and decision making process is occurring, further highlights the importance of regular, comprehensive discussions with patients about their experience of and expectations about treatments.

If adherence is guided by a process of maximising coherence between symptom appraisal and perceptions of the appropriateness of treatment, then fluctuating adherence to a treatment such as physiotherapy would be expected. Adherence could be predicted to be highest when the person with CF is experiencing an exacerbation of their lung disease and has large amounts of sputum to clear. When the person is essentially well and producing only very small amounts of sputum (if any) with their physiotherapy treatment, the coherence between the perception of the illness and the appropriateness of the treatment for it could reasonably be expected to fall, along with adherence to the physiotherapy treatment. Especially while the person felt well, the airway clearance effects of exercise may well be perceived as offering a more cost effective management option that fits better with their perception of themselves as being well.

Exploration within the health consultation, of the perceptions which patients hold about the emotional as well as practical effects of their disease, may be crucial to an understanding of the potential "coping" responses that patients perceive to be valid choices for them. Further, understanding that the meaning that patients ascribe to their CF symptoms can change, may help to keep health practitioners alert to changes in patients' attitudes or approach to treatment. Early recognition of and attention to changes in patient perceptions may help to minimise disruptions to ongoing treatments.

The incorporation into clinic practice, of a regular review mechanism for illness and treatment perceptions is one way to achieve early recognition of changes that may impact on adherence. While it is too early to confirm the validity of the CFPI as a review mechanism, the instrument does show significant promise as a disease-specific measure of beliefs and perceptions. It has an acceptable level of test-retest reliability in the short term, however it is also relatively sensitive to changes in beliefs and perceptions over time.

An indication of the kind of role this instrument might play in clinical practice emerged from the examination of responses from one young woman in Study 3. As reported in Chapter 5 she commented at the end of her CFPI: "There is a threat that staff can take away or refuse your treatment if you are not a 'good little patient'. Also, the right to refuse treatment, or 'dignity of risk' is definitely not spoken of".

Regardless of whether her perception of threat to withdraw treatments is consistent with the clinical practices of the particular clinic involved, this woman's perceptions are almost certainly impacting on her treatment decisions. This same patient reported a high level of belief in the necessity and importance of her medicines, countered by high levels of concerns about them and uncertainty about the role of individual treatments in her treatment regimen. Unsurprisingly, she also indicated that she would not feel comfortable discussing with her doctor any difficulties she was having in keeping up with all of her treatments. Understanding that this person has significant concerns about her treatments, but that she also perceives them to be necessary, puts her comments into a more readily understood framework and might in practice, provide a starting point for more open negotiations about mutually agreeable treatment goals. There are additional elements of this particular example which are discussed later.

7.11 Additional issues for adherence research

As described above, the findings from this program of research lend support to the value of the SRM as an explanatory model for adherence in adults with CF. While they were more cohesive than for other models tested in CF, the findings from these studies could by no means account for all of the variance in adherence. This suggests that other factors must still have a significant role to play in the understanding of adherence behaviour. I suggest that this will also be the case in other chronic illnesses. In this section, the challenges of dealing with accidental non-adherence will be discussed. Further, issues that are inherent to the current 'best practice' model of health care for CF, but that can be applied to several other chronic illnesses such as asthma and diabetes, will be discussed.

7.11.1 Accidental non-adherence

A finding from Study 1 highlighted that there are still risks of accidental non-adherence in this population. In Study 1 a significant discrepancy was observed between patients' reports of their prescribed treatment regimen and that available from their medical record. Agreement between the medical record and patient lists of treatment regimens varied between 41 and 85%. The discrepancy arose in most cases from patients reporting more prescribed treatments than they were currently prescribed. A complete understanding of the prescribed regimen was however, difficult to reconstruct from the medical record. Together, the inaccurate information held by patients and inconsistency of the information kept in the medical record raised the important issue of how best to ensure effective, reliable and mutual understanding about treatment.

Limited concordance between patients' recall of their treatment regimen and the regimen as recorded in their medical record, may have significant clinical implications. This lack of concordance emphasises the heightened risk of assumed knowledge between patients with chronic illnesses and their health practitioners (Ley, 1983). When people attend the same clinic on many occasions and over a long period of time, there is high probability that the health consultation will focus only on aspects of health and treatment which are of the most immediate consequence, such as a current health crisis, test or new

treatment (Ley, 1983). Some aspects of treatment might only be discussed to determine whether the patient needs a script for medication renewed. Other aspects of ongoing care may be relegated to a background position or may be subject to infrequent review.

With a chronic, complex disease such as CF, formal written treatment plans, with copies located in the medical record, in local clinic notes and given to the patient, may help to minimise the risk of omissions or confusion in communication about treatment. By doing so, the process could significantly reduce or prevent accidental non-adherence (Koocher et al., 1990). The open and methodical process of preparing the plan also has potential to facilitate negotiations about treatment within the consultation (Pendleton & David, 2000). To be effective however, such plans would need to be clearly dated, updated regularly, cover all aspects of the treatment regimen and specify the length of time that the plan is to be considered current. They would also need to prove themselves efficient with regard to time and resources within the clinic, and effective in terms of adherence (and ideally, in terms of clinical outcome) in order to be adopted and used.

While the issue of concordance was not directly addressed in Studies 2 and 3, participants were asked for their opinion about their level of understanding of all their treatments and about whether they would feel comfortable discussing difficulties with adherence with their medical practitioner. In both studies, between 5% and 10% of respondents indicated that they did not have a clear understanding about what they were supposed to do with their medications and other treatments, and up to 25% indicated that they would not be comfortable discussing adherence difficulties with their doctor. This latter finding in particular is directly relevant to another issue which cannot be left out of consideration in regards to adherence.

7.11.2 The process of health consultation

There is a risk that the same system of specialist multidisciplinary CF care centres that has been credited with the effective co-ordination of CF care and improving the prognosis for people with CF, may present a substantial barrier to adherence for some patients. This may be particularly true for patients whose poor health requires them to have very

frequent outpatient appointments and more frequent in-patient hospital admissions.

The issue is highlighted by the thoughts of the same patient quoted earlier in the discussion about the SRM under Aim 7. Here, she comments:

"Too many unqualified people know my business, especially newly rotated staff members."

This patient clearly experienced a sense of impersonality in the treatment setting. Further, her earlier comments appeared to reflect a perception that her view of the choices or coping mechanisms available to her was not validated in the CF clinic. The important role of teaching hospitals is undisputed, and their suitability as the locations for large multidisciplinary clinics is clear. It may be extremely important however, in the context of chronic illness where people are long term clients of a particular institution and clinic, that consideration is given to patients' needs and preferences for particular health care providers. The risk of patient frustration about having to give their personal and medical history to a changing procession of trainees over time should not be minimised. Further, a process of genuine negotiation about health goals and the actions required to meet them may prove to be a crucial factor in maximising communication, trust and quite possibly, adherence.

Within the wider adherence literature, there is no shortage of discussion about the importance of the health consultation in facilitating adherence (e.g., Wright, 1993). The importance of increasing the role of patients in diagnosis and decisions about treatment has been discussed (Pendleton & David, 2000), as has improving the communication and listening skills of practitioners (Wright, 1993). Taking time to discuss with patients the likely barriers to adherence and possible solutions for them (Thompson, Dahlquist, Koenning & Bartholomew, 1995) has also been implicated as important for increasing adherence behaviours among a variety of patient groups. If health practitioners can also approach discussions with their patients with an open recognition that adherence is a difficult task and that complete adherence to all aspects of a treatment regimen is known to be rare, negotiations about treatment and mutually acceptable goals may be facilitated.

7.12 Future Directions for Adherence Research in CF

Future adherence research in CF must employ larger samples. In Australia, this is unlikely to be achieved without substantial levels of co-operation between inter-state research teams and CF treatment centres. The success of major clinical trials in this country is evidence that this kind of co-operative research can and does occur. Haynes, Wang & Gomes (1987) commented that "The wind seems to have gone out of the sails of the compliance research enterprise". It seems that to some extent the wind is blowing again on the adherence research enterprise in CF and this current level of attention to the problem may help to facilitate higher levels of enthusiasm for co-operative research efforts in this country.

The complexity of the CF treatment regimen provides an important opportunity to study adherence behaviour concurrently within multiple different management regimens, for example, physiotherapy, antibiotics, enzymes and vitamins. Such studies are necessary in order to gain a stronger understanding of the theoretical underpinnings of adherence, especially to fully test the strength of the SRM as a predictive model for adherence. Such studies may also promote understanding of the relationship between adherence and outcome in CF.

The lack of knowledge about interactions between adherence and treatment outcomes is an essential limitation in the literature pertaining to adherence in general (Epstein & Cluss, 1982; Meichenbaum & Turk, 1987) and CF is no exception to this rule. Linking clinical outcome to any specific aspect of a complex treatment regimen can itself be fraught with difficulty, particularly when several treatments are directed at managing the same clinical problem (Epstein & Cluss, 1982). Introducing variations in adherence into the equation adds an extra dimension of complexity. Just as concurrent monitoring of several treatments may assist researchers to map out adherence behaviour, it might also provide new information about the relative contribution of different treatments to the health of individuals. A part of the same issue is the fact that adequate criteria for adherence, both

from a clinical and a research point of view remain unknown. This cannot be considered surprising when international (and in many cases, national) agreement about minimal standards of care in CF is yet to be achieved, let alone an understanding within different treatment regimens of how much is enough. Research investigating levels of adherence to multiple concurrent treatments may be crucial to the development of much needed standards of care for CF.

If this kind of research is to happen in a more comprehensive way than has been achieved to date, then it would be extremely valuable to have access to electronic monitoring technology specific to a wider range of treatment modes. This would enable several treatments to be monitored concurrently, with minimal intrusion into time and routine for the research participants. For example, a device that could count pills removed with each use of a dispenser, and one that could accurately record the use of the positive expiratory pressure (PEP) physiotherapy mask used by the majority of CF patients in Australia, would be very valuable. It may be that a device such as a pedometer would assist in the determination of activity levels, if not exercise adherence in adults with CF. While much of this technology remains at the "cutting edge" it will no doubt continue to be a very expensive measurement option. If in time, it takes a larger place in the process of collaborative and goal-directed treatment monitoring, the price of research of this kind may fall.

Longitudinal monitoring of adherence, while necessary, will not be sufficient on its own to achieve the goal of understanding the links between health outcomes and adherence. Repeated measurement of outcome indicators, such as lung function, sputum cultures, vitamin levels, fitness, nutritional status and bone density must be part of any investigation seeking to elucidate those links. As discussed in Chapter 6, studies must also be conducted over longer periods of time if relationships such as that between adherence and outcome are to be better understood.

There is at present no information about how adherence itself, independent of treatment effect, may relate to health outcomes in CF. This may be important to investigate in future as there is mixed evidence about whether ideal adherence is always a good thing. Epstein (1984) cited six studies of different chronic illnesses in which adherence itself,

regardless of whether the person was prescribed an active treatment or a placebo, was protective of health and associated with lower rates of relapse and mortality. Horowitz et al. (1990) examined this phenomenon in more than 2000 people who had suffered myocardial infarctions and found that better adherence predicted lower mortality at one year regardless of whether patients were on an active treatment or placebo. On the other side of the argument however, are studies such as that by Moise et al. (1987) and Strauss & Wellisch (1981), who found that those people using avoidant coping strategies (including lower levels of treatment adherence) demonstrated better psychological health and adaptation to their disease overall. It can be hypothesised that high levels of anxiety and over concern about health in adults with CF that may accompany ideal levels of adherence (Abbott et al., 1996), may be more detrimental to health than lower, but psychologically manageable levels of adherence.

An examination of the causal relationships between good adherence and good routines for treatment management may prove vital to an understanding of the process of adherence. It may offer new insights into both the initial promotion of and later support mechanisms for ongoing adherence to different treatments.

People are living longer with CF, but we know that there is a high cost in both treatment demands and the development of additional symptoms for many patients. Well designed research which can help to answer the question "How much is enough?" and then help people to attain that goal, may both lighten the burden of care for people with CF and assist them to live with maximum quality of life.

7.13 Broader implications of this research

The finding that adherence to different treatments within a complex regimen is both differential and dynamic warrants exploration in other illnesses where multiple treatments are employed. It would be foolish to assume that this finding applies uniquely to CF. It is time for health researchers to set aside the assumption that people can be categorised in any general way in relation to their adherence behaviour, and to recognise that most people will adhere much better to some treatments than to others.

On a broader level, these findings raise the question of whether people give a different level of attention to separate elements of illness. The research on illness perceptions (Leventhal et al., 1992; Weinman et al., 1996) identified the theme of *identity* as one of the five central themes of perceptions about illness; that is, an overall concept of the illness and a label for it, such as "flu" or "CF", in which a certain set of symptoms can be expected. People are then seen to make a range of appraisals about how long the illness may last, what the consequences of it will be and what level of cure or control over the illness will be attained on the basis of this central concept of the illness. These appraisals may then lead to health protective behaviours being undertaken (Leventhal et al., 1992). I would speculate that people with chronic illness may have several self-contained, self-regulatory systems that influence their behaviour in respect to different components of their illness, particularly when multiple body systems are involved.

For example, there will be occasions when people may need to untangle the interactions between an ongoing illness and the onset of a separate acute illness or new complications of the existing illness. To take an example from CF, the development of a head cold may require a shift in individuals' current representation of themselves as well or unwell depending on the state of their respiratory health at the time the new illness was developed. It may also require appraisals about whether the new illness needs to be considered within the treatment protocol for CF, or whether it requires attention in the same way as a head cold contracted by any other healthy person.

Timing may also be relevant. When for example, does a simple viral respiratory illness evolve into a more significant exacerbation of CF related respiratory infection? This eventuality is unlikely to result however, in any shift in the representations held about gastrointestinal health or reproductive health. On a day to day level, the different systems may operate virtually independently. They may be updated or influenced by different elements of social and environmental context and may operate on quite different levels of perceived need for monitoring or action.

Conceptualising the process in this way may help to account for people with chronic illness failing to see links between changes in more than one aspect of their health at a time and therefore failing to associate changes with the overall disease process. It may be

that delays in help seeking and inappropriate management of health arise from the lack of a coherent systemic view of the whole illness, with the whole being managed rather as its component parts. This view is consistent also with the apparently independent management of different aspects of treatment for a chronic illness. It would be most interesting to examine whether adherence to multiple treatments aimed at treating the same aspect of an illness, covaries more closely than adherence to treatments aimed at other aspects of the illness.

There are obvious applications for the technology employed in Study 3 of this research, to other chronic diseases. Electronic monitoring has already been employed for some years in studies of asthma (e.g., Rand et al., 1992; Rand & Wise, 1994), tuberculosis (Starr et al., 1999) and HIV/AIDS (e.g., Wagner & Ghosh-Dastidar, 2002) as a research tool. However, the role of this technology in assisting patients to manage chronic illness has been less thoroughly or widely examined (Haynes et al., 1996). As suggested in Chapter 1, the concept of blending validated psychological approaches, such as cognitive behavioural therapy, with the accuracy of self-monitoring data that electronic monitoring devices can provide, holds significant potential for the further development of effective intervention strategies for adherence among adults with chronic illness. This approach fits well with the evidence that people develop self-regulatory systems of cognitive and emotional appraisal that are guided by their perceptions of both their illness and its treatment. Guided monitoring may improve perceptions of control and may strengthen perceptions of links between behaviour, treatment and health outcome.

Some of the challenges encountered in the completion of this research also have broader implications for psychological adherence research. This field of research is expensive, both in time and money. In order to meet research goals, longitudinal, multi-measure research requires adequate funding and resources and realistic time-frames for completion. The realities of unplanned delays and potential equipment failure can not be minimised. In addition, the challenges of accounting for local differences when developing successful multi-centre research protocols must be considered. Overall however, research of this kind is rewarding and has the potential to add significantly to the expanding body of knowledge in health psychology and other disciplines.

7.14 Concluding remarks

This dissertation has demonstrated that adherence to treatment in adults with Cystic Fibrosis (CF) varies significantly between treatments, and is influenced by the beliefs and perceptions that patients hold about both their disease and its treatment.

This area of research proved to be challenging in the Australian context. The challenge resulted from limitations on funding and difficulties associated with conducting research in small populations, however the difficulties were overcome sufficiently to meet the original aims of the research and to add new information to the understanding of both psychological and practical factors associated with adherence to treatment.

It has been possible to challenge the prevailing view that better adherence can be predicted reliably for simple and inexpensive treatments compared with more complex treatments. The findings from this research program have supported instead, the proposition of Leventhal et al. (1992), that adherence decisions are based on parallel, dynamic appraisals about interactions between symptoms and treatments, as well as environmental and emotional factors. This Self-Regulatory Model has provided therefore, a stronger theoretical foundation on which to build further understanding of treatment adherence than any that had been identified previously, and the findings associated with this model are likely to be applicable not only in CF but in other chronic illnesses. Despite this stronger theoretical foundation for understanding adherence, much remains to be learned about the relative contributions of psychologically mediated versus systemic and accidental influences on adherence.

Building on the previous literature using self-report to measure adherence, more objective longitudinal measurement techniques provided confirmatory evidence about relative levels of adherence between some CF treatments and allowed a detailed examination of management routines to be made.

The Cystic Fibrosis Perceptions Inventory holds considerable promise as a research instrument and a clinical assessment tool for CF. In clinical practice it might be used to monitor the illness and treatment perceptions held by adults with the disease, as part of a broader early recognition and intervention approach. Information gained in this way

may then guide the development of tailored and specific strategies to promote adherence.

Better adherence, in combination with ever more effective treatment, has the potential to improve clinical and health outcomes for people with CF. We can not forget however, the extraordinary burden of care faced by people with this disease, who must find a balance between health maintenance and all of the usual challenges and responsibilities of leading a full and satisfying adult life. I would suggest that a crucial aspect of our duty of care must always be to build and maintain respectful and effective treatment and research partnerships with adults with CF, as they strive to maintain an optimum quality of life.

Appendix A

Interview questions for Study 1

I am going to ask you a series of questions about yourself and your CF. These questions are designed to help me to understand more about the way CF affects people and the way that they manage their CF. It is important that you answer the questions honestly. You will not be identified in connection with any of the answers you give.

1. Please indicate your gender: male or female.

2. What is your age (years)?

3. What is your marital status?
Married
Defacto
Separated/Divorced
Single
Widowed.

4. What is your current employment status?
F/T work
P/T work
Student
Looking for work
Unable to work
Choose not to work.
If you are working or studying, please describe.

---

5. Where are you currently living?
City
Country: Large Town/Small Town/Remote.

6. What is your current living situation?
Living at home with parents
Live alone
Live with spouse/partner
Share accommodation

7. Are you happy with these living arrangements Y/N?

8. Compared with other people of your age with cystic fibrosis, how would you rate your health?
Excellent
Good
Average
Below Average
Poor
Don't Know.

9. Compared with other people of your age without CF, how would you rate your health?
Excellent
Good
Average
Below Average
Poor.

10. How would you describe the severity of your cystic fibrosis?
Very severe
Severe
Average
Mild
Very mild
Don't Know.

11. How has your doctor described the severity of your CF to you?
Very severe
Severe
Average
Mild
Very mild
Hasn't said.

12. Please describe your daily treatment routine for CF.

_____

_____

_____

_____

13. How closely do you follow the prescribed treatment routine for your CF?
Exactly as recommended
75% or more
50% or more
25% or more
Less than 25%.

14. How important would you judge each of the following components of your treatment to be to your **day-to-day** health?

	Essential	Important	Helpful	Not Helpful
Antibiotics				
Pancreatic Enzymes				
Diet				
Physiotherapy				
Exercise				
Vitamins				
Pulmozyme				
Other				

15. How important would you judge each of the following components of your treatment to be to your **long-term** health?

	Essential	Important	Helpful	Not Helpful
Antibiotics				
Pancreatic Enzymes				
Diet				
Physiotherapy				
Exercise				
Vitamins				
Pulmozyme				
Other				

16. How confident are you of your ability to manage your day-to-day treatments?
Very confident
Confident
Confident about some parts only.
Not confident
Don't manage.

17. What helps you to manage your CF treatment?

_____

_____

_____

_____

18. What parts of your treatment do you find it most difficult to adhere to?

19. What interferes with your adherence to treatments?

20. For you, is living with CF
Very easy
Easy
Manageable
Difficult
Very difficult.

Appendix B

Questionnaires

On the following pages are the three main questionnaires used in this thesis:

- Manchester Cystic Fibrosis Compliance Questionnaire (MCFC)
- Beliefs about Medicines—Specific Form (BMQ)
- Cystic Fibrosis Perceptions Inventory (CFPI)

All of the measures have been scaled to fit within the margin allowance for this document and appear in smaller fonts than the versions presented to patients. In the interests of avoiding undue repetition, only the final version of the CFPI is presented. The first version appeared in a very similar format and all differences between the two versions are explained in Chapter 3.

The Manchester Cystic Fibrosis Compliance Questionnaire

The following questions ask you about your treatment. So that we can assess how effective your treatment is, please answer all the questions honestly.

1 How often do you attend the CF outpatient clinic? .....
How often do you attend as an inpatient? .....

Physiotherapy

2 What age were you when you started having physiotherapy? .....
What made you start? .....
.....

3 Do you have help with your physiotherapy? Yes / No
If YES, please give details .....
.....

4 How many times each day, has it been agreed, that you should do your physiotherapy? .....

5 Over the last three months, which of the following statements best describe you?
Tick one box only
- I do my physiotherapy once or twice each day, every day.
- Occasionally I miss one or two days physiotherapy.
- I often miss one or two days physiotherapy.
- I often miss several days physiotherapy.
- The only time I do my physiotherapy is when I feel unwell.
- I never do my physiotherapy.

6 Please tick the boxes which best describe you. When I miss my physiotherapy it is usually because:
Tick as many boxes as you like
- I feel well without treatment.
- It interferes with my social life.
- There isn't enough time.
- I have to rely on someone to help me.
- I simply forget.
- My CF isn't as serious as most of the other CF patients.
- It interferes with family routine commitments.
- I can't always be bothered.
- I don't believe that it does me any good.
- I have too many different treatments to attend to, and physiotherapy is the least important of them.
- It makes me feel worse.
- I don't fully understand why I need to do physiotherapy.
- I do plenty of exercise, so I don't need to do physiotherapy.
- I don't know how to do it.
- I have difficulty doing my own physiotherapy.
- I resent having to do it.
- It's embarrassing.

7 Do you think that the amount of physiotherapy you do is:
Tick one box only

About right	Not enough	Too much	Don't know

Exercise

8 Do you do any exercise? Yes / No

9 If YES, what do you do and how often? .....
.....

10 If YES, why do you exercise? .....
.....

11 If I don't exercise at all, or my usual exercise sessions lapse, it tends to be because:
Tick as many boxes as you like
- I don't enjoy exercise.
- I simply forget.
- Most of the time I don't feel well enough to exercise.
- I resent having to exercise.
- I don't fully understand why I should exercise.
- I have too many different treatments to attend to, and exercise is the least important of them.
- I don't believe that it does me any good.
- I haven't enough time.
- I don't want to lose weight.
- I can't always be bothered.
- Exercise makes me feel worse.
- It interferes with my social life.
- Exercise makes me too breathless.

12 Do you think your present level of exercise is:
Tick one box only

About right	Not enough	Too much	Don't know

Pancreatic enzymes

13 Do you take your enzymes with a MAIN meal?
Tick one box only

Never	Occasionally	Usually	Always

14 How many do you usually take with a MAIN meal? .....

15 With a MAIN meal do you take them:
Tick one box only
- Throughout the meal.
- Only at the beginning of the meal.
- Only at the end of the meal.

16 Do you take them with snacks?
Tick one box only

Never	Occasionally	Usually	Always

17 If I don't take my enzymes it is usually because:
Tick as many boxes as you like
- I only take them when they are given to me.
- I am embarrassed to take them in front of other people.
- I don't like the taste.
- I have difficulty swallowing them.
- I have difficulty getting repeat prescriptions.
- I simply forget.
- My body occasionally needs a rest from medication, otherwise I may become immune to them, and they will not work when I really need them.
- I only take enzymes when I feel unwell.
- I resent having to take them.
- I don't want my friends/colleagues to know that I have CF.
- I don't fully understand why I need to take them.
- My CF isn't as serious as most of the other CF patients.
- I have too many different treatments to attend to, and this is the least important of them.
- I don't believe that they do me any good.
- I can't always be bothered.
- They make me feel worse.
- It interferes with my social life.

18 Do you think that your pancreatic enzyme intake is:
Tick one box only

About right	Not enough	Too much	Don't know

19 Do you eat whatever you like? Yes / No
Do you eat a fat-free diet? Yes / No
Do you eat a vegetarian diet? Yes / No

Vitamins

20 Are you prescribed vitamins? Yes / No

21 If YES, what has been prescribed, and how often should you take them?
.....
.....

22 How often do you actually take your vitamins?
Tick one box only

Never	Occasionally	Usually	Always as prescribed

23 If I don't take my vitamins as prescribed it is usually because:
Tick as many boxes as you like
- I only take them when they are given to me.
- I don't like the taste.
- I have difficulty swallowing them.
- I take more than has been prescribed for me.
- I have difficulty getting repeat prescriptions.
- They make me feel worse.
- I simply forget.
- My body occasionally needs a rest from medication, otherwise I may become immune to them, and they will not work when I really need them.
- I only take vitamins when I feel unwell.
- I resent having to take them.
- I don't want my friends/colleagues to know that I have CF.
- I don't fully understand why I need to take them.
- My CF isn't as serious as most of the other CF patients.
- I have too many different treatments to attend to, and this is the least important of them.
- I don't believe that they do me any good.
- I can't always be bothered.

24 Do you think that your vitamin intake is:
Tick one box only

About right	Not enough	Too much	Don't know

25 Do you take any medication which has not been prescribed by a doctor?

Never	Occasionally	Usually	Always

26 What do you take, and how often? .....
.....

27 Why do you take it? .....
.....

BMQ-S10 Project Number .....

YOUR VIEWS ABOUT
MEDICINES PRESCRIBED FOR YOU

- We would like to ask you about your personal views about medicines prescribed for you.
- These are statements other people have made about their medicines.
- Please show how much you agree or disagree with them by ticking the appropriate box.

There are no right or wrong answers.
We are interested in your personal views

	Views about **MEDICINES PRESCRIBED FOR YOU:**	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
BS1	My health, at present, depends on my medicines					
BS2	Having to take medicines worries me					
BS3	My life would be impossible without my medicines					
BS5	I sometimes worry about long-term effects of my medicines					
BS4	Without my medicines I would be very ill					
BS6	My medicines are a mystery to me					
BS7	My health in the future will depends on my medicines					
BS8	My medicines disrupt my life					
BS9	I sometimes worry about becoming too dependent on my medicines					
BS10	My medicines protect me from becoming worse					

CFPI (Cystic Fibrosis Perceptions Inventory)

Below are some statements about CF treatment. Please read each statement carefully and **tick** the response which **BEST DESCRIBES** the way **YOU** feel. Please place your tick **INSIDE** a box, not on the lines between boxes.

		Strongly Disagree	Disagree	Agree	Strongly Agree
1	I am the best judge of the treatment I need.				
2	Decisions about my treatment must be made jointly by me and my doctors.				
3	It is okay for me to vary my treatments depending on how well I feel each day.				
4	When I do it properly, I believe that my CF treatment works well overall.				
5	Keeping exactly to my prescribed treatment is very important.				
6	I always have a clear understanding of what I am supposed to do with my medications and other treatments.				
7	I am prescribed too much medication.				
8	My treatment is too demanding on my time.				
9	Missing some doses of medication won't do me any harm.				
10	Taking my medication at the wrong time of day won't do me any harm.				
11	Missing my exercise or physio sometimes won't do me any harm.				
12	I will beat CF.				
13	I would feel comfortable about telling my doctor if I was having trouble keeping up with all my treatments.				

		Strongly Disagree	Disagree	Agree	Strongly Agree
14	I focus on the future more than what is happening right now.				
15	My treatment costs too much money.				
16	At times I genuinely forget to do some of my treatment.				
17	I need "time-out" from my CF treatment routine from time-to-time.				
18	At times I try to forget that I have CF.				
19	Sometimes, the hassles involved with my CF treatment (e.g., effort/time/expense) outweigh the benefits.				
20	When I am on holidays I keep up with less of my CF treatment.				
21	When I feel down or depressed I keep up with less of my CF treatment.				
22	When I have a goal to work towards I keep up with more of my CF treatment.				
23	When I get home after a hospital admission I keep up with more of my normal CF treatment.				
24	When my lung function drops I keep up with more of my CF treatment.				
25	After a regular clinic visit I keep up with more of my CF treatment.				
26	When I feel worried about my CF I keep up with more of my CF treatment.				
27	When I feel positive about the future I keep up with more of my CF treatment.				

		Strongly Disagree	Disagree	Agree	Strongly Agree
28	When I am pressured with work I keep up with less of my CF treatment.				
29	When I start a new treatment I keep up with more of my usual CF treatment.				
30	When I feel supported or encouraged by people around me I keep up with more of my CF treatment.				
31	When I am in a good routine I keep up with more of my CF treatment.				
32	When I am tired I keep up with less of my CF treatment.				
33	When I don't feel any better after my treatment I keep up with less of my CF treatment.				
34	When I have problems or hassles in my family I keep up with less of my CF treatments				
35	When I am busy in my social life I keep up with less of my CF treatments				

Please estimate how many days each week you have been able to keep up with your prescribed treatments **over the past month**. If the treatment has **not** been prescribed for you in the past month, please write "NA" in one of the blank squares for that item.

		7 or 6	5 or 4	3 or 2	1 or 0
1	I have taken my antibiotics as prescribed				
2	I have taken my enzymes as prescribed				
3	I have done my physiotherapy as prescribed				
4	I have taken my vitamins as prescribed.				
5	I have done the exercise recommended for me				
6	I have eaten in the way recommended to me				
7	I have taken my Pulmozyme as prescribed				

How important would you judge each of the following treatments to be to your ongoing health? Please tick the box which corresponds to your answer. If the treatment does not apply to you please write "NA" in one of the boxes for that treatment.

		Essential	Important	Helpful	Not Helpful
1	Antibiotics				
2	Enzymes				
3	Physiotherapy				
4	Vitamins				
5	Exercise				
6	Diet				
7	Pulmozyme				

Thank you for taking the time to fill out this questionnaire.
If you wish to make any further comments, please use the remaining space on this page below.
Your feedback and comments are valuable to us.

Appendix C

CFPI internal reliability tables

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
C3	22.5789	13.1693	.6621	.6019	.7743
C5	22.7632	13.8613	.6818	.6023	.7746
C6	22.9737	13.8101	.5076	.6201	.8039
C7	22.5526	14.1458	.6758	.5798	.7774
C27	23.3421	13.7987	.5264	.3708	.7999
C37	23.5000	14.2027	.4773	.6197	.8084
C39	23.1842	15.5057	.4260	.3063	.8133

Table C.1: Reliability coefficients for scale Treatment Value: $\alpha = .8177$, standardised item $\alpha = .8230$.

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
C9	20.3947	32.6238	.5579	.5023	.8417
C10	20.0789	33.1017	.4306	.4552	.8545
C11	20.4211	31.4936	.5633	.5032	.8404
C12	20.3158	31.9516	.6188	.5864	.8357
C13	20.3158	29.3030	.6533	.5902	.8295
C20	19.8684	27.7390	.7075	.5967	.8222
C21	19.7368	29.8748	.6461	.5403	.8305
C23	20.2368	29.2667	.6082	.4198	.8359

Table C.2: Reliability coefficients for scale Cost vs Benefit: $\alpha = .8542$, standardised item $\alpha = .8545$.

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
C14	5.4737	3.8777	.2647	.0807	.7153
C17	5.9474	4.4836	.4275	.3111	.4270
C22	6.3158	4.0597	.5140	.3439	.2978

Table C.3: Reliability coefficients for scale Denial: $\alpha = .5756$, standardised item $\alpha = .6081$.

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
C15	23.9118	20.4465	.2643	.3026	.8459
C16	24.4412	19.9510	.2594	.3958	.8538
C29	24.1471	18.6141	.6337	.5703	.7951
C30	24.0294	18.2112	.6689	.6674	.7899
C31	24.5000	17.3485	.7625	.7112	.7757
C32	24.0882	17.8405	.7607	.7370	.7788
C33	24.2059	17.5624	.8070	.7544	.7726
C36	24.2059	19.5018	.4444	.5794	.8191

Table C.4: Reliability coefficients for scale Concern/Attention: $\alpha = .8256$, standardised item $\alpha = .8429$.

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
C25	17.1429	25.0672	.6386	.6848	.8716
C26	17.2857	23.7983	.7288	.6262	.8596
C35	17.3429	25.8202	.5945	.6509	.8768
C40	16.9714	26.5580	.6155	.6531	.8736
C41	17.3714	25.5933	.7017	.5094	.8635
C42	17.4000	26.3059	.6976	.6199	.8651
C43	17.0000	24.2941	.7504	.7480	.8566

Table C.5: Reliability coefficients for scale Lifestyle/Energy: $\alpha = .8837$, standardised item $\alpha = .8852$.

Appendix D

Items for the revised version of the CFPI

Item	Content
	Treatment Value
C2	Decisions about my treatment must be made jointly by me and my doctors.
C4	When I do it properly, I believe that my treatment works well overall.
C5	Keeping exactly to my prescribed treatment is very important.
C6	I always have a clear understanding of what I am supposed to do with my medication and other treatments.
C22	When I have a goal to work towards I keep up with more of my CF treatment.
C30	When I feel supported or encouraged by people around me I keep up with more of my CF treatment.
C31	When I am in a good routine I keep up with more of my CF treatment.
	Cost vs Benefit
C7	I am prescribed too much medication.

Item	Content
C8	My treatment is too demanding on my time.
C9	Missing some doses of medication won't do me any harm.
C10	Taking my medication at the wrong time of day won't do me any harm.
C11	Missing my exercise or physio sometimes won't do me any harm.
C16	At times I genuinely forget to do some of my treatment.
C17	I need "time-out" from my CF treatment routine from time-to-time.
C19	Sometimes, the hassles involved with my treatment (e.g., effort/time/expense) outweigh the benefits.
	Denial
C12	I will beat CF.
C15	My treatment costs too much money.
C18	At times I try to forget that I have CF.
	Concern/Attention
C13	I would feel comfortable about telling my doctor if I was having trouble keeping up with all my treatments.
C14	I focus on the future more than what is happening right now.
C23	When I get home after a hospital admission I keep up with more of my normal CF treatment.
C24	When my lung function drops I keep up with more of my CF treatment.
C25	After a regular clinic visit I keep up with more of my CF treatment.
C26	When I feel worried about my CF I keep up with more of my CF treatment.
C27	When I feel positive about the future I keep up with more of my CF treatment.

Item	Content
C29	When I start a new treatment I keep up with more of my usual CF treatment.
	Lifestyle/Energy
C20	When I am on holidays I keep up with less of my CF treatment.
C21	When I feel down or depressed I keep up with less of my CF treatment.
C28	When I am pressured with work I keep up with less of my CF treatment.
C32	When I am tired I keep up with less of my CF treatment.
C33	When I don't feel any better after my treatment I keep up with less of my CF treatment.
C34	When I have problems or hassles in my family I keep up with less of my CF treatment.
C35	When I am busy in my social life I keep up with less of my CF treatment.

Appendix E

CFPI internal reliability tables (Study 3)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
C2	18.5652	3.2569	.3966	.3675	.5010
C4	18.5217	4.1700	.2663	.3461	.5539
C5	18.7391	4.2016	.1341	.1822	.6028
C6	18.5217	3.8972	.3146	.4402	.5367
C22	18.9565	3.9526	.2650	.2152	.5544
C30	19.0870	4.0830	.2792	.4290	.5495
C31	18.8261	3.6047	.4757	.4899	.4789

Table E.1: Reliability Coefficients for scale *Treatment Value*: $\alpha = .5801$, standardised item $\alpha = .5828$.

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
C7	17.6957	8.0395	.4704	.3904	.6545
C8	17.3043	7.1304	.7586	.6340	.5885
C9	17.3478	7.8735	.5263	.4110	.6425
C10	17.1304	7.3004	.6371	.5934	.6127
C11	17.2609	7.0198	.6267	.6357	.6096
C16	17.0000	11.0909	-.2782	.3572	.8054
C17	17.1739	9.0593	.1582	.3206	.7218
C19	17.5652	8.0751	.4569	.6654	.6573

Table E.2: Reliability coefficients for scale *Cost vs Benefit*: $\alpha = .7003$, standardised item $\alpha = .7085$.

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
C12	4.8261	2.5138	.6951	.5028	.7296
C15	5.1739	2.6047	.6141	.3777	.8103
C18	5.1304	2.3913	.7119	.5211	.7107

Table E.3: Reliability coefficients for scale *Denial*: $\alpha = .8194$, standardised item $\alpha = .8197$.

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
C13	18.9048	8.3905	.4150	.6140	.8469
C14	19.4762	8.1619	.6066	.6802	.8175
C23	19.2857	8.3143	.7069	.7914	.8085
C24	18.9048	9.0905	.3633	.6817	.8458
C25	19.3333	7.8333	.7174	.8566	.8028
C26	19.0476	8.3476	.5779	.8794	.8213
C27	19.2857	8.4143	.4453	.7045	.8405
C29	19.0952	7.7905	.8884	.8652	.7866

Table E.4: Reliability coefficients for scale *Concerns/Attention*: $\alpha = .8407$, standardised item $\alpha = .8519$.

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
C20	15.0000	9.3684	.7081	.6391	.8811
C21	15.2500	9.6711	.7829	.7539	.8699
C28	15.0000	9.6842	.7156	.6574	.8785
C32	15.1000	10.2000	.7658	.6921	.8737
C33	15.3000	11.1684	.6141	.3976	.8907
C34	15.4500	10.5763	.6018	.4563	.8910
C35	15.1000	9.8842	.7330	.6370	.8760

Table E.5: Reliability coefficients for scale *Lifestyle/Energy*: $\alpha = .8957$, standardised item $\alpha = .8982$.

Appendix F

Sample consent forms and information sheets

A sample of the standard RAH consent form used in Studies 2 and 3 is provided, along with a sample of the information sheets given out to participants in the two studies. A different standard protocol is used by the Alfred hospital. The substantive information directly relevant to the study (rather than to the institution) is the same however, and it was considered unnecessary to include a copy of Plain Language Statement given to participants there.

The sub-headings "Study 2" and "Study 3" are used to avoid confusion. These sub-headings were not used on the forms presented to participants in these studies.

CONSENT FORM—Study 2

PROTOCOL NAME: *Keeping up with Treatment: How do Adults with Cystic Fibrosis do it?*

SUPERVISORS: *Dr. Helen Winefield, PhD, Psychology Department, University of Adelaide.*
Dr. Hugh Greville, M.B.B.S., F.R.A.C.P., Department of Thoracic Medicine, RAH.

INVESTIGATOR: *Lisa Kettler, M.App.Psych., PhD student, Psychology Department, University of Adelaide.*

1. The nature and purpose of the study has been explained to me. I understand it and agree to take part.
2. I understand that I may not directly benefit from taking part in the study.
3. I understand that, while information gained from the study may be published, I will not be identified and my personal results will remain confidential.
4. I understand that my involvement in the study will not affect my medical care, now or in the future.
5. I have had the opportunity to discuss taking part in this investigation with a family member or friend.

Name of Subject: _____

Signed: _____

Dated: _____

I certify that I have explained the reason for the study to the patient/volunteer and consider that he/she understands what is involved.

Investigator: _____

INFORMATION SHEET—Study 2

PROTOCOL NAME: *Keeping up with Treatment: How do Adults with Cystic Fibrosis do it?*

SUPERVISORS: *Dr. Helen Winefield, PhD, Psychology Department, University of Adelaide.*
Dr. Hugh Greville, M.B.B.S., F.R.A.C.P., Department of Thoracic Medicine, RAH.

INVESTIGATOR: *Lisa Kettler, M.App.Psych., PhD student, Psychology Department, University of Adelaide.*

This is a research project and you do not have to be involved. If you do not wish to participate, your medical care will not be affected in any way.

Reason for the Study

In CF, where daily treatment is often important for every day **and** long-term health, health teams are concerned about how closely people follow the treatment programs designed for them. If researchers can understand how adults feel about their CF treatment and what they do to manage it, the information may be helpful in a number of ways.

- Health teams may be able to provide adults with CF with better support for their treatment.
- Health teams may be able to gain more accurate information about how well various treatments work.
- Better understanding may lead to more effective communication between adults with CF and their health teams about treatment issues.
- The overall goal of improving understanding about the way adults manage their CF treatment is to improve health outcomes for adults with CF.

As with any research project, there is no guarantee that this study will result in a direct benefit to you.

Procedure

This investigation will involve you completing some pen and paper questionnaires, probably while you are waiting for your usual CF clinic consultations. In the questionnaires you will be asked some general questions about yourself and your family along with questions about your CF and its treatment. You will be asked to complete the same questionnaires exactly two weeks later, so that we can make sure these questionnaires are reflecting your views correctly. We will give you a reminder telephone call about completing the second set of questionnaires and ask you to return them to us in a reply paid envelope.

If you agree to participate, your current weight, height and FEV1 will be recorded with your questionnaires in order to help us understand your current health status. **Your personal details will remain confidential and any information you give will be presented in such a way as to ensure that you are not identifiable from it.**

People you can talk to

You may speak with Lisa Kettler about this study, Dr. Helen Winefield can be contacted and Dr. Hugh Greville can be contacted on

If you wish to discuss aspects of the study with someone not directly involved, you may also contact the Chairman, Research Ethics Committee, Royal Adelaide Hospital

INFORMATION SHEET—Study 3

PROTOCOL NAME: *Keeping up with Treatment: How do Adults with Cystic Fibrosis do it?*

SUPERVISORS: *Dr. Helen Winefield, PhD, Psychology Department, University of Adelaide.*
Dr. Hugh Greville, M.B.B.S., F.R.A.C.P., Department of Thoracic Medicine, RAH.

INVESTIGATOR: *Lisa Kettler, M.App.Psych., PhD student, Psychology Department, University of Adelaide.*

This is a research project and you do not have to be involved. If you do not wish to participate, your medical care will not be affected in any way.

Reason for the Study

In CF, where daily treatment is often important for every day **and** long-term health, health teams are concerned about how closely people follow the treatment programs designed for them. If researchers can understand how adults feel about their CF treatment and what they do to manage it, the information may be helpful in a number of ways.

- Health teams may be able to provide adults with CF with better support for their treatment.
- Health teams may be able to gain more accurate information about how well various treatments work.
- Better understanding may lead to more effective communication between adults with CF and their health teams about treatment issues.
- The overall goal of improving understanding about the way adults manage their CF treatment is to improve health outcomes for adults with CF.

As with any research project, there is no guarantee that this study will result in a direct benefit to you.

Procedure

This investigation will have three parts.

Firstly, you will be asked to complete some pen and paper questionnaires, probably while you are waiting for your usual CF clinic consultations. In the questionnaires you will be asked some general questions about yourself and your family along with questions about your CF and its treatment.

Secondly, you will be asked to use a different pill bottle for your vitamins and a different nebuliser for your Pulmozyme over the next four months. This will allow us to keep track of how much of your prescribed vitamin therapy and Pulmozyme you are needing. At the end of the four months you will be asked to return your different vitamin container and nebuliser to us.

Thirdly, when you return your vitamin container and nebuliser, you will be asked to complete the same questionnaires as before, so that we can make sure these questionnaires are reflecting your views correctly.

If you agree to participate, your current weight, height and FEV1 will be recorded at the beginning and end of the study and at any outpatient visits you have during the four months of this study, in order to help us understand your current health status. We will also note when you attend your scheduled appointments and whether you have any inpatient stays during the time of the study.

Your personal details will remain confidential and any information you give will be presented in such a way as to ensure that you are not identifiable from it.

People you can talk to

You may speak with Lisa Kettler about this study, Dr. Helen Winefield can be contacted and Dr. Hugh Greville can be contacted on

If you wish to discuss aspects of the study with someone not directly involved, you may also contact the Chairman, Research Ethics Committee, Royal Adelaide Hospital

Appendix G

Instructions for participants in Study 3

Instructions for "Keeping up with Treatment" Project.

- Complete the questionnaires before you leave and give them to Lisa Kettler.
- Take home your assigned nebuliser pump and vitamin D container.
- Always use the assigned nebuliser pump when you take your Pulmozyme.
- Always take your Vitamin D tablet out of the assigned container just as you are about to take it.
- Only take one Vitamin D tablet from the container at a time. **Do not take out several doses at once and put them into different pill containers.**
- Do not throw out left over tablets at the end of the study.
- If you run out of Vitamin D tablets before the end of the study, please bring your special container and your prescription with you for the pharmacy to refill.
- Do not get your nebuliser pump or Vitamin D container wet.
- Do not drop your nebuliser pump or Vitamin D container.
- If you come into hospital for an admission during the study, please bring your special nebuliser pump and Vitamin D container with you and use them as normal.
- If your nebuliser pump stops working or gets broken, please contact Lisa Kettler (ph 0428 856 407) immediately.
- Return your nebuliser pump and Vitamin D container after three months.
- Complete the questionnaires.

Appendix H

Publication list

Publications

- Kettler, L.J., Sawyer, S.M., Winefield, H.R. and Greville, H.W. (2002) Determinants of Adherence in Adults with Cystic Fibrosis. *Thorax, 57*, 459–464.

Abstracts

- Kettler, L., Winefield, H., Greville, H. and Sawyer, S. (2002) Adherence to Pulmozyme and vitamins in adults with Cystic Fibrosis: do opinions about treatment matter?. Paper presented at the 25th Congress of the European Cystic fibrosis Society, Genoa, ITALY. *Journal of Cystic Fibrosis*, Suppl.1. WS2.6/P346, s39–s40.

- Kettler, L., Winefield, H., Sawyer, S. and Greville, H. (2001) Understanding adherence to treatment in adults with Cystic Fibrosis. Paper presented at the 15th Annual North American Cystic Fibrosis Conference, Orlando, Florida, USA. *Pediatric Pulmonology*, Suppl.22. A:519.

- Kettler, L., Winefield, H., Greville, H. and Sawyer, S. (2001) Understanding adherence to treatment in adults with Cystic Fibrosis. Paper presented at the 36th Annual Australian Psychological Society Conference, Adelaide, AUSTRALIA. *Australian Journal of Psychology* 153, 2001 Suppl., p 158.

- Kettler, L., Winefield, H., Sawyer, S. and Greville, H. (2001) Treatment perceptions and adherence in adults with Cystic Fibrosis. Paper presented at the 4th Australian and New Zealand Cystic Fibrosis Conference, Brisbane, AUSTRALIA.

- Kettler, L. and Winefield, H. (2000) Treatment adherence in adult cystic fibrosis: an Australian perspective. Paper presented at the 14th Conference of the European Health Psychology Society: Models of health and illness behaviour, Leiden, THE NETHERLANDS.

Bibliography

Abbott, J., Dodd, M., Bilton, D., & Webb, A. K. (1994). Treatment compliance in adults with cystic fibrosis. *Thorax, 49*, 115–120.

Abbott, J., Dodd, M., & Webb, A. K. (1995). Different perceptions of disease severity and self care between patients with cystic fibrosis, their close companions, and physician. *Thorax, 50*, 794–796.

Abbott, J., Dodd, M., & Webb, A. K. (1996). Health perceptions and treatment adherence in adults with cystic fibrosis. *Thorax, 51*, 1233–1238.

Abbott, J. & Gee, L. (1998). Contemporary psychosocial issues in cystic fibrosis: treatment adherence and quality of life. *Disability and Rehabilitation: an International Multidisciplinary Journal, 20*(6/7), 662–671.

Anthony, H., Collins, C. E., Davidson, G., Mews, C., Robinson, P., Shepherd, R., & Stapleton, D. (1999). Pancreatic enzyme replacement therapy in cystic fibrosis: Australian guidelines. *Journal of Paediatrics and Child Health, 35*, 125–129.

Azjen, I. (1988). *Attitudes, Personality and Behaviour*, chapter From Intentions to Actions, (pp. 112–145). Milton Keynes: Open University Press: Milton Press.

Bandura, A. (1986). *Social Foundation of Thought and Action: A Social Cognitive Theory.* Englewood Cliffs, NJ: Prentice-Hall.

Blair, C., Cull, A., & Freeman, C. P. (1994). Psychosocial functioning of young adults with cystic fibrosis and their families. *Thorax, 49*, 798–802.

Bohannon, N. J. & Jack, D. B. (1996). Type II diabetes: tips for managing your older patients. *Geriatrics, 51*(3), 28–35.

Campbell, D. T. & Fiske, D. W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological Bulletin, 56*(2), 81–105.

Chapman, K. R., Walker, L., Cluley, S., & Fabbri, L. (2000). Improving patient compliance with asthma therapy. *Respiratory Medicine, 94*, 2–9.

Chmielewski, S. A. (1995). Advances and strategies for glucose monitoring. *American Journal of Clinical Pathology, 4 Suppl 1*, 559–571.

Clark, D. M. (1989). Anxiety states: panic and generalized anxiety. In K. Hawton, P. M. Salkovskis, J. Kirk, & D. M. Clark (Eds.), *Cognitive Behaviour Therapy for Psychiatric Problems. A Practical Guide* (pp. 52–96). New York: Oxford University Press.

Cluss, P. A. & Epstein, L. H. (1985). The measurement of medical compliance in the treatment of disease. In P. Karoly (Ed.), *Measurement Strategies in Health Psychology* (pp. 403–432). New York: John Wiley and Sons.

Conway, S. P., Morton, A. M., Oldroyd, B., Truscott, J. G., White, H., Smith, A. H., & Haigh, I. (2000). Osteoporosis and osteopenia in adults and adolescents with cystic fibrosis: Prevalence and associated factors. *Thorax, 55*, 798–804.

Conway, S. P., Pond, M. N., Hamnett, T., & Watson, A. (1996). Compliance with treatment in adult patients with cystic fibrosis. *Thorax, 51*, 29–33.

Conway, S. P., Pond, M. N., Watson, A., & Hamnett, T. (1996). Knowledge of adult patients with cystic fibrosis about their illness. *Thorax, 51*, 34–38.

Czajkowski, D. R. & Koocher, G. P. (1987). Medical compliance and coping with cystic fibrosis. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 28*(2), 311–319.

Dapiran, E. (2000). Patterns of medication use in patients with cystic fibrosis. Unpublished thesis for degree of bachelor of medical science, Department of Medicine, University of Melbourne, Melbourne, Australia.

Davis, P. B. (1999). Clinical pathophysiology and manifestations of lung disease. In J. R. Yankaskas & M. R. Knowles (Eds.), *Cystic Fibrosis in Adults* (pp. 45–67). Philadelphia: Lippincott-Raven.

Eisenberg, J. D., Aitken, M. L., Dorkin, H. L., Harwood, I. R., Ramsey, B. W., Schidlow, D. V., Wilmott, R. W., Wohl, M. E., Fuchs, H. J., Christiansen, D. H., & Smith, A. L. (1997). Safety of repeated intermittent courses of aerosolized recombinant human deoxyribonuclease in patients with cystic fibrosis. *Journal of Pediatrics, 131*, 118–124.

Elborn, S. (1998). The management of young adults with cystic fibrosis: 'genes, jeans and genies'. *Disability and Rehabilitation: an International Multidisciplinary Journal, 20*(6/7), 217–225.

Epstein, L. H. (1984). The direct effects of compliance on health outcome. *Health Psychology, 3*, 385–393.

Epstein, L. H. & Cluss, P. A. (1982). A behavioural medicine perspective on adherence to long-term medical regimens. *Journal of Consulting and Clinical Psychology, 50*(6), 950–971.

Fehrenbach, A. M. B. & Peterson, L. (1989). Parental problem solving skills, stress and dietary compliance in phenylketonuria. *Journal of Consulting and Clinical Psychology, 57*, 237–241.

Geddes, D. (2002). Segregation—cons. *Journal of Cystic Fibrosis, 1*(Suppl 1), PS3.2.

Gong, H., Simmons, M. S., Clark, V. A., & Tashkin, D. P. (1988). Metered-dose inhaler usage in subjects with asthma: comparison of nebulizer chronolog and daily diary recordings. *Journal of Allergy and Clinical Immunology, 82*(1), 5–10.

Gordis, L. (1976). Methodological issues in the measurement of patient compliance. In D. L. Sackett & R. B. Haynes (Eds.), *Compliance with Therapeutic Regimens*. Baltimore: Johns Hopkins University Press.

Gordis, L. (1979). Conceptual and methodologic problems in measuring patient compliance. In R. B. Haynes, D. W. Taylor, & D. L. Sackett (Eds.), *Compliance in Health Care* (pp. 23–45). Baltimore: The Johns Hopkins University Press.

Gudas, L. J., Koocher, G. P., & Wypji, D. (1991). Perceptions of medical compliance in children and adolescents with cystic fibrosis. *Journal of Developmental and Behavioral Pediatrics, 12*, 236–242.

Haynes, R. B., McKibbon, K. A., & Kanani, R. (1996). Systematic review of randomised trials of interventions to assist patients to follow prescriptions for medications. *Lancet, 348*, 383–386.

Haynes, R. B., Taylor, D. W., Sackett, D. L., Gibson, E. S., Bernholtz, C. D., & Mukherjee, J. (1980). Can simple measures detect patient noncompliance? *Hypertension, 2*, 757–764.

Haynes, R. B., Wang, E., & Gomes, M. D. M. (1987). A critical review of interventions to improve compliance with prescribed medications. *Patient Education and Counselling, 10*, 155–166.

Henley, L. D. & Hill, I. D. (1990). Errors, gaps, and misconceptions in the disease-related knowledge of cystic fibrosis patients and their families. *Pediatrics, 85*(6), 1008–1013.

Hodson, M. E. (1995). Adults. In M. E. Hodson & D. M. Geddes (Eds.), *Cystic Fibrosis* (pp. 237–257). London: Chapman and Hall Medical.

Horne, R. (1997). Representations of medication and treatment: Advances in theory and measurement. In K. J. Petrie & J. A. Weinman (Eds.), *Perceptions of Health and Illness. Current Research and Applications* (pp. 155–188). Amsterdam: Harwood Academic Publishers.

Horne, R. (2000). Assessing perceptions of medications: psychological perspectives. In H. McGavock (Ed.), *Handbook of Drug Research Methodology* (pp. 299–319). Newcastle-Upon-Tyne: United Kingdom Drug Utilisation Research Group.

Horne, R. & Weinman, J. (1999). Patients' beliefs about prescribed medicines and their role in adherence to treatment in chronic physical illness. *Journal of Psychosomatic Research, 47*(6), 555–567.

Horne, R. & Weinman, J. (2002). Self-regulation and self-management in asthma: Exploring the role of illness perceptions and treatment beliefs in explaining non-adherence to preventer medication. *Psychology and Health, 17*, 17–32.

Horne, R., Weinman, J., & Hankins, M. (1998). The beliefs about medicines questionnaire (BMQ): The development and evaluation of a new method for assessing the cognitive representation of medication. *Psychology and Health, 14*, 1–24.

Horowitz, R. I., Viscoli, C. M., Berkman, L., Donaldson, R. M., Horowitz, S. M., Murray, C. J., Ransohoff, D. F., & Sindelar, J. (1990). Treatment adherence and risk of death after a myocardial infarction. *Lancet, 336*, 542–545.

Ievers, C. E., Brown, R. T., Drotar, D., Caplan, D., Pishevar, B., & Lambert, R. G. (1999). Knowledge of physician prescriptions and adherence to treatment among children with cystic fibrosis and their mothers. *Journal of Developmental and Behavioral Pediatrics, 20*(5), 335–343.

Kerem, B. S., Rommens, J. M., Buchanan, J. A., Markiewicz, D., Cox, T. K., Chakravarti, A., Buchwald, M., & Tsui, L. C. (1989). Identification of the cystic fibrosis gene: genetic analysis. *Science, 245*, 1073–1080.

Koocher, G. P., McGrath, M. L., & Gudas, L. J. (1990). Typologies of non-adherence in cystic fibrosis. *Journal of Developmental and Behavioral Pediatrics, 11*, 353–358.

Landau, L. I. (1995). Cystic fibrosis: transition from paediatric to adult physician's care. *Thorax, 50*, 1031–1032.

Lanng, S. (2001). Cystic fibrosis related diabetes mellitus. In *Book of Abstracts; Fourth Australian and New Zealand Cystic Fibrosis Conference*, Brisbane Australia. Cystic Fibrosis Australia.

Lask, B. (1994). Non-adherence to treatment in cystic fibrosis. *Journal of the Royal Society of Medicine, 87 Suppl 21*, 25–27.

Lask, B. (1997). Understanding and managing poor adherence in cystic fibrosis. *Pediatric Pulmonology, Suppl 16*, 260–261.

Leventhal, H., Diefenbach, M., & Leventhal, E. A. (1992). Illness cognition: Using common sense to understand treatment adherence and affect cognition interactions. *Cognitive Therapy and Research, 16*, 143–163.

Leventhal, H., Nerenz, D. R., & Steele, D. J. (1984). Illness representations and coping with health threats. In A. Baum, S. E. Taylor, & J. E. Singer (Eds.), *Handbook of Psychology and Health, Volume IV: Social Psychological Aspects of Health* (pp. 219–252). Hillsdale, N. J.: Erlbaum.

Lewis, P. A. (2000). The epidemiology of cystic fibrosis. In M. E. Hodson & D. M. Geddes (Eds.), *Cystic Fibrosis* (pp. 13–25). London: Arnold Publishers.

Ley, P. (1982). Satisfaction, compliance and communication. *British Journal of Clinical Psychology, 21*, 241–254.

Ley, P. (1983). Patients' understanding and recall in clinical communication failure. In D. Pendleton & J. Hasler (Eds.), *Doctor-Patient Communication*. London: Academic Press.

McCubbin, H., McCubbin, M., Patterson, J., Cauble, A. E., Wilson, L., & Warwick, W. (1983). CHIP—coping health inventory for parents: An assessment of parental coping patterns in the care of the chronically ill child. *Journal of Marriage and the Family, 45*, 359–370.

McKelvey, J., Waller, D. A., Stewart, S. M., Kennard, B. D., North, A. J., & Chipman, J. J. (1989). Family support for diabetes: A pilot study for measuring disease-specific behaviors. *Children's Health Care, 18*, 37–41.

McQuitty, L. L. (1961). Elementary factor analysis. *Psychological Reports, 9*, 71.

Meichenbaum, D. & Turk, D. C. (1987). Treatment adherence: terminology, incidence and conceptualization. In *Facilitating Treatment Adherence* (pp. 19–39). Plenum Press.

Meyers, A., Dolan, T. F., & Mueller, D. (1975). Compliance and self-medication in cystic fibrosis. *American Journal of Diseases of Children, 129*, 1011–1013.

Moise, J., Drotar, D., Doershuk, C., & Stern, R. (1987). Correlates of psychosocial adjustment among young adults with cystic fibrosis. *Journal of Developmental and Behavioral Pediatrics, 8*, 141–148.

Moos, R. H. & Moos, B. S. (1994). *Family Environment Scale Manual* (Third ed.). Palo Alto, CA: Consulting Psychologists Press Inc.

Morisky, D. E., Green, L. W., & Levine, D. M. (1986). Concurrent and predictive validity of a self-reported measure of medication adherence. *Medical Care, 24*, 67–74.

Nunally, J. C. & Bernstein, I. R. (1994). *Psychometric Theory* (3rd Edition ed.). New York: McGraw-Hill.

Oppenheim, A. N. (1992). *Questionnaire Design, Interviewing and Attitude Measurement.* London: St. Martins Press.

Pagano, R. R. (1986). *Understanding Statistics in the Behavioural Sciences* (Second ed.)., chapter Power, (pp. 199–214). West Publishing Company.

Parcel, G. S., Swank, P. R., Mariotto, M. J., Bartholomew, L. K., Czyzewski, D. I., Sockrider, M. M., & Seilheimer, D. K. (1994). Self-management of cystic fibrosis: a structural model for educational and behavioural variables. *Social Science and Medicine, 38*(9), 1307–1315.

Patterson, J. M. (1985). Critical factors affecting family compliance with home treatment for children with cystic fibrosis. *Family Relations*, *34*, 79–89.

Patterson, J. M., Budd, J., Goetz, D., & Warwick, W. (1993). Family correlates of a 10 year pulmonary health trend in cystic fibrosis. *Pediatrics*, *91*(2), 383–389.

Patterson, J. M., McCubbin, H. I., & Warwick, W. J. (1990). The impact of family functioning on health changes in children with cystic fibrosis. *Social Science and Medicine*, *31*, 291–301.

Pendleton, D. A. & David, T. J. (2000). The compliance conundrum in cystic fibrosis. *Journal of the Royal Society of Medicine*, *93*(Suppl. 38), 9–13.

Petrie, K. J. & Weinman, J. A. (1997). Perceptions of health and illness. In K. J. Petrie & J. A. Weinman (Eds.), *Perceptions of Health and Illness. Current Research and Applications* (pp. 1–19). Amsterdam: Harwood Academic Publishers.

Phelan, P. D., Olinsky, A., & Robertson, C. F. (1994). Cystic fibrosis. In P. D. Phelan, A. Olinsky, & C. F. Robertson (Eds.), *Respiratory Illness in Children* (pp. 207–251). London: Blackwell Scientific Publishing.

Quittner, A. L., Buu, A., Watrous, M., & Davis, M. A. (2000). *CFQ: Cystic Fibrosis Questionnaire: a Health Related Quality of Life Measure. User Manual* (Version 1 ed.). Florida: USA: University of Florida and Genentech.

Quittner, A. L., Drotar, D., Ievers-Landis, C., Seidner, D., Slocum, N., & Jacobsen, J. (2000). Adherence to medical treatments in adolescents with cystic fibrosis: the development and evaluation of family-based interventions. In D. Drotar (Ed.), *Promoting Adherence to Medical Treatment in Chronic Childhood Illness: Concepts, Methods and Interventions*. Mahwah, N. J.; London: Lawrence Erlbaum Associates.

Quittner, A. L., Espelage, D. L., Ievers-Landis, C., & Drotar, D. (2000). Measuring adherence to medical treatments in childhood chronic illness: Considering multiple methods and sources of information. *Journal of Clinical Psychology in Medical Settings*, *7*, 41–54.

Quittner, A. L., Tolbert, V. E., Regoli, M. J., Orenstein, D. M., Hollingsworth, J. L., & Eigen, H. (1996). Development of the role-play inventory of situations and coping strategies for parents of children with cystic fibrosis. *Journal of Pediatric Psychology, 21*(2), 209–235.

Rand, C. S., Nides, M., Cowles, M. K., Wise, R. A., & Connett, J. (1995). Long-term metered-dose inhaler adherence in a clinical trial. *American Journal of Respiratory and Critical Care Medicine, 152*, 580–588.

Rand, C. S. & Wise, R. A. (1994). Measuring adherence to asthma medication regimens. *American Journal of Respiratory and Critical Care Medicine, 149*, S69–76.

Rand, C. S., Wise, R. A., Nides, M., Simmons, M. S., Bleecker, E. R., Kusek, J. W., Li, V. C., & Tashkin, D. P. (1992). Metered-dose inhaler adherence in a clinical trial. *American Review of Respiratory Diseases, 146*, 1559–1564.

Rapoff, M. A. (1999). *Adherence to Pediatric Medical Regimens.* New York: Kluwer Academic/Plenum.

Rosenstock, I. M. (1974). Historical origins of the health belief model. *Health Education Monographs, 2*, 328–335.

Rotter, J. B. (1954). *Social Learning and Clinical Psychology.* Englewood Cliffs, NJ.: Prentice-Hall.

Sackett, D. L. & Snow, J. C. (1979). The magnitude of compliance and non-compliance. In R. B. Haynes, D. W. Taylor, & D. L. Sackett (Eds.), *Compliance in Health Care* (pp. 11–22). Baltimore: The Johns Hopkins University Press.

Sawyer, S. M. (2000). Reproductive and sexual health. In M. E. Hodson & D. M. Geddes (Eds.), *Cystic Fibrosis* (pp. 301–312). London: Arnold Publishers.

Sawyer, S. M., Blair, S., & Bowes, G. (1997). Chronic illness in adolescents—transfer or transition to adult services? *Journal of Paediatrics and Child Health, 33*, 88–90.

Sawyer, S. M. & Dapiran, E. (2001). Patterns of adherence with pulmozyme in CF. *Respiratory and Critical Care Medicine, 163*, A639.

Sharp, C., McNeil, R., Wales, S., Cooper, P., & Dawson, K. (1994). Young adults with cystic fibrosis: Social well-being and attitudes. *Australian Nurses Journal, 2*(4), 38–40.

Shepherd, S. L., Hovell, M. L., Harwood, I. R., Granger, L. E., Hofstetter, C. R., Molgaard, C., & Kaplan, R. M. (1990). A comparative study of the psychosocial assets of adults with cystic fibrosis and their healthy peers. *Chest, 97*(6), 1310–1316.

Spector, S. L., Kinsman, R., Mawhinney, H., Siegel, S. C., Rachelefsky, G. S., Katz, R. M., & Rohr, A. S. (1986). Compliance of patients with asthma with an experimental aerosolized medication: implications for controlled clinical trials. *Journal of Allergy and Clinical Immunology, 77*(1), 65–70.

Stapleton, D. R., Anthony, H., Collins, C. E., Powell, E. B., & King, S. J. (1999). Clinical practice guidelines: Implementing the australian pancreatic enzyme replacement therapy guidelines for cystic fibrosis. *Australian Journal of Nutrition and Dietetics, 56*, 91–96.

Starr, M., Sawyer, S. M., Carlin, J. B., Powell, C. V. E., Newman, R. G., & Johnson, P. D. R. (1999). A novel approach to monitoring adherence to preventive therapy for tuberculosis in adolescence. *Journal of Paediatrics and Child Health, 35*, 350–354.

Strauss, G. & Wellisch, D. (1981). Psychosocial adaptation in older cystic fibrosis patients. *Journal of Chronic Diseases, 34*, 141–146.

Swinburne, L. M. (1993). Non-compliance or rational decision. *The Lancet, 342*, 1427.

Thompson, S. M., Dahlquist, L. M., Koenning, G. M., & Bartholomew, L. K. (1995). Brief report: Adherence-facilitating behaviours of a multidisciplinary pediatric rheumatology staff. *Journal of Pediatric Psychology, 20*(3), 291–297.

Wagner, G. J. & Ghosh-Dastidar, B. (2002). Electronic monitoring: Adherence assessment or intervention? *HIV Clinical Trials, 3*(1), 45–51.

Wallston, B. S. & Wallston, K. A. (1978). Locus of control and health: a review of the literature. *Health Education Monographs*, *6*(2), 107–117.

Weinman, J., Petrie, K., Moss-Morris, R., & Horne, R. (1996). The illness perception questionnaire: a new method for assessing the cognitive representation of illness. *Psychology and Health*, *11*, 431–445.

Wright, E. C. (1993). Non-compliance—or how many aunts has Matilda? *The Lancet*, *342*, 909–913.