CHANGE IN PATIENT-REPORTED OUTCOMES

AFTER CARDIOVERTER-DEFIBRILLATOR IMPLANTATION

by

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Abstract

Some people, because they have a genetic predisposition or heart disease, are at high risk for cardiac arrhythmias that could cause their hearts to stop. The implantable cardioverter-defibrillator (ICD) is an effective therapy that recognises abnormal heart beats, can administer an electrical shock to stop a potentially lethal heart rhythm, and affords protection from the devastating consequences of sudden cardiac arrest. Patient-reported outcomes (PROs) are assessments provided directly by patients about various aspects of their health and quality of life. We sought to study the change in PROs after ICD implantation to identify people's patterns of change, explore individual trajectories of change, and identify predictors of differences in individuals' trajectories.

The study was grounded in the Wilson and Cleary (1995) conceptual framework of quality of life and informed by the Patient-Reported Outcomes Measurement Information System domain framework. Using a prospective, longitudinal study design, data were obtained from 171 people undergoing ICD implantation at quaternary centres in British Columbia, Canada (55.5% response rate). PRO assessments were obtained immediately before implantation and at one, two, and six months following implantation. We employed individual growth modelling to analyse change within and between people.

The participants had different physical, mental, and social health status PROs at baseline and, on average, demonstrated improvement. At most of the measurement occasions, the participants' PROs remained poorer than those of average adult, urban-dwelling Canadians. There was significant individual variability in most of the trajectories, especially in the social functioning domains. Relative to men, women reported worse PROs initially (the relative mean difference in men's and women's scores ranged from 4.5% to 24.7% for 6 of the 12 indicators).

Yet, the women's rates of improvement were significantly faster than those of men. Women equalled or exceeded the men's PROs at the six-month assessment (the relative mean difference ranged from 4.5% to 10.4%, depending on the PRO).

Further research is needed to explore the individual change trajectories identified in this study, especially for those patients who did not improve over time, fully test the conceptual model that framed the research, and evaluate interventions aimed at improving PROs after ICD implantation.

Preface

The research project conducted in this study received approval from the University of Bristish Columbia – Providence Health Care Research Ethics Board (Certificate number: H09-00920).

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List of Abbreviations

ACC	American College of Cardiology
AHA	American Heart Association
AIC	Akaike information criterion
ARVD	Arrhythmogenic Right Ventricular Dysplasia
ATP	Antitachycardia pacing
CABG-Patch	Coronary Artery Bypass Graft Patch Trial
CAD	Coronary artery disease
CAT	Computerised adaptive testing
CCS	Canadian Cardiovascular Society
CEID	Cardiovascular electronic implantable device
CHF	Congestive heart failure
CHRS	Canadian Heart Rhythm Society
CHQ	Chronic Heart Failure Questionnaire
CID	Clinically important difference
COMPANION	Comparison of Medical Therapy, Pacing, and Defibrillation in Heart Failure
CPR	Cardio-pulmonary resuscitation
CRT	Cardiac resynchronisation therapy
df	Degree of freedom
DHHS	Department of Human and Health Services
DIF	Differential item functioning
DINAMIT	Defibrillators in Nonischemic Cardiomyopathy Treatment Evaluation
EF	Ejection fraction
EFM	Enterprise Feedback Management
EMEA	European Medicines Agency
EP	Electrophysiology
ERIQA	European Regulatory Issues on Quality of Life Assessment Group
FDA	Food and Drug Administration
FHA	Fraser Health Authority
FPAS	Florida Patient Acceptance Survey
FSAS	Florida Shock Anxiety Scale
Heart-HELD	Heart and Health Experiences Living with a Defibrillator
HIE	Health Information Exchange
HRQL	Health-related quality of life
HRQOL	Health-related quality of life
HRS	Heart Rhythm Society
ICD	Implantable cardioverter-defibrillator
IBM®	International Business Machines
IHA	Interior Health Authority
IRT	Item response theory

ISOQOL	International Society for Quality of Life Research
ISPOR	International Society for Pharmaeconomics and Outcomes Research
LVEF	Left ventricular ejection fraction
MADIT	Multicenter Automatic Defibrillator Implantation Trial
MCID	Minimal clinically important difference
MeSH	Medical subject headings
MID	Minimal important difference
MOS	Medical Outcomes Study
MVA	Missing values analysis
MUSTT	Multicenter Unsustained Tachycardia Trial
NHA	Northern Health Authority
NHS	National Health Service
NNT	Number needed to treat
NYHA	New York Heart Association
PASW®	Predictive Analytics Software
PHC	Providence Health Care
PROMIS	Patient-Reported Outcomes Measurement Information System
QOL	Quality of life
RCH	Royal Columbian Hospital
SCD-HeFT	Sudden cardiac Death in Heart Failure Trial
SD	Standard deviation
SF-36V2	Short Form-36 Version 2
SPH	St. Paul's Hospital
SPSS®	Statistical Package for Social Sciences
T0	Time 0 – Baseline
T1	Time 1 – 1 month post implantation
T2	Time 2 – 2 months post implantation
T3	Time 3 – 6 months post implantation
VCH	Vancouver Coastal Health
VIHA	Vancouver Island Health Authority
VF	Ventricular fibrillation
VGH	Vancouver General Hospital
VT	Ventricular tachycardia

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1. Introduction

1.1. The Implantable Cardioverter-Defibrillator: A Life-Saving Therapy

Since their introduction in the early 1980s, implantable cardioverter defibrillators (ICDs) have evolved from rudimentary and cumbersome devices with uncertain efficacy and limited use to effective life-saving therapy (Dorian et al., 2005). The first ICD was conceptualised in the 1960s by Dr. Michael Mirowski whose professional mentor died of ventricular arrhythmia. Despite considerable opposition from the medical community, Dr. Mirowski led a team of researchers to design the first device implanted in a human via surgical thoracotomy in 1980. The American Food and Drug Administration approved ICDs for treatment of ventricular fibrillation in 1985 (Sola & Bostwick, 2005).

Today's ICD is a small electronic device that measures approximately 5 cm in length and width, and less than 2 cm in depth. It is surgically permanently implanted in a pocket beneath the skin of the anterior aspect of the shoulder, and attached to an electrical lead or system of leads that are placed in the right ventricle of the heart or in direct contact with other cardiac tissues (Sowell, Kuhl, Sears, Klodell, & Conti, 2006).[1] The role of the ICD is to constantly monitor the heart's electrical conduction or rhythm, to accurately recognise unpredictable and sudden abnormal fast rhythms coming from the heart's lower chambers, which could cause cardiac arrest,[2] and to reliably terminate these life-threatening arrhythmias with pacing or high-energy shocks to restore a life-sustaining heart rhythm (Aliot, Nitzsche, & Ripart, 2004; Dorian et al., 2005).

[1] A pacemaker or ICD lead is an electrical wire that conducts monitoring information from the heart muscle to the device, and can transmit an electrical pulse or charge from the device to the heart muscle.
[2] These abnormal heart rhythms are categorised as ventricular arrhythmias. Ventricular refers to the right and left ventricles, the lower or bottom chambers of the heart.

Unlike medications taken daily to increase the heart's pumping capacity, or procedures such as percutaneous coronary intervention, which increase coronary perfusion and alleviate symptoms of coronary artery disease, the ICD is not aimed at improving day-to-day physiological functioning or reducing the burden of symptoms. The ICD is a safety device that provides rapid access to cardiac resuscitation, akin to having an "ambulance in the chest". People may or may not experience any ICD shocks in their lifetime, but they are provided with some degree of "life insurance" against ventricular arrhythmias if and when it may be needed.

ICD therapy is a "prophylactic" intervention designed to prevent the potentially fatal consequences of ventricular arrhythmias, including ventricular tachycardia (VT) and ventricular fibrillation (VF),[3] in high risk patients. The evidence supporting ICD implantation categorises the indications as either "primary" or "secondary" prevention based on the patient's past arrhythmic history and underlying cardiac disease. The adoption of ICD therapy as a standard of care is based on two separate waves of trials that addressed these two different sets of clinical indications.

The early ICD clinical trials have become known as the "secondary prevention" trials because eligible subjects were either survivors of an arrhythmia-related cardiac arrest, had a history of sustained ventricular tachycardia, or experienced syncope associated with sustained ventricular tachycardia, and were considered to be at very high risk of sudden cardiac arrest. Comparing the efficacy of optimal medical therapy and ICDs, the pivotal trials included the

[3] Ventricular tachycardia (VT) is a fast heart rhythm that occurs in one of the ventricles. It is akin to an electrical short circuit that races in a circle, causing the heart to beat at rates of 150 to 250 cycles per minute. As the heart beats faster, it pumps less blood, decreasing the filling time and reducing the cardiac output available to the organs and tissues. Ventricular fibrillation (VF) originates from many different locations in the ventricles, each one trying to signal the heart to beat. In VF, the ventricles quiver instead of contracting, and very little, if any, blood is pumped from the heart to the rest of the body. With this loss of circulation and organ perfusion, people usually become unconscious very quickly, and the heart may stop beating due to a lack of coronary artery circulation (Woods, Froelicher, Motzer, & Bridges, 2010).

Antiarrhythmics Versus Implantable Defibrillators (AVID) study (AVID investigators, 1997), the Canadian Implantable Defibrillator Study (CIDS) (Connolly et al., 2000), and the Cardiac Arrest Study Hamburg (CASH) (Kuck, Cappato, Siebels, & Ruppel, 2000). These pioneering trials demonstrated a significant reduction in mortality (Connolly, Hallstrom et al., 2000). In 2002, the American College of Cardiology (ACC)/American Heart Association (AHA)/North American Society of Pacing and Electrophysiology (NASPE) guidelines allotted a Class I (Level of Evidence: A) recommendation, the highest level of evidence, that patients in this "secondary prophylaxis" category receive an ICD as first-line therapy and standard of care (Gregoratos, 2002). The Canadian Working Group on Cardiac Pacing reached the same consensus in 2003 (Gillis et al., 2003), which was further accepted by the Canadian Cardiovascular Society in 2005 (Tang et al., 2005). Since the publication of the initial trials and the consensus documents, clinicians and health policy makers have accepted ICD treatment as first-line therapy for patients with a prior history of sustained life-threatening ventricular arrhythmia not due to a reversible cause and perceived to be at high risk of recurrence.

Patients who survive a cardiac arrest represent only a small proportion of the population at risk for lethal arrhythmias (Huikuri, Castellanos, & Myerburg, 2001). More recent studies demonstrated that many patients with heart disease and with no prior history of ventricular arrhythmias are at high risk of sudden cardiac arrest and could potentially benefit from ICD therapy for "primary prophylaxis". Although there is no single variable or cluster of variables that accurately predict the probability of developing a life-threatening arrhythmia and the timing of its occurrence, the most well-established predictor of sudden cardiac arrest is the impaired capacity of the heart, measured by the left ventricle ejection fraction (LVEF),[4] to effectively and

[4] The left ventricular ejection fraction (LVEF) refers to the percentage of blood volume in the left ventricle ejected with each cardiac contraction, which normally ranges between 60 and 70% (Dorian, Talajic, & Tang, 2005).

adequately pump blood to the tissues. Patients with moderate LVEF dysfunction (< 35%) who receive optimal medical therapy have a 25% risk of premature sudden cardiac arrest over 2.5 years from the onset of heart failure, with 50% of these deaths associated with potentially preventable arrhythmias (Anderson & Bardy, 2006). Multiple clinical trials have supported ICD therapy for primary prophylaxis, including the Multicenter Automatic Defibrillator Implantation Trial II (MADIT-II) (Moss et al., 2002), the Comparison of Medical Therapy, Pacing and Defibrillation in Chronic Heart Failure (COMPANION) (Bristow, Feldman, & Saxon, 2000), the Defibrillators in Non-Ischemic Cardiomyopathy Treatment Evaluation (DEFINITE) (Kadish et al., 2004), and the Sudden Cardiac Death in Heart Failure (SCD-HeFT) trial (Bardy et al., 2005).

The ACC/AHA/Heart Rhythm Society (HRS) guidelines published in 2008 recommend that patients who have survived a prior cardiac arrest, have a history of ventricular tachycardia or fibrillation, have an impaired left ventricular ejection fraction less than 35%, or are at high risk for sudden cardiac arrest due to a congenital heart defect be considered for ICD implantation (Epstein et al., 2008).

1.2. Living with an Implantable Cardioverter-Defibrillator

The ICD saves lives. The decision to consent to an ICD involves the assessment of risk and potential benefit, and the consideration that the device may unpredictably treat a ventricular arrhythmia with a shock, or may never deliver any electrical therapy during a patient's lifetime (Exner, 2002).

Unlike standard pharmacological treatment, the ICD is visible and palpable under the skin, requires regular electronic monitoring, and necessitates surgical replacement every five to ten years because of battery depletion. Furthermore, the innovative and technological nature of the device is associated with device or lead manufacturers' advisories leading to additional

monitoring or surgery, inappropriate shock treatment, restrictions to travel because of the need for electronic monitoring equipment, limitations on proximity to electromagnetic fields, and daily reminders of the presence and impact of the ICD in the individual's life (Daubert et al., 2008). Despite increased tolerability, experiencing an ICD shock is generally reported to be a frightening and painful experience. People speak of being "kicked by a mule in the chest from the inside" and living with the uncertainty and fear of being "whacked by the whacker" (Sola & Bostwick, 2005, p. 232). ICDs allow people to live longer. Nevertheless, patients who require an ICD must adapt to living with a unique and complex life-saving treatment.

Patient-reported outcomes (PROs) directly measure patients' experiences of treatment, dimensions not fully captured by clinician-reported outcomes such as morbidity and mortality, and complement the information typically gained from the history, physical assessment, and diagnostic findings (Acquadro et al., 2003; Cella et al., 2010). PROs are historically grounded in the study of quality of life and the development of measures of health-related quality of life, and aim to report the impact of disease and treatment on people's daily lives, including their physical, mental, and social health. The measurement of PROs allows us to understand whether, from the affected person's perspective, ICDs influence people's capacity to live well – their quality of life.

The recommendation for an ICD implantation is a milestone in the progression of multiple cardiac conditions because it signifies that the risk of sudden cardiac death is excessively high, and warrants a permanent safety device. The ICD does not offer a cure for the underlying heart disease responsible for people's vulnerability to ventricular arrhythmias. Recipients must learn to live with an ICD, most often for the rest of their lives. The following

stories, compiled from encounters in clinical practice, illustrate some of the challenges that people face at the time they are scheduled to receive an ICD.

> Naomi is a 35-year old pharmacist and mother of two young children. She and her family live in a small community in the south-west corner of British Columbia, about ten hour from Vancouver by car. Her father died of cardiac arrest when she was young, and her brother collapsed and died during a soccer game two years ago. Genetic testing and electrophysiology studies confirmed that she carries the gene that caused the deaths of her relatives. She decided to undergo ICD implantation to protect herself from ventricular arrhythmias. She made arrangements for the children to stay with neighbours while she and her husband travelled to Vancouver for her surgery. She's worried about not being able to lift her youngest child because he weighs more than the maximum 10-pound load her electrophysiologist advised that she could lift once she had an ICD. She is not sure what she will do about the groceries, the laundry, or the day-to-day housekeeping. She's also worried about how she will look after the surgery; her doctor showed her and her husband pictures of how the ICD will look under the skin, just below her collar bone. There will be the regularly scheduled travel to Vancouver to see her specialist. She wonders what it will like if the ICD ever shocks her, especially if the children are present.
>
> Enzo emigrated from Italy in the 1960s, settled in Vancouver, married Clara, and had four children. He did well in the construction business and retired ten years ago. In 2008, he had a large heart attack. His heart was badly damaged and is now pumping at less than half its normal capacity. He often feels short of breath, does not walk easily, and must take medications. Clara does most of the chores around the house, and he worries about how tired she has been lately. He decided to get an ICD because the doctors told him that his heart could have a "short circuit" and stop beating. He was too worried to ask questions while meeting with the doctor, and Clara told him she really wanted him to have the surgery.
>
> Dave used to work for the government. For years, he played hockey with friends from work, and enjoyed "hanging out" with them. After his divorce, he continued to coach his son's baseball team; they went to the provincial championship. Although he didn't see his children every day, they stayed close; he was so proud to see them off to university. He never knew he had heart disease. His doctor told him that his blood pressure was high, and that he should cut back on smoking, the beers with his friends, and his dinners at the neighbourhood restaurant. A few weeks before his 70th birthday, he was heading out to play golf. He collapsed in a parking lot. At the hospital, he was told that he was lucky that someone did CPR right away. After his emergency bypass surgery, his heart stopped again. Now he needs an ICD.
>
> When Harvinder had an electrocardiogram before elective surgery to repair his damaged elbow, he was sent to see a specialist who ordered more tests. He never knew that one of his heart valves was badly damaged, and that this caused his heart to enlarge over time. The Holter monitorshowed that the palpitations and dizzy spells he had been having for

the past year were actually abnormal beats coming from the bottom of his heart.[5] He needed an ICD. His doctor told him that he was not sure whether Harvinder could continue to work as a cable installer for a telephone company because of the interference of the electromagnetic field on the ICD programming. He was also told that he would not be able to drive for six months after his surgery because of what the Holter monitor showed. If the ICD ever shocked him, he would lose his licence for another six months. As a contractor, he didn't have long-term benefits. He did not know how he was going to be able to hold a job. He understood that the ICD could save him, but he worried about what it would mean for his life as he knew it.

1.3. Purpose and Significance of the Study

The aim of our research was to study the change in PROs following ICD implantation to describe the presence and direction of group level change, to identify variation in individual level change, and to test whether variables, selected on theoretical grounds, could predict membership in individual trajectories.

This study of the change in PROs after the implantation of an ICD stems from discussions held with patients, nurses, and electrophysiologists at St. Paul's Hospital Heart Centre, a quaternary provincial referral centre for British Columbians with heart disease.[6] St. Paul's Hospital is the largest volume ICD implanting centre in British Columbia, where over 500 people receive a new device every year. Patients receive their care from a group of electrophysiologists and nurses at an arrhythmia device follow-up clinic. St. Paul's Hospital, like many hospitals, currently lacks the resources to offer a clinician-led decision support group or a program for those who face significant challenges in the recovery period, following ICD shocks, or at other potentially vulnerable times. In addition to contributing to scientific evidence, the findings of the study can add to clinicians' understanding of the patterns of change in PROs following ICD implantation, help identify people who may be at relatively higher risk for

[5] A Holter monitor is a recording of a person's electrocardiogram over 24 hours or longer. The purpose of the test is to assess the presence of arrhythmias.
[6] An electrophysiologist is a cardiologist with specialised training in conduction defects and arrhythmia-related interventions.

experiencing poor outcomes, and support the development of appropriate and timely interventions to support people with ICDs.

2. Literature Review

To support the development of the conceptual framework underlying our study and guide the selection of the analytical approach best suited to answer the research questions, the literature review provides an introduction to the function and indications of the ICD, and focuses on the literature related to the measurement of PROs and the current evidence of PROs in people who require an ICD.

The purpose of the following literature review is two-fold: (a) to provide a conceptual analysis of what is meant by PROs, and a discussion of their scientific measurement; and (b) to explore the current evidence related to the self-reported physical, mental, and social health status of people with ICDs.

After briefly reviewing the clinical context related to the ICD, we preface our discussion with a general examination of the science of PRO assessment, to provide a frame of reference for the evaluation of the evidence about the unique health experiences of people with ICDs. We initially examine the development, defining characteristics, and theoretical assumptions of PRO assessment, the various approaches to PRO measurement, and its use and significance in research and clinical practice. We then focus our discussion on the emergence of salient PROs for people with ICDs. In particular, we discuss the current evidence about the physical, mental, and social health status or PROs of this patient population.

2.1 Living with an Implantable Cardioverter-Defibrillator

The potentially catastrophic consequences of ventricular arrhythmias and sudden cardiac arrest, the benefits afforded by the implantation of a permanent cardioverter-defibrillator, and the multiple implications of living with the device, frame our discussion of the clinical imperative to assess the changes in PROs following ICD implantation.

The ICD is a complex technological intervention used as a supplementary therapy in diverse cardiac conditions to identify abnormal and life threatening heart rhythms, and to treat these dangerous events with an electrical shock to restore normal conduction. To understand people's experiences of living with the device, it is helpful to review briefly the physiology of cardiac function.

The primary function of the heart is to pump blood to meet the body's metabolic requirements. The heart muscle is activated by an organised cell-to-cell conduction system that transmits an electrical impulse. The heart's pacemaker originates in the top right chamber and propagates the impulse from the upper to the lower chambers, causing the chambers to contract sequentially with each cardiac cycle. This orderly electrical conduction is pivotal to the heart's capacity to perform its pumping function and to the mechanisms of organ perfusion.[7]

Arrhythmias refer to abnormal and often disorganised heart beats that can be intermittent and self-limiting, or permanent. Atrial arrhythmias,[8] such as atrial fibrillation or supraventricular tachycardia, are not usually life-threatening arrhythmias, although they can lead to complications. In contrast, ventricular arrhythmias,[9] including ventricular tachycardia and ventricular fibrillation, can lead to sudden cardiac arrest and death if normal conduction is not rapidly restored, either spontaneously, with cardio-pulmonary resuscitation (CPR), electrical shock and/or medications. At best, the brain can only tolerate two to five minutes of reduced cerebral perfusion before the onset of cerebral ischaemia and potential brain damage (Heart and Stroke Foundation of Canada, 2005).

[7] Organ perfusion refers to the oxygenation through the circulatory system of vital organs and other tissues such as the heart itself, the brain, lungs, kidneys, and digestive system.
[8] Atrial refers to the right and left atria, the upper chambers of the heart.
[9] Ventricular refers to the right and left ventricles, the bottom chambers of the heart.

Sudden cardiac arrest may be caused by an injury to the heart due to a previous heart attack, cardiac surgery, heart failure, coronary artery disease, or other conditions that damage the heart's muscle and conduction system, or related to inherited heart defects, such as Long QT syndrome, hypertrophic cardiomyopathy, Brugada syndrome or arrhythmogenic right ventricular dysplasia (ARVD). Sometimes, ventricular arrhythmias affect people with no history of a heart condition (Woods, Froelicher, Motzer, & Bridges, 2010).

Randomised clinical trials have demonstrated that the ICD is the most effective treatment available for terminating potentially life-threatening ventricular arrhythmias. The device confers a significant survival benefit compared with anti-arrhythmic drug therapy for people with severe heart failure or who have survived an arrhythmia-induced cardiac arrest (Connolly et al., 2000; Klein et al., 2003; Mark et al., 2008; Namerow, Firth, Heywood, Windle, & Parides, 1999; Noyes et al., 2007). The growing scientific evidence and clinical appeal of the ICD have led to a 20-fold increase in annual insertions completed during the past 15 years (Bokhari et al., 2004; Kedia & Saeed, 2012; Tung, Zimetbaum, & Josephson, 2008).

Despite its efficacy, the ICD remains an "imperfect" therapy. Unlike other cardiac surgical interventions including coronary artery bypass grafting or valve replacement which usually leave a visible scar but are otherwise "invisible", the ICD remains discernible and palpable under the skin – it is a small metal box measuring approximately six cm long, four cm wide, and one and a half cm deep, the size of a small pager, lodged into a pocket under the shoulder blade. The device is connected to the right lower chamber by at least one high voltage wire ("lead") that is able to transmit information about the heart's condition to the computer program contained in the ICD, which analyses each heart beat. The lead conducts an electrical

charge from the ICD to the ventricular muscle, should a ventricular arrhythmia that warrants treatment be detected.

The treatment administered by the ICD includes rapid pacing and electrical shock. The magnitude of a shock consists of the administration of a single or repeated electrical voltage of 30 joules. Although the electrical change is significantly less than the standard 200 to 360 joules administered by an external defibrillator, the ICD shock is administered directly on the heart muscle. This treatment is usually unpredictable because most people do not experience prodromal feelings of ventricular events. The shock can be extremely painful and can result in significant lifestyle changes and emotional distress for some recipients and their families (Dougherty, 1995; Magyar-Russell et al., 2011; Pedersen, Versteeg, Nielsen, Mortensen, & Johansen, 2011; Sears Jr & Conti, 2002; Sears Jr & Conti, 2003).

The ICD is a permanent device, not easily or readily explanted. In contrast to taking a medication, it cannot be easily "stopped", although its defibrillator capacity can be deactivated through electronic programming.[10] Most people who receive an ICD keep the device for the duration of the lives. At a minimum, the device must be electronically checked twice annually, and needs to be replaced every two to six years.[11] Because of its technological complexity and the invasiveness of the implanting procedure, the risks associated with ICD implantation include technological failure, device manufacturers' advisories and recalls, and systemic infections (Maisel, Sweeney, Stevenson, Ellison, & Epstein, 2001; Mehta et al., 1998).[12]

[10] The ICD is equipped with extensive programming capacity. If end of life care planning is required, the defibrillation function can be suspended to prevent the administration of shocks during the natural dying process.
[11] The frequency of ICD replacement depends, in part, on the frequency of pacing requirements and shocks administered. The device contains a finite electrical charge, which is monitored regularly. The electrical charge cannot be replenished without replacing the ICD.
[12] Severe ICD or lead infections require the surgical removal of the device or the lead(s), and the implantation of a new system.

The decision to undergo ICD implantation presents significant implications for most patients, and requires the provision of care by clinicians specialised in arrhythmia services. In British Columbia, all provincial referrals must involve an electrophysiologist who is familiar with the risks and benefits of the intervention, on-going device programming, patient monitoring requirements, and long-term care planning, and is responsible for making decisions about patients' eligibility.

The unique characteristics of the ICD and the diversity of clinical indications and patient presentations at the time of referral for treatment highlight the exceptional challenges experienced by people who undergo device implantation. The standard measures of mortality benefits, or the quantity of life gained by the life-restoring ICD shock, and morbidity costs, the absence of negative impact on heart function and other physiological processes, are not sufficient to capture the health experiences of patients who require an ICD (Exner, 2002; Gasparini & Nisam, 2012). The ICD may change the way people look or feel, may affect their activities of daily living, may administer unpredictable shocks, requires some knowledge of its basic functioning, and may affect people's capacity to care for themselves as they adapt to living with the device. Device electronic interrogation, heart auscultation or blood pressure measurement will not yield an assessment of these effects. The only means to obtain this information is to ask the patient directly.

2.2 Literature Search Strategy

The literature reviewed was drawn from a comprehensive search of English language reports published between 1997 and 2012 encompassing the fields of nursing, medicine (cardiology), psychology, psychiatry, and rehabilitation sciences. The strategies used to search the PubMed, EMBASE, CINAHL and PsychINFO data bases are outlined in Appendix A. Key

words for the literature search included the Medical Subject Heading (MeSH) “quality of life” as well as “health-related quality of life” (HRQOL), and “patient-reported outcomes”. To support the discussion focused on PROs in the context of ICDs, we added the MeSH term “Defibrillators, Implantable”. To verify that the search was comprehensive, a manual search of the reference lists of retrieved articles was conducted. In addition, the scientific statements about ICD indications and clinical practice of the American College of Cardiology, the American Heart Association, the Heart Rhythm Society (Strickberger et al., 2006), the Canadian Cardiovascular Society, and the Canadian Heart Rhythm Society (Tang et al., 2005) were reviewed.

2.3 Understanding Patient-Reported Outcomes

The way clinicians, researchers, policy-makers, and the general public think about health, health care, and the role of patients is changing. Increasingly, multiple stakeholders recognise the importance of the physical, mental, and social domains of PROs and the adverse consequences of illness. Most important, they acknowledge that clinical outcomes measuring the value of medical interventions and healthcare programs must account for the quality of people’s lives as perceived and reported by those faced with illness.

The study and use of PROs have become increasingly prevalent in clinical research and practice to complement the evaluation of new therapeutic options, health services, and healthcare policies (Sloan et al., 2007; Sloan, Halyard et al., 2007). The term PRO first appeared in the early 1990s in research published by the Harvard Medical School Department of Health Care Policy (Guadagnoli, Ayanian, & Cleary, 1992; Mort et al., 1994). In a 1994 study of the influence of age on clinical and PROs after cholecystectomy, Mort et al., (1994) concluded that “More use of patient-reported outcomes, such as those assessed in this study, will improve our understanding of the broader impact of therapeutic interventions on patients' lives.” (p. 64).

PROs were initially commonly referred to as measures of quality of life (QOL), health-related quality of life (HRQOL), and self-perceived health status. PROs comprise information obtained directly from patients about a health condition and its management, and include measures of QOL or HRQOL, the impact of a disease state on daily living and social functioning, symptom information, satisfaction with treatment, adherence to prescribed regimens, and other dimensions of self-reported health status (Carr, Gibson, & Robinson, 2001). Types of PRO data collection range from oral medical histories and discussions with healthcare providers, to cognitive interviews and validated surveys (Sloan et al., 2007). Although inconsistently operationalised, measured, and utilised, PROs have been assessed in various clinical, research, and policy settings for over forty years (Greenhalgh, 2009; Lohr & Zebrack, 2009).

Research about PROs in ICD populations is gaining prominence and is strengthening the awareness of a broader model of ICD care that includes physical, mental, and social health status (Kapa et al., 2010; Rozanski, Blumenthal, Davidson, Saab, & Kubzansky, 2005). Current research suggests that about one half of people with heart failure would choose enhanced QOL with a shorter life expectancy over their current QOL with more years of life expected (Kong, Al-Khatib, Sanders, Hasselblad, & Peterson, 2011; Stevenson, 1998). Consequently, clinicians need to better understand how individuals experience living with an ICD, whether they report changes in their health status over time, what the rate and direction of that change is, and if distinct groups of people experience different patterns of change. This knowledge is key to the development of well-timed and targeted interventions to support care from the time of referral, implantation, and anticipated adaptation and recovery (Dickerson, Kennedy, Wu, Underhill, & Othman, 2010; Matchett et al., 2009).

2.3.1 Historical Development

To understand the scientific and clinical context in which PROs in people with ICDs have been reported and used to date, it is helpful to review the historical development of PROs. The current interest in and debate about PROs are directly related to a movement that originated in the 1970s which questioned the ability of the healthcare system to provide high quality, patient-centred care. In a 1975 study of the patient's assessment of the results of surgery following peptic ulcer published in The Lancet, Cay et al. (1975) cautioned that "the assessment of the result of surgery for peptic ulcer is based on doctor-determined criteria. Failure to distinguish one operation as being better than another may be because these criteria do not include the patient's rating of outcome" (p. 29). The same year, physicians pioneering the early adoption of PRO research in the field of oncology, reported that the treatment of inoperable bronchus carcinoma did not result in "a significantly better policy both for patients' survival and for quality of remaining life" (Laing, Berry, Newman, & Peto, 1975, p. 7946). In the early 1980s, the US Department of Health and Human Services (DHHS) supported Health Insurance Experiment (HIE) examined the impact of alternative forms of health insurance on health outcomes through the widespread collection of patients' self-reports of their health status (Brook et al., 1983). The study concluded that linking patient-reported health status with clinical endpoints provided unique and useful information to manage patient care. The Medical Outcomes Study used both patient and clinical outcomes reporting, and significantly expanded the science of health outcomes measurement to improve care (Tarlov et al., 1989). Concurrently, other health services researchers and medical decision-makers focused on innovative ways to assess health outcomes. In the *New England Journal of Medicine Shattuck Lecture*, Ellwood (1988) outlined the significant contributions of these research activities to meet the challenges facing healthcare

providers, and suggested that physicians could use HRQOL management "to bring a better quality of life to their patients" (p. 1550). This opened the possibility of measuring PROs to better gauge the success of treatment.

The convergence of these initiatives convinced the pharmaceutical research community to recognise the value of measuring PROs outcomes during drug development. In 1985, the United States Food and Drug Administration (FDA) asked manufacturers of new oncology pharmaceuticals to measure patient-reported symptoms, arguing that traditional objective measures, such as tumour response, may not always reflect true benefit (Johnson & Temple, 1985). This prompted the introduction of standardised patient-reported measures to evaluate the impact of treatment in clinical trials for new drug development. These included multi-item "health-related quality of life" or "health status" measures (Willke, Burke, & Erickson, 2004). In 1986, the *New England Journal of Medicine* published the findings of a clinical trial of an anti-hypertensive agent in which a PRO was a primary endpoint (Croog et al., 1986). A pre-publication leak of the positive findings of the study prompted a surge in the drug manufacturer's stock price (Bishop, 1986). Such events resulted in the increased interest of the pharmaceutical industry to seek FDA approval for PRO claims to promote the benefits of their products (Willke et al., 2004).

The early enthusiasm for PROs led the FDA to caution that broad PRO claims by industry could be misleading in the absence of adequate development, appropriate application, and correct interpretation of standardised measures, and required regulatory and scientific leadership to formulate some principles to guide the meaningful use of PROs (Acquadro et al., 2003). In 1999, the *International Society for Quality of Life Research* (ISOQOL), the *International Society for Pharmaeconomics and Outcomes Research* (ISPOR), the

Pharmaceutical Manufacturers' Association Health Outcomes Committee (PhRMA-HOC), and the *European Regulatory Issues on Quality of Life Assessment* (ERIQA) formed the HRQOL Harmonization Group to produce supporting guidance documents in collaboration with the FDA on the use of PRO evaluation in drug development (Revicki et al., 2000; Santanello et al., 2002).

In 2001, in collaboration with the FDA and the European Medicines Agency (EMEA), a working group composed of members of several professional, clinical, and regulatory organisations with an interest in health outcomes research proposed the use of the umbrella term "patient-reported outcomes" to describe a broad spectrum of disease and treatment outcomes reported subjectively by the patient. The working group was re-named the PRO Harmonization Group (Acquadro et al., 2003). The publication of the 2006 FDA "Draft Guidance for Industry: PRO Measures – Use in Medical Product Development to Support Labeling Claims", subsequently revised as a final version in 2009, formalised the recommendations for standardised inclusion of PROs in clinical trials (U.S. Department of Health and Human Services, Food and Drug Administration, Center for Drug Evaluation and Research, Center for Biologics Evaluation and Research, and Center for Devices and Radiological Health, 2006 and 2009).

2.3.2 Defining Characteristics

PROs can be generally defined as direct subjective assessments that only patients can provide about various aspects of their health and healthcare, including symptoms, functioning, well-being, QOL, perceptions about treatment, satisfaction with care received, and satisfaction with professional communication with clinicians (Karanicolas et al., 2011; Rothman et al., 2007).

In their draft consensus document published in 2006, the PRO Harmonization Group defined HRQOL as "the patient's evaluation of the impact of a health condition and its treatment

on daily life", and PROs as "the patient's report of a health condition and its treatment" (U.S. Department of Health and Human Services, Food and Drug Administration, Center for Drug Evaluation and Research, Center for Biologics Evaluation and Research, and Center for Devices and Radiological Health, 2006, p. 524). In the 2009 guidelines, the FDA and the affiliated American agencies proposed that: "a PRO is a measurement of any aspect of a patient's health status that comes directly from the patient (i.e., without the interpretation of the patient's responses by a physician or anyone else)" (U.S. Department of Health and Human Services, Food and Drug Administration, Center for Drug Evaluation and Research, Center for Biologics Evaluation and Research, and Center for Devices and Radiological Health, 2009, p. 2). The United Kingdom National Health Service (NHS) defined PROs as "standardised, validated questionnaires that are completed by patients to measure their own functional status and general health" (Rogers & Carrothers, 2012, p. 64). To date, there is no similar definition proposed by a Canadian regulatory body or agency.

The definition of PROs continues to evolve, but the concepts of disease activity, as reflected by symptoms, physical, mental, and social self-reported health or functional status, and satisfaction with and adherence to treatment generally delineate the range of dimensions of interest (S. Chang et al., 2011). The unique data obtained are distinct from clinicians' proxy or interpreted measures and reflect the patient's experience, influenced by internal standards, intrinsic values, and expectations, which are not directly observable by others (Bottomley, Jones, & Claassens, 2009; Gotay, Kawamoto, Bottomley, & Efficace, 2008; Rothman et al., 2007).

The terminology employed in the PRO field of research is shifting away from the equivocal terms "quality of life" and "health-related quality of life". The term "PRO" is

increasingly adopted by researchers, clinicians, regulatory agencies, and policy-makers, and is used in this study to describe these outcomes.

2.3.3 Theoretical Assumptions and Conceptual Frameworks

The conceptualisation of PROs can be framed within the larger context of four potential sources of patient outcomes assessment:

1. Clinician-reported outcomes, which include global impressions and observations, and various tests of functional status (e.g., neurocognitive and respiratory function testing);
2. Physiological assessments (e.g., blood tests, radiological investigations, and measurement of tumour size);
3. Caregiver-reported assessments (e.g., dependency and social interactions); and
4. Patient-reported outcomes (Acquadro et al., 2003).

The inclusion of PROs assumes that the patient is a potential informant, which has clear implications for the tailoring of assessment instruments for people with neurocognitive impairment, clinical deterioration, mental health related limitations, language and cultural barriers, and very young paediatric patients. Greenfield and Nelson (1992) called attention to the theoretical challenges of clarifying the true aims of health care, standardising measures across patients, clinicians, settings and conditions, and delineating the linkages between the processes and outcomes of care. These concerns were further echoed by Feinstein (1992) who recommended that researchers reflect on the definition of health itself and question who is best suited to decide what to include and what to emphasise in measures of self-reported health status. These perspectives led to varying approaches by researchers, ranging from allowing patients to specify what is uniquely important to them, such as assessed by the *Schedule for the Evaluation of Quality of Life* (SeiQOL) (Hickey et al., 1996), to constructing standardised domains based on

patients' views, to instruments developed by researchers without input from patients, such as the *Medical Outcomes Study Short Form* (SF-36) (McHorney, Ware, & Raczek, 1993; Ware, Snow, Kosinski, & Gandek, 1993). The absence of patient input in the development of widely used instruments remains a significant criticism in scientific discussions (Greenhalgh et al., 2005).

From a clinician's and researcher's perspective, the study of PROs assumes that QOL and other related outcomes can be defined and measured to adequately reflect patients' views. Greenhalgh et al. (2005) emphasised that PRO-related decision making occurs most frequently at a single moment, and is undertaken by a single decision maker, most likely a physician. They further contended that additional, implicit assumptions and beliefs underpin the present debate about PROs, including that patients wish to talk about their PROs, and will do so during their consultation with clinicians, clinicians perceive it as their role to discuss PROs with patients, and clinicians view PROs as clinically important to initiate changes in treatment (Greenhalgh et al., 2005).

Importantly, a conceptual model must be developed to appropriately frame a PRO assessment to provide a rationale for the goal of measurement (i.e., the "thing" that is to be measured by the PRO instrument), and specify the PRO of interest, the target population, and the nature of the treatment that the PRO should guide (Rothman et al., 2007). The complexity and selection of the PRO instrument must be driven by the concept being measured, and the conceptual framework must include the interrelationships among the PRO domains being measured, the content validity, and the construct validity, reliability, and responsiveness of each PRO instrument to support the claims (Valderas & Alonso, 2008). To this end, guidance documents for the development and validation of PROs issued by regulatory bodies recommend the use of conceptual frameworks, which outline the structure of the concept that a PRO aims to

measure (Gimeno-Santos et al., 2011). An absent or inadequate conceptual framework is likely to lead to inadequate development and validation of a PRO, and to jeopardise the rigour and meaning of its measurement (Lohr & Zebrack, 2009; Rothman et al., 2007).

In the field of oncology, where the development and uptake of PROs is the most advanced in clinical practice, there is a lack of consensus about the appropriate conceptual model for PRO assessment (Lipscomb, Gotay, & Snyder, 2005). This is further reflected in criticisms of the concept of QOL, both for its lack of a standardised theoretical basis, as well as lack of consensus regarding its definition (Greenhalgh et al., 2005). The field of PRO research remains in theoretical infancy, and lacks consistent conceptual justification and standardised definitions (Gimeno-Santos et al., 2011; Lipscomb et al., 2005).

Having explored the historical development, defining characteristics, and theoretical underpinnings of PROs, we further discuss their use, including their intended purpose, and approaches to measurement.

2.3.4 Paying Attention to Patient-Reported Outcomes

The purpose of collecting PROs is aimed at improving the quality of patient care and optimising resource utilisation by: (a) promoting the early detection of patients' problems with daily functioning and well-being; (b) informing the selection and use of therapeutic interventions, and monitoring responses to treatment; and (c) enhancing communication between patients and their care providers and improving satisfaction with care (Chang, 2007; Lipscomb et al., 2005). In a comprehensive systematic review, Valderas et al. (2008) identified 28 original studies of the use of PROs in clinical practice in international jurisdictions. Based on their findings, they outlined the following consensus rationale for the inclusion of PROs: (a) to facilitate detection of physical or psychological problems that might be otherwise overlooked,

(b) to monitor disease progression and treatment impact, (c) to establish common patient-clinician objectives and improve patient satisfaction and adherence, and (d) to monitor outcomes as a strategy for quality improvement. They argued that most important, PROs provide important evidence to inform clinicians' and patients' decisions regarding treatment options, and add value in daily clinical practice (Valderas & Alonso, 2008).

This argument echoed the earlier statement provided by the 2001 Ad Hoc Task Force Report of the PRO Harmonization Group Meeting of the FDA (2003), which summarised the key features of the value of PROs as follows:

- "The patient's perspective is a key element in medical diagnosis and treatment.
- Patient-reported data are unique and complementary indicators of disease activity and treatment effectiveness.
- Professional organizations recognize the key role that patient-reported data play in diagnosis and treatment, as evidenced by professional practice guidelines.
- PROs in clinical trials provide important data for evaluating the effectiveness of new treatment.
- Consistent with the definition of a scientific instrument, patient reported outcome measures provide precise, reliable, valid, and reproducible data.
- The inclusion of PROs in clinical trials is sanctioned by professional organizations, as evidenced by trial guidelines put forth by professional organizations.
- PRO data are essential for evidence-based practice.
- For new pharmaceuticals, PRO data from clinical trials support evidence-based practice" (Acquadro et al., 2003, p. 527).

In the follow-up draft guidance, the FDA agencies proposed that the purpose of developing, using, and reporting PROs is "to measure the impact of an intervention on one or more aspects of patients' health status, ranging from the purely symptomatic (e.g., response to a headache) to more complex concepts (e.g., ability to carry out activities of daily living), to extremely complex concepts such as quality of life, which is widely understood to be a multi-domain concept with physical, psychological and social components" (U.S. Department of Health and Human Services, Food and Drug Administration, Center for Drug Evaluation and Research, Center for Biologics Evaluation and Research, and Center for Devices and Radiological Health, 2006 and 2009, p. 79). Although this guidance document did not establish legally enforceable responsibilities, it highlighted the current position of a regulatory body with significant global reach.

The United Kingdom has adopted a similar shift in its healthcare policy. The 2008 National Health Service (NHS) Lord Darzi report, "High Quality Care for All" recommended that the National NHS should "systematically measure and publish information about the quality of care" (National Health Service, 2008, p. 11), while the NHS White paper, "Equity and Excellence: Liberating the NHS", stressed the importance of transparent and patient-focused quality and safety of care (National Health Service, 2010). In this policy context, since 2009, the British NHS has mandated the collection of PRO data for four surgical procedures (i.e., inguinal hernia repair, varicose vein surgery, and hip and knee replacements) with the ultimate aims of achieving a quantifiable and transparent improvement in quality for multiple procedures and programs, informing individual care, and managing the performance of healthcare providers (Rogers & Carrothers, 2012). The policy decisions adopted by the FDA and the NHS are not

currently incorporated in directions provided by Health Canada or any Canadian provincial health administration.

2.3.5 The Measurement of Patient-Reported Outcomes

According to the FDA working group, PRO assessment can be defined as scientifically valid if the outcomes are conceptually defined and operationalised in questionnaires, and if the questionnaires can meet established standards of reliability, validity, and responsiveness, and can withstand the scrutiny of psychometric evaluation (Acquadro et al., 2003; Wiklund, 2004).

A group of researchers from the Mayo/FDA PRO Consensus Writing Group, which formed in response to the publication of the FDA Guidance document, proposed the following strategy for PRO measurement development: (a) identify the relevant domains to measure, (b) develop a conceptual framework, (c) identify alternative approaches to measure the domains, and (d) synthesise the information to design the measurement strategy. They argued that as long as the PRO represents a valid concept that can be operationalised and tested, conforms to a predetermined claim associated with a research question, is supported by evidence from an *a priori* statistical analysis plan, and is reported with transparency and balance, its measurement is eligible to support claims of patient benefit (Snyder et al., 2007). To this end, the group published a series of articles in *Value in Health* to collectively operationalise the direction provided by the FDA. Writing teams with representation from academia, clinical practice, the pharmaceutical industry, government and regulatory agencies, and patient advocates addressed the major themes related to appropriate measurement strategies. Their purpose was to provide a focused process to facilitate discussion among PRO users, educate stakeholders about the background, content, intent, and concerns surrounding the FDA guidance, and delineate

approaches to best operationalise the guidance using state of the science knowledge (Sloan, Halyard et al., 2007).

PROs encompass complex concepts, and the validity, reliability, responsiveness and practicality of their measurement remain debated (Arpinelli & Bamfi, 2006; Macduff, 2000). For example, a systematic review identified 1,275 different instruments measuring PROs (Garratt, Schmidt, Mackintosh, & Fitzpatrick, 2002), while a review of 68 different PRO models concluded that four of ten models did not provide clear or standardised definitions of the concepts being measured (Taillefer, Dupuis, Roberge, & Le May, 2003).

PRO research is challenged by variations in approaches to measurement, the multitude of available instruments, diversity of items, response options, and approaches to aggregations of scores, and lack of standardised units of measurement (Schunemann, Akl, & Guyatt, 2006). These factors contribute to the current debates in the measurement of PROs.

2.3.6 The Use of Patient-Reported Outcomes in Clinical Trials and Practice

The prevalence of cardiovascular trials that mentioned "quality of life" grew from less than 2% in the early 1990s to nearly 16% in 2010. However, the adoption of rigorous and effective PRO research in clinical trials remains limited (Rahimi, Malhotra, Banning, & Jenkinson, 2010), and the uptake and the value of PRO assessment in clinical decision making remain unresolved issues.

Greenhalgh and Meadows (1999) reported that feedback about overall patient assessment increased the detection of psychological and, to a lesser extent, functional problems, but found little evidence of associated changes in medical management or outcomes. Espallargues et al. (2000) identified 23 clinical trials with considerable heterogeneity of results, and no theoretical consideration for the inclusion of predictors. This precluded any definitive recommendations

concerning the use of PROs. A British group conducted a systematic review of nine studies related to the routine administration of PRO and needs assessment instruments to improve psychological outcomes. They found that, although clinicians welcomed PRO information, the routine feedback of questionnaire results had little impact on the recognition of mental disorders and on longer term psychological functioning. They concluded that "routine health-related quality of life measurement is a costly exercise and there is no robust evidence to suggest that it is of benefit in improving psychosocial outcomes of patients managed in non-psychiatric settings" (Gilbody, House, & Sheldon, 2001, p. 1345). A British primary healthcare group published a review of the impact of PRO measures on routine practice, stressing the constant pressure on healthcare systems to improve the quality of care and the efficiency of service delivery. They concluded that feedback about PROs to clinicians "appeared to impact" processes of care, especially the diagnosis of mental health outcomes, while having a less consistent effect on health status. However, they noted a general lack of clarity in the field of PRO study and reporting, especially with regards to the appropriate goals of PRO measurement, the mechanisms used to achieve them, and the rationale for including or excluding predictors (Marshall, Haywood, & Fitzpatrick, 2006). They echoed Gilbody et al.'s (2001) report of clinicians' enthusiasm for using PROs in various healthcare settings and the paradox of limited clinical uptake.

More recently, an international group of researchers, including representatives from Europe, Canada, and the United States, published an updated systematic review that summarised the impact of providing PRO information to healthcare providers in daily clinical practice. The group identified 28 studies that measured health status, mental health, or other PROs. While highlighting the methodological limitations of many of the studies and the inherent weaknesses

of the potential inferences, they concluded that "there are some grounds for optimism in the potential impact of measurement of PROs in clinical practice – specifically in improving diagnosis and recognition of problems and patient-physician communication" (Valderas et al., 2008, p. 191). They advocated that the scientific community should consider the use of generic and disease-specific PRO instruments, and invest considerable effort to design theoretically and methodologically stronger trials to implement feasible interventions with clear positive effects.

2.3.7 The Significance of Change in Patient-Reported Outcome Assessments

In a paper exploring the scientific basis for the construction of appropriate models linking symptoms, functioning, and quality of life, the choice of measurement instruments, and the analyses and interpretation of the data, Osoba (2007) asked PRO researchers to consider the hypothetical implications of a 10% change in a PRO score. He argued that the answer remains unknown because it is largely untested, and challenged researchers to integrate PRO scores with clinical/laboratory tests and then to correlate PRO change scores with other clinical variables, including changes in disease status and progression, a patient's self-reported perception of change, the ability to perform certain functions, or other parameters. Such research would significantly aid in clarifying the interpretation of findings. Osoba (2007) posed some key questions for future research in clinical practice:

- "Which are the appropriate instruments for use in clinical practice?
- Do new instruments need to be developed?
- What is the appropriate timing of…[PRO] assessment?
- How do patients react to…[PRO] assessment?
- Is the same magnitude of change in scores meaningful in all diseases?

- How useful is it to know the NNT [number needed to treat] in…[PRO research]?" (p. 10).

Similarly, Brożek, Guyatt, and Schünemann (2006) underscored the challenges inherent in the interpretation of PRO scores expressed in unfamiliar and non-standardised ordinal or continuous scores. They deemed that "even those familiar with the concept of PRO or QOL [quality of life] assessment generally have no intuitive notion of the significance of a change in score of a particular magnitude on most instruments" (p. 69). They framed the central problem as one of interpretability: what changes in score correspond to trivial, small, moderate, or large patient benefit or harm (Brozek, Guyatt, & Schunemann, 2006)?

The 2006 FDA draft guidance document recommended determining a minimally important difference (MID) benchmark when designing trials and interpreting PRO instrument scores (U.S. Department of Health and Human Services FDA Center for Drug Evaluation and Research et al., 2006). The MID has been defined as the smallest difference in score in the outcome of interest that informed patients or proxies would identify as important. The MID concept bridges evidence-based and patient-centred frameworks by defining a standard of clinically significant change in PROs (Schunemann & Guyatt, 2005; Wyrwich et al., 2007). There is limited consensus that a change in 10% of an instrument score may represent a minimally important difference in PROs (Copay, Subach, Glassman, Polly, & Schuler, 2007; Gerlinger & Schmelter, 2011; Kirby, Chuang-Stein, & Morris, 2010; Ringash et al., 2007). We further discuss the assessment of clinical significance of change scores and our interpretation of temporal change in Chapter 4.

In response to issues related to the conceptualisation of PROs, their metrics and significance, the US National Institutes of Health (NIH), in 2004, initiated a 5-year multi-centre

cooperative project referred to as the Patient-Reported Outcomes Measurement Information System (PROMIS) to build and validate common, accessible item banks to measure key symptoms and health concepts relevant across wide ranging chronic conditions, and to support the interpretation of findings. The program aimed to promote and enable efficient and interpretable clinical trial and clinical practice applications of PROs, and to catalyse changes that were deemed necessary to transform scientific knowledge into tangible benefits for patients. This ambitious undertaking involves multiple research sites, a statistical coordinating centre, and various NIH research. The PROMIS team selected the World Health Organization framework of physical, mental and social health to begin the process of domain mapping, item review and testing, analysis and validation using item response theory (IRT) and computer adaptive testing (CAT). The magnitude and endorsement of the PROMIS initiative signals the enduring commitment of funding agencies and scientists to improve the science of PRO measurement and to facilitate scientific and clinical applications (Cella, Gershon, Lai, & Choi, 2007; Cella et al., 2010; Chang, 2007). In this study, we employed three instruments issued from the PROMIS instrument bank. We further discuss the PROMIS initiative and methodology in Chapter 4.

2.3.8 Implications for Practice

As discussed previously in this chapter, the evidence supports claims that collecting PRO information is feasible and acceptable to both clinicians and patients, may facilitate patient-clinician communication, and inform plans of care. Researchers have theorised that PRO assessments can make clinic and medical visits more efficient by helping to identify priorities and by strengthening patient-clinician relationships (Cella et al., 2012; M.S. Donaldson, 2008). Yet, clinicians report significant challenges in the routine adoption of PROs, including lack of familiarity with the instruments, controversy about the evidence, and difficulty operationalising

the collection and use of PRO data (Feldman-Stewart & Brundage, 2009; Lohr & Zebrack, 2009). Current issues related to the use of PROs centre on facilitating the clinical uptake and measuring the impact of PROs on overall outcomes and processes of care (Dinan et al., 2011; Greenhalgh, 2009; Lohr & Zebrack, 2009).

The use of PROs is driven by an increasing interest of patients to frame their disease experiences within the greater viewpoint of their lives, and to actively understand, participate in, and influence their healthcare decisions (Karanicolas et al., 2011; Lipscomb et al., 2005). Especially in the context of chronic disease management, including cardiovascular disease, where no cure is attainable and the primary aim is to enhance patients' PROs while limiting the impact of disease, and where the capacity for self-care is pivotal, clinicians are increasingly recognising that it is impossible to separate the disease(s) from an individual's personal and social standpoints, since illness does not exist in a vacuum (Carr et al., 2001; Fayers, 2008; Flynn et al., 2009; Norekval et al., 2010; Wyrwich et al., 2007). Through the use of PROs, patients can gain insights into their care and have a more comprehensive understanding of the risks and benefits of various treatments. They can increase their participation in their treatment planning, and gain a voice in their healthcare decision making (Acquadro et al., 2003; Moons, 2010). PROs may offer a means to address the potential paradox between what medicine offers and what patients want. Most patients' primary concerns centre on survival and the physical, emotional, social, and existential challenges that illness and survival pose. This contrasts with the more conventional, prevailing focus of clinicians and scientists on gathering clinician-reported information for the purpose of treating the patient's condition (Lohr & Zebrack, 2009). For example, although amenable to measurement, PROs are highly individual and complex constructs. The relationship between symptoms and PROs is neither simple nor direct. Patients

with severe disease do not necessarily report poor PROs, nor do PROs correlate strongly with the progression of their disease. PROs may vary at different points in their disease trajectory because perception and experience alter expectations (Addington-Hall & Kalra, 2001).

The selection of PROs by researchers and clinicians presupposes what is important, relevant, and sufficient to patients (Dunderdale, Thompson, Miles, Beer, & Furze, 2005). Lohr and Zebrack (2009) asked, "Is it realistic to think that administering a series of PRO instruments serves as a valid and reliable method for identifying independent and salient physical and mental health condition? How many PROs and which PROs must be administered, and how much time must be expended in the administration and completion of PROs, before clinicians have enough information upon which to base appropriate and effective treatment" (p.103)? Researchers have argued that many PRO measures, such as the *SF-36,* are not patient-centred because patients were not directly involved in generating the items, questionnaires restrict patients' choices, and researchers allocate a weighting system that does not necessarily reflect the patient's perspective (Higginson & Carr, 2001). In addition, the potential impact of the power differential between the patient and clinician, and its effect on social desirability and other response biases, can determine whether a patient will respond at all. The information divulged in interactions with clinicians can be a function of the social, conversational, and emotional dynamics present in that interaction, reflecting patients' status at a particular moment in time and within a particular context (Lohr & Zebrack, 2009).

The time, effort, and energy burden of completing questionnaires and other instruments can also be a significant deterrent to PRO assessment (Garcia et al., 2007). Additional potential barriers to patients' acceptance of PRO assessment include literacy, the effects of disease and its

treatment on patients' ability to complete measurement instruments, and concerns about data confidentiality (M.S. Donaldson, 2008).

In a conceptual framework of patient-provider communication, Feldman-Stewart and Brundage (2009) hypothesised that completing PRO forms improved patients' skills at describing their symptoms. This allowed them to convey their information more effectively to their clinicians, which in turn enhanced clinicians' understanding of their patients' health states without increasing the time involved. Similarly, they argued that the use of PROs may increase recall, help overcome values that interfere with the ability to report symptoms and improve patients' emotional functioning by addressing some fundamental needs, such as the need to be cared for, or the need to have a sense of control over their health (Feldman-Stewart & Brundage, 2009). Although untested, these hypotheses raise interesting implications for patients. PRO assessments can help patients communicate their needs and concerns if the "right" instrument is selected. Conversely, if patients perceive that the information collected does not actually match their needs or reflect their priorities for treatment, or fails to meet their expectations, the ensuing interactions with clinicians based on the findings of the PROs could result in worsened communication and overall outcomes (Chang et al., 2011; Higginson & Carr, 2001; Hook, 2006).

In this discussion of the conceptualisation, scientific measurement, and clinical application of PROs, we presented the context for our interest in the measurement of PROs in the ICD population. We focused on the importance of selecting valid and precise measures grounded in a conceptual framework of PRO assessment to capture people's experiences of their disease and treatment. We introduced a discussion of the clinical significance of the measurement of PROs. This discussion informs the following section focused on the PROs of people who receive an ICD.

2.4 Patient-Reported Outcomes and Implantable Cardioverter-Defibrillators

As we discussed earlier, the ICD is a unique cardiovascular therapy. It complements optimal medical therapy by providing the guarantee of rapid resuscitation by defibrillation in the event of cardiac arrest. Depending on the patient's condition and the unpredictable course of heart disease, the ICD may be "dormant" for the duration of a patient's life, or may treat unpredictable malignant arrhythmias with electrical shocks. These unique features of the therapy warrant the study of affected people's PROs.

2.4.1 Early Comparisons

Before the development of the ICD, the standard pharmacotherapy for the management of ventricular arrhythmia was amiodarone, an antiarrhythmic drug approved in North America in 1985 for the management of difficult to treat tachyarrhythmias (Cannom & Prystowsky, 2004; Vassallo & Trohman, 2007). Lifelong amiodarone therapy is generally poorly tolerated. Common morbidity outcomes include interstitial lung disease, abnormal thyroid and liver function, corneal damage, and skin discolouration with exposure to the sun (Arteaga & Windle, 1995; Vassallo & Trohman, 2007). Early clinical trials of the safety and efficacy of the ICD were benchmarked against amiodarone treatment. The *Antiarrhythmics Versus Implantable Defibrillator* (AVID) trial (Schron et al., 2002) and the *Canadian Implantable Defibrillator Study* (CIDS) (Connolly et al., 2000; Irvine et al., 2002) were the largest clinical trials that included PROs in the study of the comparative effects of antiarrhythmics and ICDs in survivors of cardiac arrest. The AVID investigators concluded that there were no significant differences in PROs of the two groups observed over the course of the 12-month study, while adverse symptoms associated with the deterioration of cardiac disease were associated with worse PROs regardless of treatment arm (Gregoratos et al., 2002; Schron et al., 2002). Of interest, a recent

secondary analysis concluded that the PROs predicted one-year survival in the AVID participants, in addition to younger age and angiotensin-converting enzyme treatment (Kao, Friedmann, & Thomas, 2010). In contrast, the CIDS investigators reported that "QOL [quality of life] is better with ICD therapy than with amiodarone therapy" (p. 282) except for the sub-group of patients who had experienced five or more shocks from their ICD (Irvine et al., 2002).

Before the adoption of the ICD, amiodarone was also the treatment of choice for the prevention of sudden cardiac arrest in people with severe heart failure (Bardy et al., 2005). The pivotal clinical trials that broadened the indications for ICD implantation for this population also included PROs as secondary outcomes. Following large samples of patients for up to three years following ICD implantation, the *Multicenter Automatic Defibrillator Implantation Trial II* (MADIT II) (Moss et al., 2002; Noyes et al., 2007), the *Sudden Cardiac Death in Heart Failure Trial* (SCD-HeFT) (Bardy et al., 2005; Mark et al., 2008), and *the Defibrillators in Nonischemic Cardiomyopathy Treatment Evaluation* (DEFINITE) study (Kadish et al., 2004; Passman et al., 2007) concluded that there were no significant differences between the treatment groups in the longitudinal analysis of the findings. The instruments selected included the Health Utility Index (MADIT-II), the Duke Activity Status Index (SCD-HeFT), the five items of the Mental Health sub-scale of the 36-Item Short Form (SF-36), and the SF-12. Although the studies differed in their instrumentation and analysis, all were comparable in their focus on the physical and psychological domains of PROs.

The absence of significant differences between treatment modality effects on PROs was further confirmed in smaller longitudinal studies that measured PROs (Herbst, Goodman, Feldstein, & Reilly, 1999; Strickberger et al., 2003), uncertainty (Carroll, Hamilton, & McGovern, 1999), physical functioning, socioeconomic status, psychological and spiritual state,

family life (Carroll, Hamilton, & Kenney, 2002), symptom level, vitality, medical costs (Hsu et al., 2002), and functional status (Arteaga & Windle, 1995). With the development of guidelines supporting the ICD as a treatment of choice, ICD-specific PROs started to emerge in the literature.

2.4.2 Emergence of Salient Patient-Reported Outcomes

The beginnings of ICD implantation preceded the first published article that focused on PROs by more than ten years, although most early clinical trials of ICDs included the measurement of some PRO components. In 2005, there were 178 research articles that addressed patient factors associated with dimensions of PROs, published mostly in biomedical, nursing, and psychological journals. In this early period of ICD-focused PRO research, the more common research interests were related to mental health status [anxiety (33%), depression (30%), stress (16%), fear (6%), and psychosocial treatment (80%)] with additional research activity focused on the global assessment of quality of life (32%), attitude to health (13%), patient education (11%), social support (10%), activities of daily living (8%), and acceptance of therapy (4%) (Stutts, Cross, Conti, & Sears, 2007).[13]

We identified five extensive publications that provided reviews of studies of the PROs of people with ICDs (Bostwick & Sola, 2007; Groeneveld, Matta, Suh, Heidenreich, & Shea, 2006; Sears Jr & Conti, 2002; Sears Jr, Todaro, Lewis, Sotile, & Conti, 1999; Sola & Bostwick, 2005; Thomas et al., 2006) and a meta-analysis of the psychosocial impact of the device (Burke, Hallas, Clark-Carter, White, & Connelly, 2003). Although the studies lacked an explicit theoretical framework, they outlined the present scientific stance on the most relevant dimensions of people's health experiences of living with an ICD.

[13] In their publication, Stutts et al. (2007) provided an inventory of the multiple and overlapping PROs included in their systematic review. The total percentage exceeds 100% because many studies addressed more than one PRO.

The findings followed the early recommendations of a pioneering group of psychologists and other researchers at the University of Florida who highlighted the importance of paying attention to psychosocial distress, global quality of life, social and role functioning, and ICD-related fears as salient outcome measures (Sears Jr et al., 1999). Since then, systematic reviews have focused on global Quality of life or psychological distress, or a combination of both (Thomas et al., 2006), depression, anxiety, and other psychopathology (Bostwick & Sola, 2007; Sola & Bostwick, 2005), mood disturbances, anxiety, anger, fear of shock, behavioural changes, such as avoidance and social isolation, reduced physical activity, reduced sexual activity, satisfaction with intimate relationships, and alterations in role functioning (Burke et al., 2003). This early focus on mental health has shaped the focus of PRO research in the ICD population.

The findings related to the psychological and other risks associated with ICDs remain equivocal. We examine the current evidence about the physical, mental, and social PROs of people with ICDs.

2.4.3 Physical Health Status

PROs related to the physical health status of people with ICDs reflect their capacity to physically perform activities or tasks that attend to the necessities of daily living. For the purposes of this discussion, we focus on the outcomes that describe (a) general physical health, (b) the experience of pain, (c) the physical effects of cardiac disease and other co-morbidities, (d) the capacity to exercise and participate in physical recreational activities, (e) sexual activity, and (f) sleep health.

General Physical Health Status

The relationship between changes in general physical health status and PROs after ICD implantation is unclear. In a comparative study of people with ICDs, combined ICDs and

antiarrhythmic medications, and antiarrhythmic medications alone, no significant differences were found in patients' reported general physical health status; one half of all the patients reported that their health status was about the same as compared with one year earlier, while 25% reported that their health status was either somewhat or much worse, regardless of their treatment modality (Herbst et al., 1999). In contrast, in a small study of change in health status between six months and one year after ICD implantation, most of the participants reported progress and better physical functioning, which translated into improved vitality and participation in social activities (Carroll et al., 2002).

Some common cardiovascular factors play a role in changes in physical health status explained by people with ICDs. The progression of heart failure is associated with significant worsening of physical functioning and other PROs after receiving an ICD, which is consistent with the ICD's function as a safety device, and not as a direct treatment of worsening heart function (Kamphuis, de Leeuw, Derksen, Hauer, & Winnubst, 2003; Noyes et al., 2009). In keeping with previous research that demonstrated that women displayed worse physical functioning, and other PROs, following cardiac diagnoses, events, and interventions (Pilote et al., 2007), women experienced this same pattern after ICD implantation. For example, in a large (n = 718, 81% men) multi-centre study, women reported significantly poorer physical functioning and vitality compared with men 12 months after receiving an ICD (Habibovic et al., 2011).

General Pain

The implantation of an ICD requires a surgical incision into the sub-clavicular area, and the stretching of tissues to create a "pocket" to seat the device, often deep below the fascia, and to protect it. The incision is approximately 10 cm long, and may result in swelling and bruising at the site. Most elective patients are discharged with a prescription for mild analgesia, including

acetaminophen and codeine. In our literature search, we failed to identify evidence related to post-operative pain following ICD implantation.

Aside from surgical pain and the pain associated with sustaining an ICD shock, discussed further in this chapter, the principal sources of physical pain and discomfort in people with ICDs are related to their underlying disease process, especially heart failure. One of the main indications of ICD implantation is categorised as "primary prevention", which targets people with severe heart failure resulting from various factors, including myocardial infarction and coronary artery disease, and who have not sustained a previous ventricular arrhythmia (Exner, 2002).[14] Current guidelines indicate that patients' cardiac function must be severely impaired to warrant ICD therapy (Gregoratos et al., 2002).[15] The discomfort associated with symptomatic heart failure, which primarily includes angina and shortness of breath, has been identified as a significant predictor of physical functioning and overall quality of life of people with ICDs (Johansen et al., 2008). In addition, pain related to concomitant diseases, such as arthritis, diabetic peripheral neuralgias, and chronic infection, is also known to have a cumulative effect on ICD patients' PROs (Goldfinger & Adler, 2010; Tsai et al., 2010).

Exercise and Recreation

Without accounting for the progression of underlying disease, the implantation of an ICD does not preclude a return to most normal activities of daily living (Burke et al., 2003). Routine physical exercise is highly recommended for all people with heart disease, including ICD patients, and is an important determinant of quality of life (Irvine et al., 2002; Klein et al., 2003;

[14] The ICD is also indicated for "secondary prevention" in people who are at high risk for a primary ventricular arrhythmia (e.g., genetic and electrocardiographic markers of long QT syndrome) or survivors of sudden cardiac arrest not attributable to myocardial infarction.

[15] The standard measurements of impaired cardiac function include left ventricular ejection fraction – the percentage of blood ejected from the left ventricle with each cardiac cycle and the assessment produced with the New York Heart Association Functional Classification.

Sinha, 2008). Prescriptions for exercise are based on patients' underlying medical condition, angina threshold, programmed ICD parameters, and current level of activity, with initial monitoring often undertaken by cardiac rehabilitation programs (Shea, 2004).

Although ventricular tachyarrhythmias are usually unpredictable and unrelated to physical activities, fear of reaching the device's tachycardia threshold and provoking a shock is common in people with ICDs. In a study of the fear of exercise in a group of ICD recipients and a matched group of "healthy" people, people with ICDs experienced significantly more fear and avoided exercise, which was associated with impaired quality of life, even after correcting for sex, age, and number of years since implantation (van Ittersum et al., 2003). These findings were echoed in a study that focused on sports activities and high altitude travel; the researchers concluded that, in spite of recommendations to pursue a moderate exercise regimen and reassurance about the safety of travelling to higher altitudes, one half of the surveyed participants reported that they did not participate in sports activities that raised their heart rate and avoided high altitude (Kobza, Duru, & Erne, 2008).

The effect of age on the exercise and recreation of ICD recipients was highlighted in a study conducted by Hamilton and Carroll (2004) who found that older ICD recipients (mean age: 74 years) had a higher prevalence of cardiac events and symptomatic heart failure, and reported less active lifestyles, less satisfaction with their physical fitness, and more anxiety about the risk of shock during exercise, compared with younger people (mean age: 51 years).

Sexual Activity and Reproductive Health Status

The sexual health and concerns of people with ICDs are not well studied or understood (Hegel, Griegel, Black, Goulden, & Ozahowski, 1997; Steinke, 2003; Steinke, Gill-Hopple, Valdez, & Wooster, 2005). Concerns about resuming sexual activity, reductions in the frequency

of sexual activity, and fears of triggering the device when engaged in sexual activity have been reported (Eckert & Jones, 2002; Pauli, Wiedemann, Dengler, Blaumann-Benninghoff, & Kuhlkamp, 1999; Vazquez, Sears, Shea, & Vazquez, 2010). Steinke (2003) reported reduced interest in sexual activity in 29% of people with an ICD and in 39% of their partners, which was noted to occur especially in the first year. Reports of abstinence or declines in sexual activity have ranged from 41% to 55%, and have been posited to be related to altered body image (Sneed & Finch, 1992) and a failure of clinicians to discuss sexual matters with their patients (James, 1997). In a qualitative descriptive study about the sexual concerns of people with ICDs and their partners, Steinke et al. (2005) identified the following themes in their samples of 12 people with ICDs and 4 partners: (a) anxiety, apprehension, and partner over-protectiveness, (b) varying interest and patterns, (c) powerfulness of ICD discharge, and (d) a need for information and sexual counselling.

Little is known about the predictors of sexual health in people with ICDs. Heller, Ormont, Lidagoster, Sciacca, and Steinberg (1998) observed a positive correlation between ICD patients' resumption of work and their sexual interest and frequency. Studies of younger people with ICDs suggest that they experience substantial problems with lifestyle adjustment that are different from those experienced by older recipients and may last for a greater period of time; they have reported diminished social interactions, worry, avoidance behaviour, and body image concerns (Dubin, Batsford, Lewis, & Rosenfeld, 1996; Groeneveld et al., 2006; Sowell, Kuhl, Sears, Klodell, & Conti, 2006; Vitale & Funk, 1995). In spite of the relatively younger age of people undergoing ICD implantation for secondary prevention, the available evidence about their sexual health is limited to the study of sexual concerns, with little known about their

reproductive health and childbearing concerns (Kron & Conti, 2007; Wilson, Greer, & Grubb, 1998).

One of the challenges of studying sexual health in people living with an ICD is people's reluctance to complete questionnaire items related to sexual behaviour and anxiety. The Florida Patient Acceptance Survey was originally developed as an 18-item scale measuring return to function, device-related distress, and body image concerns (Burns et al., 2005; Burns, Serber, Keim, & Sears, 2005). Through use in subsequent studies and further psychometric analysis, the items, "I have continued my normal sex life", "I am careful when hugging and kissing my loved ones", and "I feel less attractive because of my device" were removed from the scale because of numerous missing responses to the items pertaining to intimacy (Pedersen et al., 2011; Versteeg et al., 2012). Similarly, the Florida Shock Anxiety Scale, which measures patients' appraisals of the consequences of sustaining a shock and their perceptions of triggers, initially contained 10 items. The statement, "I do not engage in sexual activity because it will cause my ICD to fire"' was removed for the same reason (Kuhl, Dixit, Walker, Conti, & Sears, 2006). Although an important PRO, assessing sexual health remains difficult to accomplish with currently available measurement tools.

Sleep Health

Although poorly understood, ICD implantation is associated with sleep disturbances and a lack of satisfaction with rest and sleep (Herbst et al., 1999; May, Smith, Murdock, & Davis, 1995; Sears Jr, Burns, Handberg, Sotile, & Conti, 2001). A study of people with sleep-disordered breathing and ICDs demonstrated a significant prevalence of central and obstructive sleep apnea in previously undiagnosed individuals (Grimm et al., 2009), placing them at higher risk for additional comorbid conditions and relatively poorer Quality of life. In a randomised

longitudinal intervention trial, 67% of patients who required an ICD reported poor sleep quality at baseline, and 57% continued to report sleep dysfunction after six months when measured with the Pittsburgh Sleep Quality Inventory. Female gender and higher NYHA class were found to be significant predictors of poor sleep quality (Berg, Higgins, Reilly, Langberg, & Dunbar, 2012). There also is evidence that sleep function may be associated with heightened shock-related anxiety at night (Serber et al., 2003). Sleep disturbance can be a predictor of poorer health outcomes (Berg et al., 2012; Ensrud et al., 2012), and warrants further investigation in this population.

2.4.4 Mental Health Status

Early research recognised that people with ICDs encountered significant mental health challenges, including fear, anxiety, and depression (Burke et al., 2003). There is on-going concern that the ICD does not constitute a psychologically benign device, regardless of its clinical indication, the experience of shock, or changes in cardiac status (Bilge et al., 2006; Kapa et al., 2010).

The various terms used in the literature to conceptualise the psychological domains of PROs include mental health, psychological distress, and psychological maladaptation (Stutts, Cross et al., 2007). We prefer *mental health status* as the most appropriate term to discuss how people with ICDs describe the effects of the device on their mental functioning.

The principal outcomes explored in the literature include depression and anxiety. In a comprehensive review, Sears, Lewis, Kuhl, and Conti (2005) found that 24% to 87% of people with ICDs experienced some degree of anxiety, 13% to 38% had clinically diagnosed anxiety, and 9% to 15% had clinically relevant depression. There is a wide spectrum of disorders reported as mental health outcomes, ranging from emotional distress and low mood, to psychopathology

and mental illness (Bostwick & Sola, 2007; Crow, Collins, Justic, Goetz, & Adler, 1998). In a recent systematic review, Magyar-Russell et al. (2011) identified 45 studies that assessed over 5,000 adults with ICDs with validated self-reported measures of anxiety and depression. They reported that 11% to 28% of these patients had a depressive disorder, while 11% to 26% experienced anxiety, and concluded that "it may be appropriate to assume a 20% prevalence rate for both depressive and anxiety disorders post-ICD implant" (p. 223), which is consistent with rates observed in other cardiac populations.

Emotional states, such as anger, mental stress, and anxiety can precipitate arrhythmias in ICD patients, alter the ventricular tachycardia cycle length, and make ventricular arrhythmias more difficult to terminate (Lampert et al., 2002). Mood disturbances are independent predictors of arrhythmia events, even when the influence of heart failure, antiarrhythmic medication, and history of coronary artery disease (CAD) are taken into account (Dunbar et al., 1999). Depression also contributes to adverse outcomes and poorer Quality of life in people with CAD and myocardial infarction. There is increasing evidence that depression and anxiety are associated with adverse events through the mechanisms of sympatho-adrenal hyperactivity and increased levels of catecholamines, diminished heart rate variability, ventricular instability, alteration in platelet receptors, and secretion of immune factors (Bruce & Musselman, 2005; Miller, Stetler, Carney, Freedland, & Banks, 2002; Musselman et al., 2000). These mechanisms are also arrhythmogenic (i.e., capable of inducing arrhythmias).

In the following discussion, we focus on the literature related to the unique experience of depression and anxiety in people living with ICDs.

Depression

Measurement tools designed to capture the spectrum of symptoms and responses associated with depression vary in their conceptual and diagnostic dimensions, and include the Beck Depression Inventory (BDI) (Friedmann et al., 2006), the Center for Epidemiologic Studies Depressions Scale (CES-D) (Radloff, 1977), the Hospital Anxiety and Depression Scale (HADS) (Zigmond & Snaith, 1983), the mental health subscale of the SF-36 (Ware et al., 1993), the Schedule for Affective Disorders and Schizophrenia (SADS) (Endicott & Spitzer, 1978), and specially designed or lesser used questionnaires (Fritzsche et al., 2007; Heller, Ormont, Lidagoster, Sciacca, & Steinberg, 1998; Lemon & Edelman, 2007). The statistical analyses of data obtained with these measures are typically limited to the comparison of group scores at various longitudinal points, and regression analysis techniques for the identification of predictors, often in the absence of any theoretical grounding. Consequently, it is challenging to draw conclusions about people's experience of depression, and the effects and trajectories of pre-existing or new onset depression.

Factors associated with depression or depressive tendencies in people with ICDs include the extreme age brackets (i.e., older than 75 years and younger than 25 years), female gender, limited social support, multiple co-morbid conditions, greater numbers of symptoms and symptom burden, and diminished physical functioning (Bilge et al., 2006; Dunbar, 2005; Heller et al., 1998; Sears Jr & Conti, 2002). There also is evidence to support the need to screen people for "at-risk" personality traits, such as Type-D personality (characterised by the stable traits of negativity and social inhibition) (Burg, Lampert, Joska, Batsford, & Jain, 2004; Pedersen, van Domburg, Theuns, Jordaens, & Erdman, 2004), trait optimism (the tendency to view situations as likely to turn out in a positive manner) (Dunbar, 2005; Sears et al., 2004), and depressive, ineffective, or passive coping behaviour (Dougherty, 1995; Lemon & Edelman, 2007); in so

doing, clinicians can estimate the risk for depression. A sense of loss of personal, social, and economic resources also has been hypothesised to lead to depression in this patient group (Luyster et al., 2006), while there is evidence that mental health improves over time, especially in the first 12 months following implantation (Kapa et al., 2010; Wheeler et al., 2009).

It is unclear whether symptoms of depression occur in greater frequency in ICD recipients compared with other patient groups (McCready & Exner, 2003). Major depression and depressive symptoms occur in 15% to 31% of people following MI (Frasure-Smith & Lesperance, 2003), and 10% to 35% of people with arrhythmias (Herrmann et al., 1997). A pre-implantation history of depression associated with limited social support and muted optimism traits may account for more of the variance in self-reported mental health than do age and severity of heart disease (Sears et al., 2005). The challenge lies in determining whether depression is caused by – or merely associated with – ICD implantation, given the prevalence of mood disorders among cardiac patients and the general population, the multiple effects of additional comorbid conditions, and social, cultural, and economic factors (McCready & Exner, 2003). Most important, we lack a theoretical understanding of the important predictors, an awareness of the factors that affect change in PROs over time or how people's trajectories of impaired mental health affect their outcomes, and how to plan therapeutic interventions accordingly.

Anxiety

The experience of fear and anxiety following ICD implantation or shocks is widely reported in the literature (Bostwick & Sola, 2007; Dickerson et al., 2010; Godemann et al., 2004; Sears Jr & Conti, 2002; Sola & Bostwick, 2005). Approximately 33% of the articles published about ICDs and patients' experiences, before 2005, focused on anxiety symptomatology or

clinical anxiety disorders, including panic disorder (Stutts, Cross et al., 2007), while 11 of the 27 studies published before 2008 addressed anxiety associated with ICD shocks (Pedersen, Sears, Burg, & Van Den Broek, 2009; Stutts et al., 2007). Again, the current literature lacks a consistent conceptualisation and operationalised measurement of the range of possible anxiety-related responses and behaviours (Bostwick & Sola, 2007), and fails to capture individuals' changing conditions over time. The true prevalence of anxiety among ICD recipients is not known, and the degree to which the ICD itself alters mental health functioning remains controversial (Crossmann, Pauli, Dengler, Kuhlkamp, & Wiedemann, 2007; McCready & Exner, 2003; van den Broek, Nyklicek, & Denollet, 2009). Up to one third of ICD recipients experience a significant level of anxiety, often in the form of generalised anxiety, panic disorder, avoidance behaviour, and agoraphobia (Schuster, Phillips, Dillon, & Tomich, 1998; Sears Jr et al., 1999).

The primary precipitating factor for anxiety is the arrhythmia-terminating ICD shock, a distinguishing feature for people living with an ICD (Chair, Lee, Choi, & Sears, 2011; Stutts, Cross et al., 2007). The occurrence of a shock in conscious people is always a physically painful and often unpredictable event, is associated with worsening heart disease and increased mortality, and negatively affects people's return to routine daily functioning. The discharge from the device can leave a person immobilised because of fear that any movement or activity might trigger another (Ahmad, Bloomstein, Roelke, Bernstein, & Parsonnet, 2000). The occurrence of one or more shocks in the initial year following implantation is associated with declines in functioning and constitutes an important predictor of health status (Kamphuis et al., 2003; Schron et al., 2002).

The ICD experience and its impact on PROs appear to differ between people who experience ICD shocks and those who do not (Daubert et al., 2008; Gehi, Mehta, & Gomes,

2006; Jacq et al., 2009; Klein, Turvey, & Pies, 2007; Noyes et al., 2009), while others have disputed this conclusion, claiming that research about shocks and PROs has produced equivocal findings. These critics suggest that the impact of ICD shocks may be more benign than generally assumed (Raitt, 2008). Nonetheless, research groups have found that sustaining one or more ICD shocks results in poorer PROs, including worse mental health, avoidance behaviour, social isolation, fatigue, panic, dependence on others, and thoughts of dying (Ahmad et al., 2000; Carroll & Hamilton, 2005; Groeneveld et al., 2006; Hegel et al., 1997; Pelletier, Gallagher, Mitten-Lewis, McKinley, & Squire, 2002; Schuster et al., 1998). Additionally, device-related anxiety is associated with loss of control (Dickerson, 2002; Dunbar, 2005; Eckert & Jones, 2002; Ladwig et al., 2008), and the sequelae of post-traumatic stress disorder (Hamner, Hunt, Gee, Garrell, & Monroe, 1999; Ladwig et al., 2008). Research findings support the hypothesis that there may be a "dose response" associated with the number and frequency of shocks sustained, and the severity and duration of people's adverse responses (Exner et al., 2001; Irvine et al., 2002). Approximately 50% to 70% of people with an ICD will sustain an appropriate shock within the first two years of implantation (Sears Jr & Conti, 2003),[16] while 10% to 30% of people with ICDs will experience an electrical storm over the course of their life time (Gatzoulis et al., 2005; Kovacs et al., 2006),[17] and 10% will receive inappropriate shocks (Undavia et al., 2008).[18] Therefore, understanding the relationships between the timing and indication of shocks and other changes over time is particularly salient to the study of PROs in people with ICDs.

[16] An appropriate shock is delivered when the ICD correctly identifies a malignant ventricular tachyarrhythmia and activates a pre-programmed algorithm to attempt to terminate the arrhythmia and convert the heart to a stable rhythm.
[17] An electrical storm refers to a cluster of multiple shocks during a 24-hour period.
[18] An inappropriate shock is the result of device failure and the incorrect recognition and unnecessary treatment of arrhythmias.

The negative impact of shocks is disputed by some researchers who have failed to find a significant relationship between ICD shocks and anxiety (Duru, Buchi, Klaghofer, Mattmann, Sensky, Buddeberg, & Candinas, 2001; Kamphuis et al., 2003; Sears et al., 2005), and argue that premorbid conditions and psychological traits account for people's responses (Lemon & Edelman, 2007; Pedersen & van den Broek, 2008). Currently, the study of the impact of ICD shocks on individual patients' self-reported health status lacks rigorous and standardised methodology. With changing ICD programming and technological improvements leading to fewer shocks, the study of other determinants, including the progression of underlying heart disease and patients' psychological profiles, warrants further effort (Pedersen, Van Den Broek, Van Den Berg, & Theuns, 2010).

A limited number of studies of ICD patients have examined sex and gender differences in their psychological distress (Vazquez, Conti, & Sears, 2010), and several calls have been made for intensified attention to gender disparities in mental health outcomes and responses to intervention (Brouwers, van den Broek, Denollet, & Pedersen, 2011). Some researchers have observed significantly more anxiety, shock-related distress, and depressive symptoms among women (e.g., Piotrowicz et al., 2007; Whang et al., 2005), whereas others have failed to identify any sex or gender disparities in self-reported mental health status (e.g., Luyster et al., 2006; Noyes et al., 2009). This has led some researchers to deduce that "there is insufficient evidence to conclude that gender *per se* is a major autonomous predictor for disparities in psychological distress and QOL [quality of life] in ICD patients" (Brouwers et al., 2011, p. 798).

The recent surge in manufacturers' recalls and advisories related to ICDs (Schwartz et al., 2011) has turned researchers' attention to the health experiences of patients who receive notice that their implanted device may potentially malfunction, that they may require heightened

clinical vigilance, or that they may need to undergo lead or ICD extraction and replacement (Pedersen et al., 2011; Sears, Matchett, & Conti, 2009).[19] The unexpected failure of an ICD can be catastrophic and result in electrical storm and failure to terminate a ventricular arrhythmia (Sowell et al., 2006). There is conflicting evidence about the effects of a device advisory on PROs, as some researchers have found no significant differences in anxiety levels between groups of people that have or have not received an advisory (Birnie et al., 2009; Cuculi, Herzig, Kobza, & Erne, 2006; Gibson, Kuntz, Levenson, & Ellenbogen, 2008; Pedersen et al., 2011; Stutts et al., 2007; Undavia et al., 2008; Van den Broek, Nyklicek, Van der Voort, Alings, & Denollet, 2008), while others have concluded that people with ICDs are more likely to experience higher levels of anxiety after receiving a warning of potential device malfunction (Hauser & Maron, 2005; Sears Jr & Conti, 2006). The available evidence fails to account for the timing of the advisory in relation to other aspects of people's trajectories of adaptation following ICD implantation.

Psychological Interventions

The research community is increasingly focused on the effects of interventions aimed at addressing the mental health challenges of people with ICDs. Although beyond the scope of the present study, the PROs reported in this literature merit a limited discussion.

After conducting a review of nine randomised controlled studies (RCT) of cognitive behavioural therapy (CBT) interventions, published between 1980 and 2007, Pedersen, van den Broek, and Sears (2007) concluded that psychological interventions may be useful in improving exercise capacity and in reducing anxiety, but recommended that larger scale and better designed

[19] When a new trend in device malfunction is noted, national regulatory bodies may analyse the data and issue a "recall" or "advisory" with various degrees of urgency and recommendations. This information must be communicated to the ICD recipient, and frequently receives extensive media coverage.

studies be conducted to substantiate their claims. Since then, further research has demonstrated that CBT interventions contribute to improved psychological functioning, including reduced anxiety, depressive symptoms and disability days (Dunbar et al., 2009; Irvine et al., 2011), but that treatment aimed at psychopathology cannot be expected to have uniformly positive effects on ICD patients without careful attention to their individual characteristics, including their age, gender, and experience with ICD shocks (Crossmann et al., 2010). This recommendation was echoed by researchers who launched the FEMALE-ICD Study to examine the effects of a women-specific education, self-care management, and lifestyle intervention to produce changes in self-reported mental health status and found, in their pilot work, that younger women appear to be an at-risk sub-group, who may warrant a targeted intervention to improve outcomes (Vazquez et al., 2010). Similarly, a large scale Danish RCT is currently underway to test the effects of an ICD-specific psycho-educational rehabilitation intervention designed to improve psychological functioning and self-reported health status, device-related hospital admissions, and mortality (Berg et al., 2011). There is increasing evidence that clinicians should attend to patients' critical events, such as ICD shocks or device recalls or advisories, to facilitate their psychological adjustment and to improve their return to optimal daily functioning (Sears et al., 2009).

2.4.5 Social Health Status

We conceptualise the social dimension of self-reported health status as reflecting people's capacity enjoy social activities and roles in various communities, including with their families, friends, colleagues, and society, and to successfully accept and incorporate the implications of living with an ICD. Again, we acknowledge the over-lapping nature of the

various dimensions of health, but aim to differentiate social health indicators that distinctly describe outcomes related to participation and performance in society.

The US National Institutes of Health-supported PRO Measurement Information System (PROMIS) offers a helpful conceptual framework, and posits that measuring the important aspects of social health includes the assessment of social function and social support. Developers of PROMIS define social function as "involvement in, and satisfaction with, one's usual social roles in life's situations and activities" (Cella et al., 2010, p. 1182). These roles might exist within marital relationships, in parental and work responsibilities, and for social activities, and conceptually encompass *social roles,* such as work and family responsibilities, and *discretionary social activities,* such as leisure activity and relationships with friends, reflecting both the ability and satisfaction with participation. In the PROMIS framework, social support reflects "a person's perception of the availability or adequacy of resources provided by other persons" (p. 12), and includes both quantitative domains – marital status, number of relationships, frequency of contact with others – and qualitative domains – feeling cared for and valued, communication with others, and feelings of belonging and trust (Cella et al., 2010).

The PRO findings in the published ICD literature do not reflect the comprehensiveness of the framework suggested by PROMIS, and researchers have failed to theorise about the potential mechanisms of identified predictors of PROs. Components of social health are overshadowed by the study of psychological distress. To this end, we specifically discuss the limited evidence about the social functioning and social support of people living with ICDs.

Social Functioning

There are no studies that have focused specifically on patients' change in social health after ICD implantation. This is a significant gap because we presently lack an understanding of

how or when individuals resume their previously held roles, participate in work-related or social activities, and the extent of their satisfaction with fulfilling these roles over time, while adapting to a device that can affect their capacity to work, travel, and attend to social functions.

People with an ICD can experience higher levels of social dysfunction, including conflict, social anxiety, difficulties in parenting, economic losses, and loss of control (Dougherty, 1995; Eckert & Jones, 2002; Hallas, Burke, White, & Connelly, 2010; Sowell et al., 2006; Vitale & Funk, 1995). Little is known about how people with ICDs participate in their roles as parents or grandparents, friends, and members of communities. A small study of 18 people who received an ICD before the age of 40 years found that the participants described themselves as active and productive members of society, yet also reported diminished social interactions, worry, and avoidance of exercise and sexual activity, and body image concerns (Dubin et al., 1996).

Changes in women's social functioning after receiving an ICD remain poorly studied (Spindler, Johansen, Andersen, Mortensen, & Pedersen, 2009). Limited evidence suggests that the ICD may have a unique impact on women's lives, including raising body image concerns and affecting women's identities as professionals, caregivers, and caretakers (Smith, Dunbar, Valderrama, & Viswanathan, 2006; Walker et al., 2004). Qualitative researchers have reported that women describe the noticeability of device placement and scarring as "mutilation" (Palacios-Cena et al., 2011), and may experience difficulties in adjusting to their family roles in family planning and caring for their children (Tagney, James, & Albarran, 2003). Additional reports of diminished social interaction, social avoidance behaviour, perceived loss of independence, and family over-protectiveness suggest that living with an ICD may be associated with significant alterations in social function, especially in the face of ICD shocks, worsening

heart disease, and economic burden (Flemme et al., 2001; Flemme et al., 2005; May et al., 1995; Wallace et al., 2002).

The capacity to return to work and perform within the expected scope of professional practice is an important outcome in people with ICDs (Sears Jr & Conti, 2002). There is only limited evidence available to understand people's eligibility, experience, and satisfaction in resuming their employment. A study of 18 young ICD recipients reported that ten participants were gainfully employed, eight of whom returned to the job they held before their ICD implantation (Dubin et al., 1996). In contrast, other researchers have stressed that ICD patients might require significant changes to their employment, and may experience significant financial and emotional concerns about medical insurance coverage (particularly relevant in the USA), loss of employment, and financial insecurity (Luyster et al., 2006; Ocampo, 2000; Probst et al., 2011; Shea, 2004). There is no existing analysis of the timing of people's return to work, the satisfaction with their employment before and after ICD implantation, or changes in financial earnings, professional capacity, and identity over time.

The restrictions placed on automobile driving following ICD implantation and each subsequent shock can require major lifestyle changes (Finch, Sneed, Leman, & Watson, 1997). This is a primary concern to most people with ICDs because the loss of driving rights can significantly affect their personal freedom, capacity and eligibility for continued employment, parental responsibilities, and overall Quality of life (Carroll & Hamilton, 2008; Shea, 2004). Most jurisdictions impose restrictions ranging from zero to 18 months following ICD implantation and every subsequent shock (Shea, 2004) because the danger of syncope is greatest in the first six months following an aborted tachyarrhythmia, and then drops to a constant level that is never completely eliminated (Miles, 1997). People with ICDs are at higher risk of

partially or completely losing consciousness due to a ventricular arrhythmia before their ICD can resolve the arrhythmia, and they may lose control of a vehicle they are driving as a result of an ICD shock (Larsen et al., 1994).

Social Support

Diminished social support is both an outcome and a predictor of other PROs in people with ICDs (Wallace et al., 2002). People with ICDs may experience greater and more distressing levels of social isolation as a result of social avoidance behaviour and family and social dysfunction (Deaton & Namasivayam, 2004; Sears et al., 2005). Lack of social support is a known predictor of multiple poor outcomes in cardiac care (Deaton & Namasivayam, 2004), yet there is little literature about changes in the availability of social support after ICD implantation. Researchers who have conducted longitudinal studies have described no significant differences in groups' repeated measures of social support, which suggests that having an ICD does not significantly or negatively affect the availability of social resources (Carroll & Hamilton, 2008; Dickerson, 2002; Godemann et al., 2004; Kamphuis et al., 2003; Pelletier et al., 2002; Sossong, 2007). In contrast, qualitative researchers have reported that people with ICDs may perceive a loss of social support that can significantly affect their Quality of life and capacity to adapt (Fridlund et al., 2000; Kelley, Mehta, & Reid, 2008; Tagney et al., 2003; Williams, Young, Nikoletti, & McRae, 2007).

Device Acceptance

Device acceptance is emerging as a significant factor associated with social functioning. Device acceptance refers to a person's experience of living with an ICD and the complex adaptation process required to successfully become used to the permanency and implications of the device (Zayac & Finch, 2009). The degree of ICD acceptance is related to return to routine

functioning, device-related distress, appraisal of the device, and body image concerns (Frizelle, Lewin, Kaye, & Moniz-Cook, 2006; Ricci et al., 2010), which may be correlated with aspects of physical and mental health status (Burns et al., 2004; Duru et al., 2001). The relationship between device acceptance and self-reported health status at various points in patients' trajectories following implantation, including critical events and end of life changes, remains poorly understood (Goldstein, Lampert, Bradley, Lynn, & Krumholz, 2004; Healey & Connolly, 2008; Hupcey, Penrod, & Fogg, 2009; Sears et al., 2009). In a recent prospective study of 70 Canadian patients undergoing ICD implantation for primary prevention, lower acceptance was associated with younger age (unspecified value) and poor pre-implantation self-reported mental health status (Carroll, Markle-Reid, Ciliska, Connolly, & Arthur, 2012). The measurement of device acceptance continues to be examined and validated (Pedersen et al., 2011; Ricci et al., 2012).

2.5 Summary

The study of the PROs of people with ICDs is in its infancy, and has primarily focused on the psychological aspects of people's experiences. Early studies concluded that the ICD was generally a well-tolerated treatment modality, especially when compared with previous treatment options. To better inform clinical practice, the study of ICD PROs must capture the complexity and ICD-specific domains of people's experiences, and account for the variability in individual trajectories of change. To this end, it is pivotal to conceptualise and define outcomes that reflect the physical, mental, and social health implications of life with an ICD.

We highlighted the limited evidence available to describe and understand the changes in people's physical functioning, exercise, sleep, and sexual activity, and the experience of pain. We emphasised the significant relationship found between ICDs and mental health status in the

discussions focused on the experience of depression and anxiety. We stressed the potential implications and scientific debate about the impact of living with an ICD on social functioning, social support, and device acceptance, and the current gap in research related to understanding the social health PROs of this population.

The most significant limitations of the knowledge accumulated to date are the absence of a theoretical framework to guide the study of PROs in people with ICDs, the lack of a comprehensive approach to the measurement of PROs equally inclusive of the physical, mental, and social components of people's health experiences, and the failure to understand individuals' change over time, including the distinct trajectories that may describe outcomes experienced by specific groups of patients. The analyses conducted to date have been limited to comparisons of the mean scores of various measures at different points in time, leading researchers to conclude that people's various negative responses to receiving an ICD generally abate over time, possibly with the exception of the effects of shocks. This approach fails to account for the possible different trajectories experienced by groups of people whose common characteristics may differentiate them from the entire group's mean scores, and whose particular outcomes are lost in the analyses. These gaps in current research limit clinicians' capacity to design and implement interventions that are appropriately timed in the recovery phase, and target groups of patients who may share a higher risk of experiencing poorer PROs.

We hypothesised that distinct trajectories of change are present in this patient population, and that special attention must be afforded to the study of social functioning. Our study was designed (a) to include theoretically-derived measures of physical, mental and social PROs and potential predictors, (b) to obtain longitudinal measures in the early recovery phase following implantation, (c) to conduct a statistical analysis of change over time designed to identify various

trajectories and predictors of membership, if distinct trajectories were found to be found, and (d) to explore the magnitude and meaning of change over time.

3. Conceptual Framework

In the literature review that precedes this discussion, we highlighted the clinical motivation for and theoretical underpinnings of the study of PROs, as well as the available evidence about the PROs of people living with an ICD. We argued that the study of individual change in PROs in this population is pivotal to the development of appropriately-timed and targeted supportive interventions to optimise the therapeutic benefits of the device, general health, and quality of life. We concluded that the scientific literature does not provide sufficient information about relevant PROs that specifically reflect the complexity of the lives of people with ICDs, independent of the variations in their underlying cardiac diseases. Furthermore, the analytical approaches widely used to compare mean scores at various points in time have failed to capture individuals' distinct trajectories of change that occur as they adjust to the presence of an ICD. The study described herein aimed to address these research gaps.

In this chapter, we discuss the conceptual framework that served to establish the underpinnings of the study design and to support the analytical method applied to answer the research questions.

3.1 Conceptual Framework for the Study of Patient-Reported Outcomes

The study of PROs casts a wide net in the exploration of variables that reflect the multiple, inter-connected aspects of people's experiences with disease and responses to treatment. In contrast with conventional medical outcomes, which are typically focused on morbidity and mortality, PROs must be grounded in a conceptual framework and taxonomy that explicitly defines and connects the concepts and domains (sub-concepts) under investigation, and the indicators selected for their measurement.

Early PRO models focused primarily on the identification of salient domains (Ferrans, Zerwic, Wilbur, & Larson, 2005). The absence of explicit theoretical underpinnings for most PRO frameworks resulted in lists of variables being commonly studied with no hypotheses about the associations among them (Sousa & Kwok, 2006). According to Haase and Braden (2003), an atheoretical approach to the assessment and measurement of PROs fails because the relationship(s) between domains cannot be assessed, the meaning of relationship patterns cannot be interpreted, and there is no basis for specifying whether the dimensions measured are moderated or mediated by the person, the disease processes, the treatment-related factors, or all three. To be clinically relevant and supportive of practice, a good framework must be relatively simple, intuitively reasonable to clinicians and researchers, and empirically testable (Guyatt et al., 2007).

The present study also required theoretical justification related to the selection of predictor and outcome variables that reflect the unique experiences of people who receive an ICD. In particular, the conventional differentiation used in most studies between patients who are implanted to prevent an arrhythmic event associated with severe heart failure (primary prevention therapy) and those who have already sustained a significant ventricular arrhythmia and receive an ICD to prevent a further event (secondary prevention therapy) must be discussed. Given the relative infancy of PRO research in cardiac device groups, we propose a beginning explication of the domains of PROs most salient to people who require an ICD, and which warrant inclusion in a comprehensive conceptual framework.

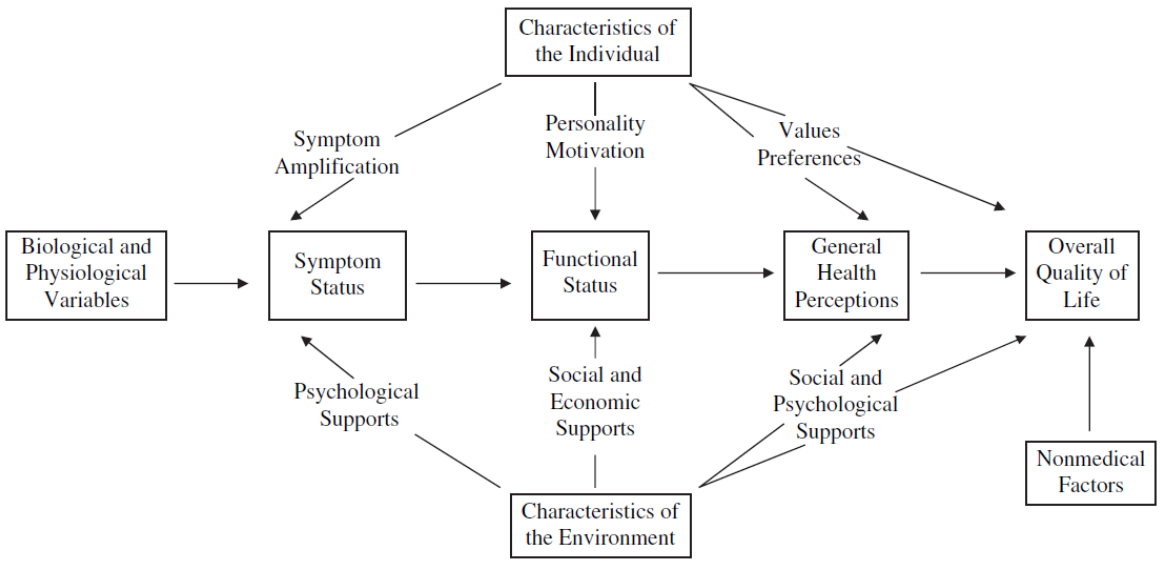
To this end, the following discussion outlines the conceptual framework that underpins this study. As noted in earlier chapters, the terms “patient-reported outcomes”, “quality of life”, and “health-related quality of life” have similar meanings in the literature. We favour “patient-

reported outcomes" as the term that most appropriately describes the outcomes measured in this study. For the purposes of the following discussion, we also refer to the terms originally employed by the authors of seminal manuscripts.

3.2 The Measurement of Patient-Reported Outcomes of People with Heart Disease

Wilson and Cleary (1995) developed a health-related quality conceptual model that provides a useful framework to define and operationalise PROs as a multidimensional construct, and bridges and unifies the biomedical and social science paradigms. They argued that the biomedical framework aims to understand causal relationships and to classify patients in prognostic or therapeutic groups, whereas the social science paradigm focuses on the social context and the multiple factors that contribute to illness and patients' experiences. The Wilson and Cleary conceptual model integrates these two perspectives, and links biological and physiological variables, symptom status, functional health status, general health perceptions, and overall quality of life (See Figure 3-1).

Figure 3-1: Wilson and Cleary Conceptual Model of Health-Related Quality of Life



The Wilson and Cleary (1995) conceptual model is relatively simple, focuses on five types of patient outcomes, and spans the cellular and organ level to that of the entire person. The first component focuses on the function of cells, organs, and organ systems, and involves objective indicators of biological and physiological variables. This starting point of the determinants of health status does not represent a type of quality of life measure, *per se*, but rather delineates the basis for the following four components of the model that can be measured in terms of PROs. The second component encompasses symptom status, including emotional, cognitive, and physical symptoms perceived by the patient. Functional status includes physical, social, role, and psychological functioning. General health perceptions refer to patients' evaluations and integration of all the preceding health concepts. Lastly, overall quality of life refers to patients' evaluations of their quality of life, as measured by their satisfaction with life and "global" quality of life (Ferrans, 2007; Wilson & Cleary, 1995). The model also links individual and environmental characteristics, although these components are not discussed in the original text. Wilson and Cleary (1995) stated that the absence or direction of arrows between categories does not imply that other relationships do not exist, but rather that the pathway from biological and physiological variables to overall quality of life is the dominant causal relationship between the dimensions measured.

The Wilson and Cleary (1995) model resonates with clinicians and is applicable to clinical research (Guyatt et al., 2007; Sousa & Kwok, 2006). It supports the paradigm shift outlined in Chapter 2 that is broadening how clinicians, researchers, policy makers, and society think about health in that it goes beyond the absence of disease (Gralla, 2012; Sousa & Kwok, 2006). The model has been widely applied to different populations, including patients with cancer (Ferrans, 2007; Osoba, 2007; Wettergren, Bjorkholm, Axdorph, & Langius-Eklof, 2004),

HIV/AIDS (Landon et al., 2002; Nokes et al., 2009; Phaladze et al., 2005; Sousa & Chen, 2002), and chronic obstructive pulmonary disease (Arnold, Ranchor, Koeter, de Jongste, & Sanderman, 2005). To date, the uptake of the model in cardiovascular research has been limited to the study of people with heart failure (Bennett et al., 2001; Heo, Moser, Riegel, Hall, & Christman, 2005; Lee, Yu, Woo, & Thompson, 2005; Masoudi et al., 2004; Ulvik, Nygard, Hanestad, Wentzel-Larsen, & Wahl, 2008), coronary disease (Ulvik et al., 2008), and combined cardiac and respiratory comorbid burden (Arnold et al., 2005).

At the time of publication of the Wilson and Cleary (1995) framework, the concept of PROs had not yet fully emerged, and the focus was on understanding health-related quality of life. Wilson and Cleary aimed to augment objective measures of health-related quality of life, such as aetiologies, pathological processes, and biological, physiological, and clinical outcomes, with more subjective measures of "complex behaviors and feelings" which are "... conceptually distinct constructs of disease, functional limitations, and self-rated health" (p. 59). They interpreted health-related quality of life and health status as interchangeable concepts, although they recognised the potential controversy of this approach. Further, they argued that most conceptualisations of health-related quality of life focus on physical, social, and role functioning, mental health, and general health perceptions, while "important concepts such as vitality (energy/fatigue), pain, and cognitive functioning are subsumed under these broad categories" (p. 60). At the time, existing frameworks excluded clinical data, such as measures of "biological and physiological function, tissue diagnoses, and patient-reported symptoms" (p. 60). The impetus for the development of their model was the absence of an adequate conceptualisation of the relationships between traditional clinical variables and health-related quality of life, both in research activity and in clinical practice. To this end, they categorised and linked health

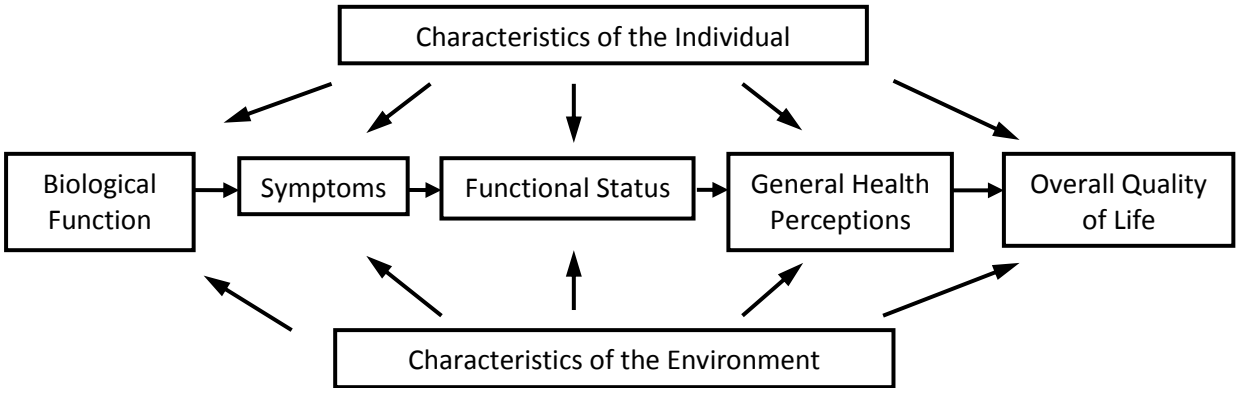
outcomes, and proposed specific causal relationships to facilitate the overall assessment of health-related quality of life and to improve health outcomes. Thus, the Wilson and Cleary framework is not a conceptual model of PROs *per se* because it integrates clinician-reported, physiological measures, and patient-reported health information. Nevertheless, it offers an integrated conceptualisation of self-reported health status in which the patient is the primary informant, while considering other important health-related antecedents and factors and linking self-reported health status to overall quality of life.

To facilitate the use of PROs in nursing and health care, Ferrans, Zerwic, Wilsbur, and Larson (2005) proposed a revision of the Wilson and Cleary (1995) model, based on a review of the PRO literature and an exploration of the theoretical underpinnings of each of the major components of the model. They argued that characteristics of the individual and the environment are theoretically related to the five components of the model, including people's biological and physiological variables. Ferrans et al. (2005) relied on an ecological model developed by McLeroy, Bibeau, Steckler, and Ganz (1988), and later revised by Eyler et al. (2002), to theorise that intrapersonal, interpersonal, institutional, and community factors, and public policy, interact at the level of the individual and thus influence PROs. These factors fit Wilson and Cleary's original conceptualisation of characteristics of the individual and the environment, and support Ferrans at al.'s hypothesis that these characteristics are related to the theorised components of PROs. In the revised model, characteristics of the individual are categorised as demographic, developmental, psychological, or biological, and characteristics of the environment include both social and physical influences on health outcomes.

Ferrans et al. (2005) further discussed their proposed revisions to the Wilson and Cleary (1995) model to align the dimensions with existing types of patient outcomes measures, while

systematically recognising the influence of individual and environmental influences on each dimension. The final revised model differs from Wilson and Cleary's original work in three substantive ways: (a) individual and environment characteristics are represented as influences on biological function, (b) the category 'non-medical factors,' modelled as an independent influence in overall quality of life, is removed and theoretically assimilated into the characteristics of people or their environments, and (c) descriptor labels of the characteristics of the individual and the environment are removed (see Figure 3-2).

Figure 3-2: Ferrans, Zerwic, Wilbur, and Larson's Revised Wilson and Cleary Conceptual Model of Health-Related Quality of Life



The model initially proposed by Wilson and Cleary (1995) and revised by Ferrans et al. (2005) provides a useful conceptual framework for the study of PROs. The revised model captures multiple priorities and (a) challenges researchers to seek causal relationships that can influence clinical decision making and support the development of targeted interventions; (b) encompasses the continuum of biomedical and social sciences, and is amenable to the inclusion of multiple dimensions of the determinants of health and quality of life; and (c) proposes the inclusion of a constellation of salient variables into a simple and clinically intuitive conceptual framework that can support the advancement of PRO science.

3.3 The Measurement of Patient-Reported Outcomes of Individuals with Implantable Cardioverter-Defibrillators

A discussion of some additional conceptual assumptions is required to account for the unique challenges faced by patients who require an ICD. Regardless of the aetiology of their heart disease, all people referred for ICD surgery are at risk for cardiac arrest related to a ventricular arrhythmia. The indications are categorised as primary and secondary prevention of sudden cardiac death. Primary prevention includes people who do not have a history of ventricular tachycardia or fibrillation, but who are at high risk of cardiac arrest because of their underlying cardiac aetiology, including severe heart failure associated with significantly diminished left ventricular (LV) function and impaired conduction despite optimal medical therapy. Secondary prevention refers to the prevention of a subsequent event following resuscitated or documented ventricular fibrillation, ventricular tachycardia or syncope from presumed ventricular arrhythmias (Epstein, 2008).

To date, most studies of the PROs of people with ICDs have either excluded people with primary indications or those with secondary indications in order to clearly differentiate between the underlying aetiologies of heart failure and primary arrhythmias. This differentiation is aligned with medical research that is aimed at understanding the disease-specific benefits and risks of ICD therapy and establishing evidence-based guidelines to support treatment. Yet, as we further discuss in Chapter 4, there is little evidence that this differentiation is helpful in the study of PROs (Pedersen, Sears, Burg, & Van Den Broek, 2009; Versteeg et al., 2012). All people advised to have an ICD are at risk for sudden cardiac death due to a ventricular arrhythmia, and are similarly treated with ICD therapy, an effective but unpredictable and often very painful electric shock to restore normal conduction, regardless of their underlying cardiac aetiology. In addition, the ICD follow-up clinical programs do not differentiate in their models of care based

on indication. In keeping with these factors, we included patients with primary or secondary indication in the design of our study.

As discussed in Chapter 3, the ICD is categorised as a cardiovascular electronic implantable device (CEID), as are pacemakers and cardiac resynchronisation therapy devices. ICDs are programmed to provide pacemaker therapy. In contrast, single function pacemakers primarily provide heart rate support, and may be used to improve symptoms, but do not recognise or treat potentially fatal ventricular arrhythmias with an electrical shock. More recently, cardiac resynchronisation therapy (CRT) has emerged as a useful intervention to reduce the risks of negative left ventricular remodelling associated with heart failure and delayed ventricular conduction (Goldenberg et al., 2010; Solomon et al., 2010; Tang et al., 2010).[20] CRT devices include an additional lead, placed in the left ventricle, that aims to optimise the synchronisation of cardiac impulses to increase cardiac output, and are generally programmed to deliver ICD therapy in addition to CRT (Moss, 2010). The therapeutic differences between cardiac electronic implantable devices are outlined in Figure 3-3.

[20] Negative left ventricular (LV) remodelling refers to the changes in size, shape, and function of the heart after injury to the ventricle. The causes of the injury may include acute myocardial infarction, chronic hypertension, and valvular or congenital heart disease. Negative LV remodelling implies a decline in cardiac function.

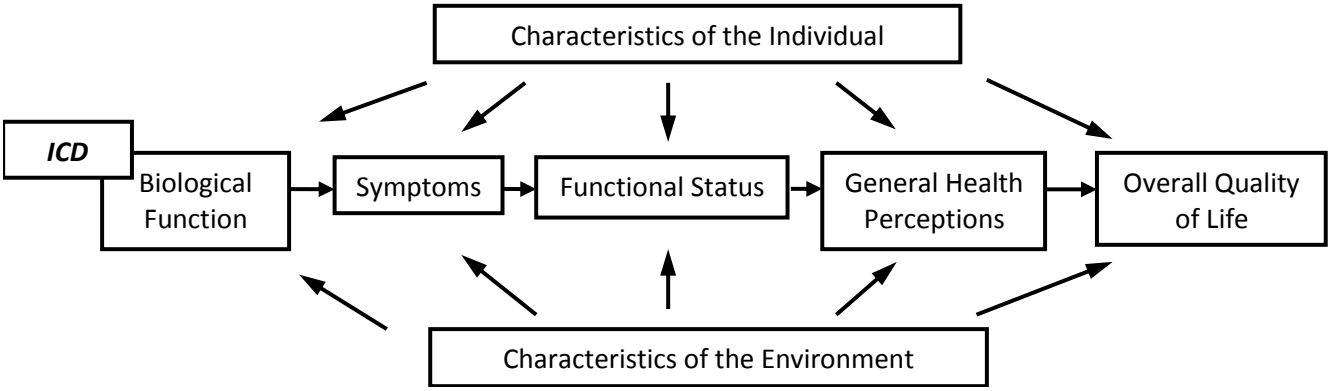
Figure 3-3: Therapeutic Differences among Cardiac Electronic Implantable Devices

Pacemaker	Implantable Cardioverter-Defibrillator	Cardiac Resynchronisation Device
• Reproduces or regulates heart rate • May improve symptoms • Does not treat ventricular arrhythmias	• Pacemaker • Recognizes and treats ventricular arrhythmias with effective, unpredictable and painful shocks • Aimed at individuals at risk for sudden cardiac death secondary to ventricular arrhythmias • Does not improve symptoms or cardiac function	• Pacemaker • If programmed. recognizes and treats ventricular arrhythmias with effective, unpredictable and painful shocks • Aimed at improving symptoms and cardiac function

In an effort to inform the research questions centred on the effects of ICD implantation on PROs, this study solely focused on people who had received an ICD, at the exclusion of people who were living with a CRT-ICD device because of the anticipated confounding effects of significant symptom improvement and altered cardiac remodelling associated with CRT.

ICDs differ from pharmacotherapy or other interventions aimed at symptom relief or altering a disease process, and are a patient safety device akin to an "ambulance in the chest." By facilitating rapid cardiac resuscitation in the event of ventricular arrhythmias and cardiac arrest, the ICD is on "stand-by" to alter biological functioning by "re-starting" the heart's conduction system, which has subsequent effects on PROs, including symptoms, functional status, general health status, and overall quality of life. We aimed to account for the conceptualisation of the ICD as a singular safety device for people with diverse heart disease aetiologies by further amending the Ferrans et al. (2005) conceptual model illustrated in Figure 3-4.

Figure 3-4: Addition of the ICD to the Revised Wilson and Cleary Conceptual Model



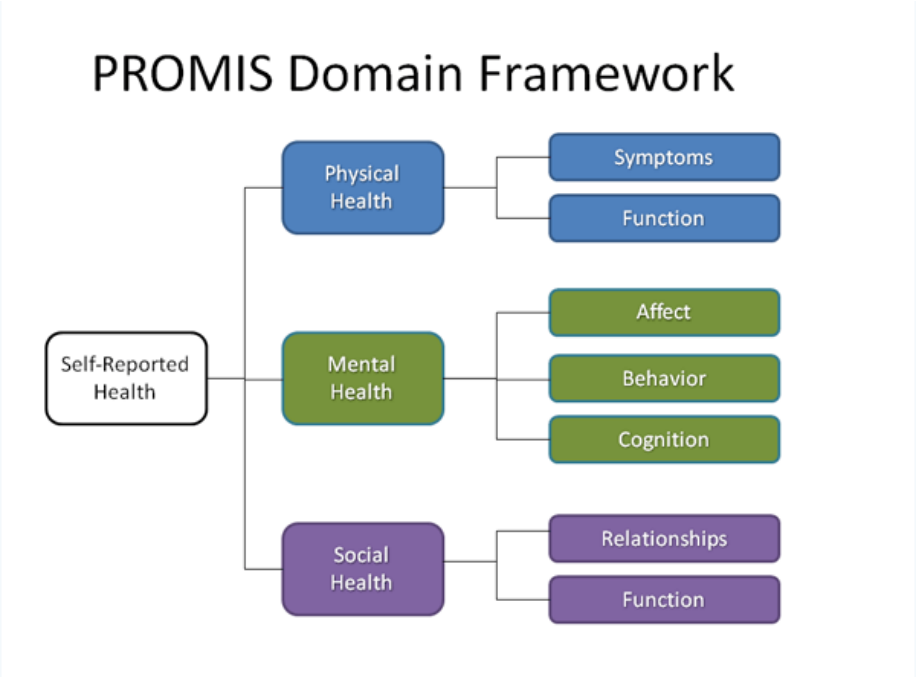
3.4 The Study of Patient-Reported Outcomes: Focus on Functional Status

For the purposes of this study, we focused on the dominant relationship between functional status, the antecedent dimensions (biological function and symptoms), and the characteristics of the individual and the environment as a preliminary, exploratory attempt to understand the PROs of people who receive an ICD. We acknowledged the dominant relationship that functional status has with general health perceptions and overall quality of life, but limited the analysis to testing the factors most significantly associated with changes in functional status. Limiting the scope of the present longitudinal study to the measurement of self-reported functional status was a necessary initial step required to inform a more complete study of PROs in this patient population.

Wilson and Cleary (1995) defined functional status as encompassing physical, social, role, and psychological functioning. Functional status refers to the largest set of PRO domains and can be categorised in multiple ways (Greenhalgh, 2009). We selected the classification system adopted by the Patient-Reported Outcomes Measurement Information Systems (PROMIS) presented in Chapter 2 and further discussed in Chapter 4. PROMIS is an initiative,

launched in 2004 by the US National Institutes of Health (NIH), that is designed to create a clinically useful framework to support PRO research, to validate common and accessible self-reported adult health outcome item banks, to establish a publicly available resource for the precise and efficient measurement of PROs, and to promote their application in clinical trials and practice (Cella, Gershon, Lai, & Choi, 2007; Cella et al., 2012; Riley et al., 2010). The PROMIS adult health domain framework includes physical, mental, and social self-reported health status, and presents an uncomplicated and clinically intuitive means of accounting for these facets of health (see Figure 3-5).

Figure 3-5: Patient Reported Outcomes Measurement Information System (PROMIS) Adult Health Domain Framework



As discussed earlier, Ferrans et al. (2005) modified the Wilson and Cleary (1995) model to imply that the characteristics of the individual and the environment affect all the domains leading to and including overall quality of life. In keeping with this study's focus on understanding the changes in functional status, we hypothesised that there are dominant

relationships between the characteristics of the individual and their environment, and their functional status. The focus of our attention would be limited to those dominant relationships.

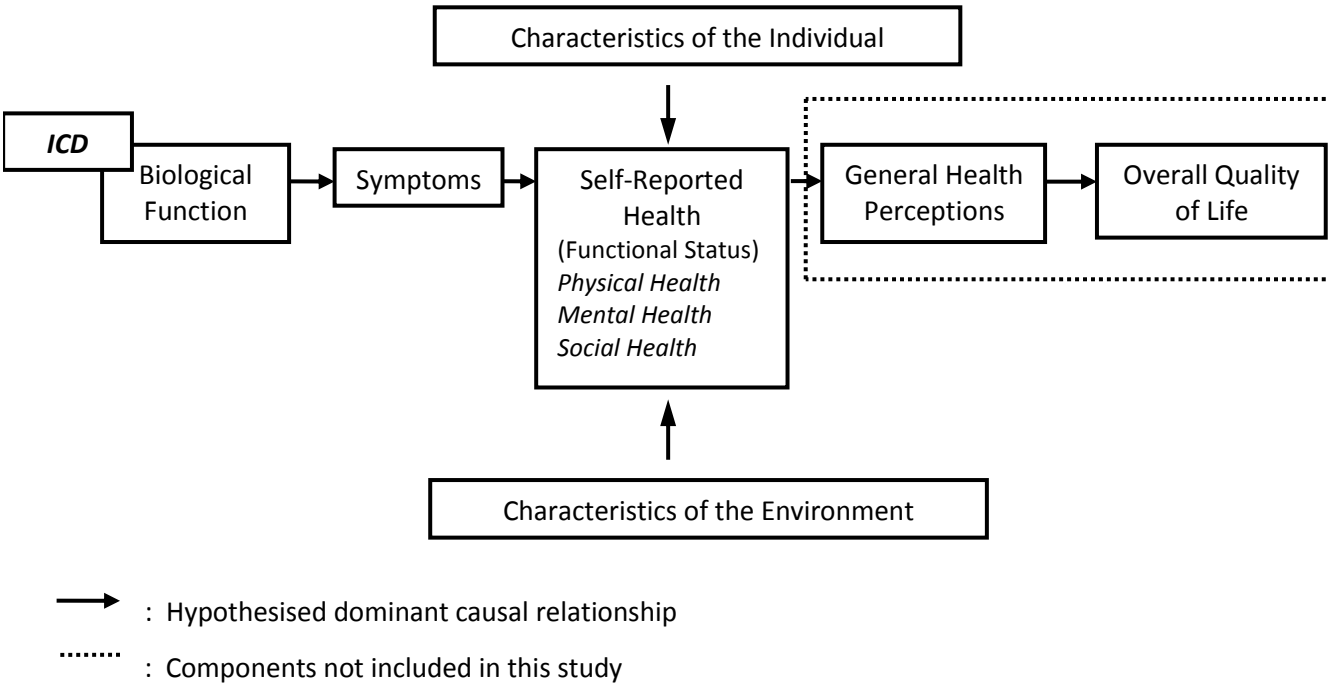
In the PROMIS framework, "Self-Reported Health" includes the components of physical, mental, and social health, which further encompass the sub-components of "Symptoms", such as pain and fatigue, "Function", "Affect", "Behaviour", "Cognition" and "Relationship". The alignment of the PROMIS and the Wilson and Cleary (1995) framework is imperfect and remains untested. For the purposes of our study, and because of our primary interest in determining how people function in their everyday lives after receiving an ICD, we conceptualised "Functional Status", the domain of interest, as "Self-Reported Health," composed of physical, mental, and social health status. We included measurements of symptoms (e.g., generalised pain and sleep disturbance) and affect (e.g., depressive symptoms and anxiety) in our overarching conceptualisation of "Functional Status" while acknowledging that these symptoms may be best treated as domains of components of the conceptual framework. We did not anticipate that the study of symptoms would be of high relevance in our study because the ICD is not aimed at modifying people's experiences of symptoms.

To best answer the research questions posed and because of the need to limit the scope of the study, we excluded the concepts "General Health Perceptions" and "Overall Quality of Life" from consideration. Although an incomplete application of the Wilson and Cleary (1995) framework may be seen as a limitation of the study, we argue that the PROMIS domain framework conceptually fits within Wilson and Cleary's use of "Functional Status." The PROMIS framework provides a more detailed explication of the functional status attributes of relevance to the ICD population, and further elaborates Wilson and Cleary's original definitions

of the four domains of functioning: physical function, social function, role function, and psychological function.

The established conceptual framework underpinning this study includes the modified Wilson and Cleary model supplemented by the conceptualisation of the ICD as a "stand-by" component of biological function, the PROMIS categories of self-reported health applied to functional status, and the hypothesised relationships between the characteristics of the individual and the environment and functional status (see Figure 3-6).

Figure 3-6: Established Conceptual Framework



3.5 Research Questions

To capture the dimensions that describe the experiences of people who receive an ICD, in terms of their everyday functioning in the early post-surgical period, and grounded in the revised

Wilson and Cleary (1995) conceptual framework, the study was aimed to answer the following questions:

1. Is there a change in PROs in the first six months following ICD implantation? If there is a change, what is the direction of the change trajectory?
2. Is the change the same for different groups of people?
3. Can these differences in the change trajectories be explained by different individual and environmental characteristics?

The above discussion aimed to clarify the theoretical underpinning of the study and support the analytical plan best suited to answer the research questions posed about changes in patient-reported functional status in people who receive an ICD. We use the established conceptual framework to discuss the study design and analyses.

4. Methods

There is a gap in our understanding of how people who receive an ICD, because of their high risk profile for sudden cardiac death, experience change in their physical, mental, and social functioning, following implantation, and how trajectories of change may differ across groups of people. We conceptualised PROs as patient-reported health status, outcomes that can only be reported and measured by asking people directly about their experiences. We hypothesised that PROs are informed by the characteristics of the individual and her or his environment, as well as by her or his biological functioning and experience of symptoms. Given the absence of research related to change in PROs after ICD surgery, we argue that the merit of the current study is its elucidation of changes in PROs in the first six months following implantation; it is a first step towards testing the full Wilson and Clearly (1995) model in this context. In this chapter, we provide a detailed account of the research methods used.

4.1 Research Design

The study involved a prospective, longitudinal design. The study name used for the purpose of participant recruitment was the "Heart and Health Experiences Living with a Defibrillator" study (Heart-HELD). A consecutive series of patients implanted with a first ICD who consented to participate completed a set of standardised and validated questionnaires at four times: (a) before implantation [baseline], (b) one month after implantation, (c) two months after implantation, and (d) six months after implantation. The time intervals were selected to optimise the study of individual change over time while focusing on the early adaptation period, which was identified as a potentially vulnerable period that is poorly described in the current literature.

The aim of the prospective, longitudinal design was to describe the change, if any, in the selected outcome variables (i.e., self-reported health status) and to determine whether differences in the pattern of change could be predicted by a set of theoretically-derived variables. The unique analytical interest was to explore the participants' individual trajectories of change (i.e., change within the same person measured at several times), and across groups of people, from the time of referral for ICD implantation to the first six months of having lived with the device.

4.2 Research Methods

The research methods of the Heart-HELD study were informed by the findings of the literature focused on approaches to the measurement of PROs in healthcare research and practice, and on the PROs of people with ICDs. We discuss, in turn, the study population and sampling; protocol and procedures; theoretically-driven selection, definition, and measurement of the variables; data quality strategies; and statistical analysis plan designed to answer the research questions.

4.2.1 Study Population and Sampling

The study population included all adult patients referred for a first ICD, for either primary or secondary indication, between April 1, 2010 and June 30, 2011, by an electrophysiology (EP) cardiologist affiliated with the study at one of three hospitals: St. Paul's Hospital and Vancouver General Hospital, in Vancouver, British Columbia (BC), and Royal Columbian Hospital, in New Westminster, BC. Completion of all follow-up measures was achieved by December 31, 2011. Patients were excluded from the study if they had been referred for ICD-cardiac resynchronisation therapy (CRT), a CRT upgrade of an existing ICD, ICD generator replacement related to battery depletion, or device replacement required because of implantation infection. Patients who were aged less than 18 years at the time of referral, unable

to read English, or unable to be contacted by telephone were excluded. Both elective out-patients and in-patients were recruited.

4.2.2 Ethical Considerations

Ethics approval was obtained from the Providence Health Care Research Ethics Board (Certificate number: H09-00920). The principles outlined in the Canadian Tri-Council Policy Statement for Research Involving Human Subjects [Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, Social Sciences and Humanities Research Council of Canada, 1998 (with 2000, 2002 and 2005 amendments)] were adhered to. The participants received written and verbal assurances that their participation was voluntary, that they had the right to refuse to participate, and that their present and future care would not be affected by their decision. The nature of the study presented minimal risk to the participants, although the potential for triggering distress associated with health events, recollection of device shocks, and other health-related challenges was discussed and outlined in the consent form. There were no known benefits anticipated as a direct consequence of participating in the study. The participants' confidentiality was protected through the use of anonymous identifier codes. All completed paper-based questionnaires were kept in a locked drawer of a secure office. Electronic data were stored on a password protected file server, which was compliant with the organisation's privacy code. All data were treated as confidential and were accessible only to the researcher and the dissertation supervisory committee. Contact information for the team of researchers and the Providence Health Care Research Ethics Board was provided (see Appendix B).

4.2.3 Study Protocol and Procedures

In British Columbia, electrophysiologists are the only physician group authorised to refer people for ICD implantation. We met with the electrophysiologists affiliated with the three study hospitals to present the research proposal and to seek their support in having their office staff facilitate participant recruitment. With their agreement secured, we established on-going collaborative relationships with their office assistants. To facilitate the recruitment of in-patients, we collaborated with the Electrophysiology Clinical Triage Coordinator, nurses at the primary hospital's out-patient unit, and the clinical nurse leaders and nurse practitioners of the cardiology and cardiac surgery wards at St. Paul's Hospital. We met regularly with clinical personnel to sustain these collaborative relationships and to address arising issues. We consistently differentiated the role of the doctoral candidate from her position as a clinical nurse specialist responsible for practice leadership in arrhythmia management.

The purpose of the study, the study protocol, and contact information were outlined in a brochure approved by the Providence Health Care Research Ethics Board (see Appendix C). The brochure was available in physicians' offices, arrhythmia clinic waiting rooms, and the out-patient and in-patient units. After securing their informed consent, the participants received a paper copy of the baseline questionnaire with standardised verbal and written directions for its completion and return (see Appendix D). The complexity of the referral for ICD implantation, the delay between the time of the EP's recommendation and the patient's decision to undergo implantation, the variability in patients' waiting times, as well as the inclusion of both elective out-patients and in-patients affected the timing of the completion of the baseline questionnaires relative to ICD implantation. We aimed to capture the participants' baseline assessment within one week before their implantation.

The study participants were given the choice of completing the follow-up questionnaires using either a paper- or web-based format. The web-based format was hosted on the University of British Columbia's on-line survey management system (Vovici®, Enterprise Feedback Management). Vovici® Enterprise Feedback Management (EFM) is a Canadian-hosted survey platform that stores and backs up all data, in Canada, and is in compliance with the BC Freedom of Information and Protection of Privacy Act.

The paper- and web-based versions of the questionnaires contained identical text, except for specific references to completing the check boxes on the paper form or electronically, and the formats were intentionally as visually similar as possible. The participants who opted to complete the paper-based questionnaires received a stamped envelope addressed to the study office. The four questionnaires (baseline and three follow-up questionnaires) were similar in appearance and wording, except for minor changes to time references. The wording of the established measurement instruments was reproduced exactly, and the sequence of the instruments was consistent in all versions. A licence agreement was established with QualityMetrics® to use the SF36v2 instrument (License agreement: QM007380). The three Patient-Reported Outcomes Measurement Instrument System (PROMIS) short form questionnaires, included in the study, were publicly available (Cella et al., 2012). We obtained written consent from the research group who developed and validated the Florida Shock Anxiety Scale (Kuhl et al., 2006), and the Florida Patient Acceptance Survey (Burns et al., 2005).

The participants' health records were reviewed and relevant data were extracted at the time of implantation. Microsoft Outlook® calendar was used to schedule the mailing of the paper-based questionnaires one week before their completion due dates, and forwarding of the

EFM Vovici® survey link, via email, was completed two to four days before the due date, to ensure consistency.

To recognise participation in the study and on-going commitment to completion of the repeated measures, promotional items were distributed. All of the patients who expressed a willingness to participate in the study received a small brooch-like study pin with the "Heart-HELD" logo. The pin was also distributed to physicians, nurses, and clerical staff who supported the project to increase the visibility of the study in the clinical setting. At the time the 2-month questionnaire was due, the participants received a fridge magnet printed with the study information. A thermal mug with the study logo was provided at the completion of the last questionnaire (at 6 months). Frequent telephone, e-mail, and automatic EFM Vovici® reminder notices were sent to promote questionnaire completion. If participants failed to complete the follow-up questionnaires within two weeks of their due date, for the web-based respondents, and three weeks for the paper-based respondents, they were called by telephone. If the completed questionnaire was not received after two reminders, the participant was deemed to have withdrawn from the study; a third telephone call was made to thank the participant for her or his participation and to confirm the withdrawal.

A study log was maintained to monitor on-going participation, to track the timing and completion of the repeated measures, and to keep a written record of all contacts with the participants.

4.2.4 Operationalisation of the Study Constructs

In Chapter 2, we discussed the importance of a theoretically-based approach to the selection of salient variables in PRO research. Failure to ground an inquiry in the *a priori* identification of variables and a framework congruent with the theoretical underpinnings of the

research questions may produce data that are of limited scientific value (G. Donaldson, 2008; Snyder et al., 2007). The U.S. Food and Drug Administration working group on PROs stressed that the conceptual definitions of variables requires the same scrutiny as their operationalisation, and the reliability, validity, and responsiveness of the questionnaires used (Acquadro et al., 2003). To this end, we discuss the selection, definitions, and measurement of outcome and predictor variables in the sequence proposed in the established conceptual framework.

The Selection of Predictor Variables

In keeping with the study's conceptual framework and the study's purpose to inform the design and tailoring of clinical programs, we categorised the predictor variables as: (a) characteristics of the individual, (b) characteristics of the environment, (c) biological function, and (d) symptoms related to heart disease and co-morbid burden.

Characteristics of the Individual

We selected sex/gender, age, marital status, household size, and employment status to describe the characteristics of the people enrolled in the study.

Age: We recorded the participants' date of birth and age at the time of device implantation. Researchers have identified a gap in understanding the relationships between age and outcomes in a population that varies widely in age at the time of implantation (Al-Khatib et al., 2011; Hamilton & Carroll, 2004; Santangeli et al., 2010). People's capacity to function in their everyday lives, and their need to resume their employment, social roles, and responsibilities, may be significant factors in their self-reported experiences of living with an ICD. Since many cardiac diseases and indications warrant ICD therapy, the ages of the eligible participant range

widely in the patient population. We used age in years as a continuous variable in the data analyses.

Sex/Gender: In Chapter 3, we identified a significant gap in the understanding of women's experiences of living with an ICD, and the absence of evidence related to sex and gender differences in PROs in this population. Recognising the importance of incorporating a sex and gender analysis while clearly defining the construct selected to achieve scientific rigour, the analysis was conducted with an interest in the effects of sex/gender on the PROs and their change over time. Sex/gender is a widely recognised predictor of functional capacity and affects treatment outcomes, and thus is likely to affect PROs (Brouwers et al., 2011; Habibovic et al., 2011; Marshall, Ketchell, & Maclean, 2011).

The record of a patient's sex/gender is usually assigned in a hospital admission form, based on the medical referral received at the time of an appointment booking and an admission clerk's interview with the patient. Biological sex is not routinely verified during the course of hospitalisation and the record of sex/gender is not usually altered during clinical care. The electronic record options include 'male' or 'female.' We recognise the limitations of constraining the assignment of sex and gender to an admission clerk's and other clinicians' visual assessments and judgement, and to medical records.

In the conceptual framework and analysis, we selected to employ the term 'sex/gender' to differentiate men and women, and to best capture the hypothesised biological and social differences of interest in this study. The definition of sex and gender in health research is evolving and there are no universally accepted definitions of the terms (Canadian Institutes of Health Research, Institute of Gender and Health, 2012a). Researchers have described the use of the terms 'sex' and 'gender' in the scientific literature as 'conceptually muddled', have

highlighted the need to clarify their use in healthcare research, and have called for better conceptualisations of the interplay between the two concepts in relation to different diseases (Hammarstrom & Annandale, 2012). We adopted the Canadian Institutes of Health Research (CIHR), Institute of Gender and Health (2012b) conceptualisation of gender as being associated with "socially constructed roles, relationships, behaviours, relative power, and other traits that societies ascribe to women and men" (para. 3), whereas sex refers to the "biological and physiological characteristics that distinguish females from males" (para. 3).

We hypothesised that both sex and gender may play a role in the PROs of people with ICDs. For example, there is growing evidence that sex explains differences in adult congenital arrhythmia heart disease (Verheugt et al., 2008), and severe arrhythmia genetic disorders (Ghani et al., 2011; Imboden et al., 2006; Liu, Choi, Drici, & Salama, 2005). Similarly, women's social context and cultural relationships may play a role in their experiences of cardiac arrhythmias, their adaptation to the ICD, and responses to treatment (Hintsa et al., 2010).

There is increasing use in the scientific literature of the term "sex/gender" to capture the complexity of the most salient features and phenomena, including: differences in anatomy; physiological systems; behavioural, cultural, and psychological traits; the self-identity or social representation of individuals; and the responses of social institutions (Mosca, Barrett-Connor, & Wenger, 2011; Torgrimson & Minson, 2005). While acknowledging such complexity, it is also important to recognise that it would be desirable to parse the social and biological factors at play – something beyond the scope of this study and perhaps the capacity of researchers, at this time. Consequently, it seems reasonable to approach the problem by recognising the multiplicity of biological and social interactions related to sex and gender that play a role in the PROs of people with ICDs – something made evident through the use of the term "sex/gender".

Marital Status and Household size: There is extensive evidence that marital status is a significant predictor of multiple health outcomes, including the PROs of cardiac populations (Chung et al., 2009; Murphy et al., 2008; Sbarra & Nietert, 2009). To this end, we recorded the participants' self-reports of their marital status, which we categorised as (a) single, (b) married or common-law, or (c) divorced, separated or widowed.

Because marital status may not be a good indicator of the available social support for older widowed or divorced people, who may be living with an adult child or someone else, we also measured household size to determine the potential social support available in the home environment. The participants were asked to report the number of people living in their households. The variable was coded with three categories: (a) lives alone, (b) lives with one other person, and (c) lives with two people or more.

Employment status: In the literature review, we discussed how the capacity to return to meaningful work and to function to the full scope of one's previous employment or activity is an important predictor of PROs in people with ICDs (Sears & Conti, 2002). In addition, ICD implantation, generator change surgery, and shock episodes impose significant activity and driving restrictions that may affect people's capacity and eligibility for continued employment (Carroll & Hamilton, 2008; Shea, 2004).

To capture activity status, the participants indicated whether they considered their main current activity, at the time of their baseline assessment, to be: (a) "caring for family", (b) "working for pay or profit", (c) "caring for family and working for pay or profit", (d) "recovering from illness", (e) "retired", or (f) "other". The variable was collapsed into two categories: (a) working for pay/profit or caring for family and (b) retired or recovering from illness; this dichotomy best captured whether the participants were actively employed or working, or not.

Characteristics of the environment

Ferrans et al. (2005) argued that there are social and physical dimensions to people's environments that must be accounted for in PRO research. We limited the selection of salient variables to geographic location as an indicator of the participants' physical environment, especially their access to healthcare services.

Geographic location of residence and access to care: British Columbians who require an ICD must travel to the larger metropolitan areas of Vancouver or Victoria, the most south western urban centres in a province that is twice as large as France. Access to specialised electrophysiology care for assessment of the appropriateness of device implantation and medical follow-up for device and arrhythmia management has significant implications for patients. Consensus guidelines state that the device should be electronically interrogated every six months and assessed in the event of shock or other cardiac events (Epstein, 2008). In addition, the device is equipped with an audible or vibrating alert system that signals to patients that the device must be checked for battery depletion, increased electrical impedance, or malfunction (Sheth, Mahmood, Singh, Carter-Adkins, & Pachulski, 2002; Simons, Feigenblum, Nemirovsky, & Simons, 2009).

We hypothesised that people's capacity to access specialised care in a timely manner to maintain their safety and to minimise their anxiety is pivotal, especially in the context of living with a complex electronic device, the risk of ventricular arrhythmias, the nature of ICD therapy, and the motor vehicle driving restrictions associated with device implantation and therapy. Most primary care providers have limited expertise in specialised ICD care given the rapid changes in device technology, the complexities of device interrogation, and the confusion associated with recurring device recalls and other advisories. Primary care providers may be unable to answer

patients' questions or issues, and may require the advice of electrophysiologists to manage their patients' care. From a patient's perspective, ease of access and proximity to electrophysiologists' expertise may be associated with their level of device-related anxiety, information needs, and capacity for self-care management, and thus may be associated with their perceptions of their physical, mental, and social health status (i.e., their PROs).

We recorded the British Columbia health authority in which the participants resided – Vancouver Coastal Health (VCH), Fraser Health (FH), Interior Health (IH), Northern Health (NH), or Vancouver Island Health (VIH) – recognising that five electrophysiologists were directly affiliated with VCH, two with FH, four with VIH, and none was associated with IH or NH. Because health authorities are primarily administrative jurisdictions and do not consistently reflect urban, suburban, or rural/remote residence, we relied on the participants' postal codes to calculate a 100-kilometre radius travel requirement to the nearest electrophysiologist. In most cases, this distance reflected a maximum two-hour travel time to the implanting centre, and was thought to be a reasonable proxy measure of ease of transportation to specialised medical care. If participants needed to travel by ferry, we classified them as living beyond the 100-kilometre radius, regardless of distance, because of the time required and travel restrictions associated with ferry schedules.

Biological Function

In the Wilson and Cleary (1995) model, biological function is assessed with indicators including specific laboratory tests, physical assessment findings, and medical diagnoses (Ferrans, 2007; Sousa & Kwok, 2006). To capture the dimensions pertinent to the study population, we recorded the participants': (a) indication for an ICD, (b) left ventricular ejection fraction (LVEF), (c) urgency status, (d) co-morbid burden, and (e) prescribed cardiac medications. ICD shock

history was self-reported in all of the follow-up questionnaires. We included the indication for ICD in the conceptual framework because it generally encompasses left ventricular function and is a strong indicator of ischaemic burden.[21] In addition, we considered whether the patients underwent implantation as an elective procedure or during the course of a hospital admission. We limited the use of the data related to the patients' comorbidities and medications to a description of the sample (i.e., these latter factors were not specified to be predictors of the patients' PROs or their trajectories).

Indications for ICD therapy: We differentiated *a priori* between the participants' indications for an ICD. The indication specified by the electrophysiologist on the referral form or in the medical history was recorded. To further describe the underlying cardiac disease processes, we documented the main cardiac aetiology when it was available. The most common conditions requiring primary prevention include ischaemic disease with or without prior myocardial infarction, dilated cardiomyopathy, and valvular, congenital, or other heart disease, which are associated with a high risk of cardiac arrest despite optimal medical therapy. Conditions warranting ICD implantation for secondary prevention include resuscitated or documented ventricular arrhythmias and syncope from presumed ventricular arrhythmias (Epstein, 2008).

We aimed to contribute to a better understanding of the influence of the indication for an ICD on patients' PROs. We hypothesised that people affected by cardiac aetiologies that produce symptoms and who receive an ICD (i.e., patients receiving primary prevention) share common experiences and effects on their physical, mental and social health, which may differ from those who receive secondary prevention (i.e., patients who do not experience symptoms but who are at

[21] Most patients undergoing ICD implantation for primary prevention have depressed left ventricular function because of previous damage to the heart, caused by their disease process. Patients who require an ICD for secondary prevention usually have normal left ventricular function because of the absence of ischaemic heart disease.

high risk of cardiac arrest). The current, dominant scientific approach that excludes either patients requiring primary or secondary prevention does not allow for such comparisons and may mask relatively strong predictors of patients' health status change trajectories.

Urgency of the need for implantation: The implantation of an ICD is not a procedure designed to address a cardiac emergency. Nevertheless, an ICD might be required during the course of hospitalisation to ensure a patient's safety. Examples of in-patient scenarios that result in relatively immediate implantation include admissions arising from sudden cardiac events and prolonged and frequent ventricular tachycardia following ST elevation myocardial infarction or cardiac surgery. We recorded whether the participants were elective out-patients admitted for same-day ICD implantation or more urgent in-patients.

Elective patients are generally medically stable, experience ICD implantation as a singular event in the continuing management of their chronic cardiac condition, and may have more resources in place, including extensive consultation with an electrophysiologist, when making the decision about whether to follow the medical recommendation for ICD implantation. In-patients are relatively more medically unstable, undergo multiple treatments while hospitalised, have less time and resources to make an informed decision, and may be more preoccupied by the often catastrophic medical events that warranted their initial hospitalisation.

Although the disposition at the time of implantation may not consistently affect their mortality or morbidity, we hypothesised that people's capacity to think about their therapeutic options, seek answers to their questions, and weigh the risks and benefits, for example, may be related to their early experiences and PROs when learning to live with an ICD. Similarly, if ICD implantation is one of many required therapeutic interventions offered during a hospital

admission for a catastrophic event, such as a cardiac arrest or acute decompensated heart failure, the indication for implantation may play an important role in patients' PROs.

Symptoms

Wilson and Cleary (1995) defined symptoms as "a patient's perception of an abnormal physical, emotional or cognitive state" (p. 61), which can be categorised as physical, psychological, or psychophysical. There is no ICD symptom-specific tool to capture the complexity of symptoms potentially associated with living with a high risk of ventricular arrhythmia and sudden cardiac death. We focused on the self-report of ICD shock(s) to capture the unique pain and mental distress associated with ICD therapy discussed in the literature review. For descriptive purposes only, we recorded selected cardiovascular self-reported symptoms when reports were available in the medical record.

Self-reported ICD shocks: The experience of ICD shock has been shown to be a strong predictor of mortality, morbidity, and quality of life in clinical trials and other studies (Gasparini & Nisam, 2012; Marcus, Chan, & Redberg, 2011). This experience is an unpredictable and painful aspect of ICD therapy, and the relationships between the experience of ICD shocks and anxiety and diminished physical, mental and social functioning are well established. We hypothesised that having had ICD shocks is associated with PROs in the early phase of living with the device when patients are adjusting to their expectations of, and responses to, device therapy.

We recorded the number of occurrences of ICD shocks in the periods between the follow-up observations reported by the participants. Because of the complexities of device follow-up and our inability to obtain device interrogation data, we were unable to verify the patients' reports. Nevertheless, the unverified reports of the participants' ICD shocks were congruent with our intention to capture their experiences; that is, it did not matter if the participants actually had

shocks, or not, what was relevant is whether they believed and remembered that they were shocked.

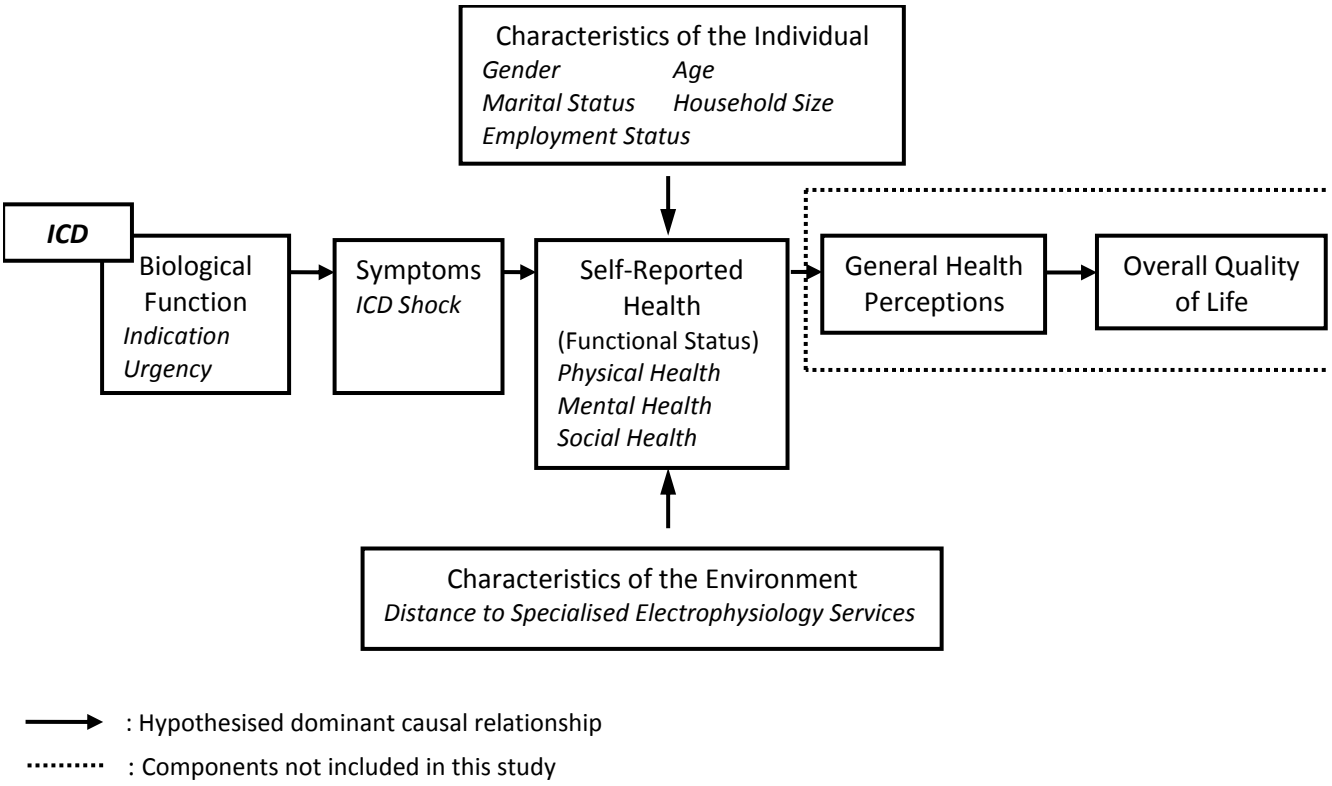
Cardiovascular symptoms: For descriptive purposes, we recorded the New York Heart Association Functional Classification of symptoms of heart failure that indicates activity tolerance and symptoms of heart failure (Saxon et al., 2010). The NYHA functional classification is widely used by healthcare providers to describe a person's symptomatology at a given level of performance, and to measure cardiac patients' level of impairment or disability related to their heart disease (Bennett, Riegel, Bittner, & Nichols, 2002). Although widely used, the classification lacks credibility; it correlates poorly with other measures of function (Rostagno et al., 2000), and evidence about its reliability and reproducibility is limited (Severo et al., 2011). Thus, the usefulness of the measure as a predictor or outcome variable is significantly limited (Bennett et al., 2002).

If the participants' presentation was consistent with ischaemic heart disease, or if available, we also recorded the Canadian Cardiovascular Society (CCS) Angina Class (Campeau, 1976) to describe the participants' burden of ischaemia in relation to their activity. The CCS classification is a four-level grading of symptom severity among angina patients. Its use in clinical practice stems from research showing that the grading is linearly associated with angiographic findings, revascularisation rates, mortality, and nonfatal myocardial infarction (Hemingway et al., 2004). To augment the descriptive value of the study, we used a question extracted from the Seattle Angina Questionnaire (Spertus et al., 1995) and asked the participants to report the frequency of their ischaemic symptoms at each observation: "Over the past 4 weeks, on average, how many times have you had chest pain, chest tightness, or angina?" The response options ranged from "none over the past 4 weeks" to "4 or more times a day." We recognise the

limitations of using a single question as a stand-alone measure of a complex experience and used the responses only to describe the study sample.

In the preceding section, we discussed the theoretical rationale for the selection of the predictor variables, the addition of select variables included for descriptive purposes, and the operational measures employed. The predictor variables are incorporated into the study`s conceptual framework depicted in Figure 4-1.

Figure 4-1: Predictor Variables Included in the Established Conceptual Framework



The Conceptualisation and Operationalisation of Self-Reported Health Status

To offer some clinical utility and to support interventions aimed at optimising health, we aimed to provide an in-depth understanding of how people who require an ICD function physically, mentally, and socially in their everyday lives, following ICD implantation surgery. The core outcomes of interest relate to operationalising and measuring changes in what people do, feel, and act as they adapt to living with an ICD. In the previous chapter, we conceptualised physical, mental, and social health as the components of patients' self-reported health status or PROs.

Selection of Instruments

We selected the general health status SF-36v2 instrument, and three Patient-Reported Outcomes Measurement Information System (PROMIS) Short Forms instruments, as well as the disease-specific Florida Patient Acceptance Survey, and Florida Shock Anxiety Scale to capture the domains of physical, mental, and social health status. Although we discuss the instruments in turn, for ease of reading, the 12 selected indicators of self-reported health status fit within the conceptual framework as follows:

Physical Health:	SF-36v2 Physical Functioning subscale
	SF-36v2 Bodily Pain subscale
	PROMIS Sleep Disturbance short form
Mental Health:	SF-36v2 Mental Health subscale
	SF-36v2 Vitality subscale
	Florida Shock Anxiety Scale
Social Health:	SF-36v2 Role Physical subscale
	SF-36v2 Role Emotional subscale
	SF-36v2 Social Functioning subscale
	PROMIS Satisfaction with Social Roles
	PROMIS Satisfaction with Discretionary Social Activities
	Florida Patient Acceptance Survey

All health-related measurements, from blood pressures and glucometers, to quality of life must satisfy basic properties if they are to be clinically useful and well accepted in practice. PRO research focuses on measuring an often ill-defined and unobservable latent variable that must be inferred from standardised self-reports (McHorney et al., 1993). The components of these required properties pertain to validity, reliability, repeatability, sensitivity, and responsiveness (Fayers & Machin, 2007; Kessler & Mroczek, 1995; Smith et al., 2006):

Validity:	Does the instrument measure what it is intended to and is the information useful for its intended purpose? Is it reasonable to claim that a PRO questionnaire is truly assessing PROs? To this end, an instrument must demonstrate content, criterion, and construct validity.
Reliability and repeatability:	Do patients whose PRO has not changed report similar or repeatable responses each time they are assessed?
Sensitivity and responsiveness:	Can the instrument detect differences between people, or groups of people? Is the instrument responsive to improvement or deterioration?

Although these properties are interrelated, each is independently important, and all can be complex to assess (McHorney, Ware, Rogers, Raczek, & Lu, 1992). Fayers and Machin (2007), two experts in PRO research methodology, reminded us that "assessing validity, in particular, is a complex and never-ending task. In QOL [quality of life] research, scales can never be proved to be valid. Instead, the process of validation consists of accruing more and more evidence that the scales are sensible and that they behave in the manner that is anticipated" (p. 78). They further argued that:

> …confirming validity is never proof that the instrument, or the scales it contains, are really tapping into the intended constructs. Poor validity or reliability can suffice to indicate that an instrument is *not* performing as intended. Demonstration of good validity, on the other hand, is a never-ending process of collecting more and more information showing that there are no grounds to believe the instrument inadequate. (p. 129)

Efforts must be made to measure, describe, and understand the limitations of instrument performance (Garratt, Schmidt, Mackintosh, & Fitzpatrick, 2002). To this end, we describe the accumulated evidence of the reliability, validity, and sensitivity of the selected instruments.

SF-36v2: The measurement of PROs in the Heart-HELD study centred on the use of the Medical Outcomes Study 36-Item Short Form initially developed by Ware and Sherbourne (1992). The aim of the Medical Outcomes Study was to "advance the state-of-the art of methods used for

routine monitoring of patient outcomes in medical practice and clinical research" (McHorney et al., 1993, p. 247). The 36-item instrument was constructed to comprehensively represent multidimensional health concepts and to measure the full range of health states, including self-reported health and well-being (McHorney et al., 1992). The original data was drawn from questionnaires completed by patients with minor (n = 638), serious (n = 168), psychiatric (n = 163), and combined serious and psychiatric (n = 45) conditions and by physicians, in 1986 and1987, and employed widely-used health surveys to capture multiple indicators of health, including healthcare behaviour, distress and well-being, objective reports and subjective assessments, and self-evaluations of general health status (McHorney et al., 1993; Ware & Sherbourne, 1992). The instrument was revised in 1996 to address deficiencies identified in the original version, including improved instructions and lay-out, and changes to the response options (Ware, Kosinski, & Dewey, 2000).

The SF-36v2 is a generic health profile questionnaire that contains 36 items that measure eight domains of health: (a) Physical Functioning, (b) Role Physical, (c) Bodily Pain, (d) General Health, (e) Vitality, (f) Social Functioning, (g) Role Emotional, and (h) Mental Health. The initial scoring options range from 1 to 5 for all subscales except Physical Functioning (1-3) and Bodily Pain – Magnitude (1-6). Following the initial scoring by respondents, the subscales are rescaled from 0 to 100 with higher scores indicating higher or better function.

The subscales were hypothesised to form two distinct higher-order clusters representing physical and mental health, which was confirmed with factor analysis. Two distinct Physical Component and Mental Component Summary scales accounted for 80 to 85% of the variance in the responses of people representing the U.S. general population (Ware et al., 2000). The Physical Function, Role Physical, and Bodily Pain subscales were found to correlate most

strongly with the Physical Component Scale (the correlation between each subscale and the rotated principal component was .88, .78, and .77, respectively), while the Mental Health (.90), Role Emotional (.81), and Social Functioning (.71) subscales contributed most to the Mental Component Summary scale. The three remaining subscales, Vitality, General Health, and Social Functioning correlated with both components (McHorney et al., 1993).

For this project, we did not use the summary second-order scales; our interest focused on the individual domains (i.e., the subscales). We used seven of the eight subscales; we opted to exclude the General Health subscale because it did not capture a specific domain of interest to the study, and to limit the number of outcomes. The SF-36v2 Health Surveys are available in two recall periods: standard (four weeks) and acute (one week). We selected the standard recall period.

The SF-36 includes a selection of instruments, including the original RAND SF-36, and the QualityMetric SF-36 versions 1 and 2, and are some the most widely used PRO instruments in clinical research, with experience documented in thousands of publications (Garratt et al., 2002). It has been validated in multiple cardiac populations, including ICD patients (Beals et al., 2006; Falcoz, Chocron, Mercier, Puyraveau, & Etievent, 2002; Kao et al., 2010; McKee, 2009; Moulaert, Wachelder, Verbunt, Wade, & van Heugten, 2010; Nishi et al., 2010). Systematic comparisons indicate that the SF-36 captures the most frequently measured health concepts, except for sleep adequacy, cognitive functioning, sexual functioning, health distress, family functioning, self-esteem, eating, recreation and hobbies, communication, and health condition-specific symptoms or problems (Ware et al., 1998).

The initial clinical validation of the instrument demonstrated that patients with serious medical conditions scored significantly lower on all eight subscales (indicating worse self-

reported health status) compared with patients with minor medical conditions (McHorney et al., 1992). The homogeneity of the subscales measured by the average inter-item correlation exceeded .55 as outlined in Table 4-1 below (McHorney, Ware, Lu, & Sherbourne, 1994), indicating reasonable unidimensionality (Garratt, Ruta, Abdalla, Buckingham, & Russell, 1993).

Table 4-1: Inter-Item Correlation Coefficients of the SF-36v2 Scales

SF-36v2 Subscale	Mean Inter-Item Correlation
Physical Functioning	.56
Role Physical	.57
Bodily Pain	.70
Vitality	.62
Social Functioning	.74
Role Emotional	.61
Mental Health	.64

McHorney et al., 1994

Cronbach's alpha coefficients estimate the internal-consistency reliability of each subscale score, with coefficients of .70 or greater indicating sufficient reliability to compare groups and .90 or greater to analyse an individual's score (Tabachnick & Fidell, 2007). In Table 4-2, we outline the Cronbach's alpha coefficients reported in the SF-36 validation studies (Falcoz et al., 2002; McHorney et al., 1994), and the consistent results found in our study.

Table 4-2: Cronbach's Alpha Coefficients of the SF-36v2 Scales in the Study Data

SF-36v2 Subscale	Reported Cronbach's Alpha Coefficients[1]	Cronbach's Alpha Coefficient in Study Data
Physical Functioning	.93	.93
Role Physical	.84	.84
Bodily Pain	.82	.82
Vitality	.87	.87
Social Functioning	.85	.85
Role Emotional	.83	.83
Mental Health	.90	.90

[1]McHorney et al. (1994).

Sensitivity to detect differences between groups and responsiveness to change can be measured with the standardised response mean (SRM: ratio of the mean change to the *SD* of that change) and the effect size (ES: ratio of the mean change to the *SD* of the initial measurement). Optimally, a sensitive instrument should be able to detect small differences in modest-sized studies (Fayers, 2007). In a study of PROs in workers with musculoskeletal disorders, during the first four weeks after an injury, the overall ES for the SF-36 was 0.67, and the instrument was found to be more responsive to change than others, including the Nottingham Health Profile, the Health Status Section of the Ontario Health Survey, and the Duke Health Profile (Beaton, Hogg-Johnson, & Bombardier, 1997). In a study of pre- and post-surgical cervical spine replacement patients, Baron, Elashaal, Germon, and Hobart (2006) found an ES ranging between 0.43 and 0.70.

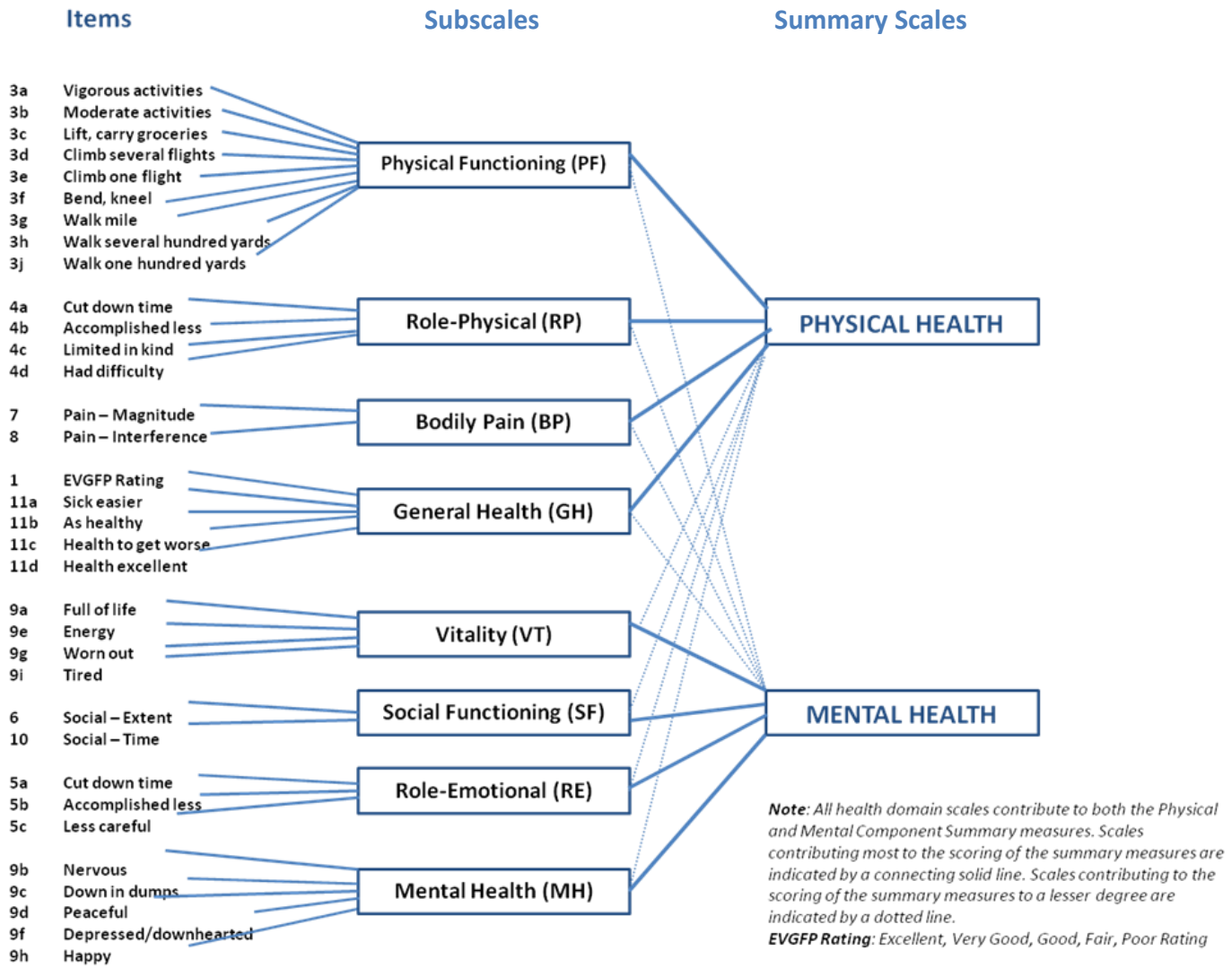
Population norm-based scoring using linear transformations to produce scores with a mean of 50 and a standard deviation of 10 has been established to facilitate the interpretation of differences across scales and for monitoring disease groups over time (Ware et al., 2000). Canadian norms also have been established (Hopman et al., 2004). The Canadian Multicentre Osteoporosis Study (CaMOS) was a prospective cohort study of over 9,000 ostensibly healthy Canadians aged 25 years and older living in a 50-km radius of nine Canadian cities, and which had established important baseline data related to health status (Hopman et al., 2000). In a five-year follow-up study, the scores appeared reasonably stable and confirmed the initial findings (Hopman et al., 2006). The CaMOS researchers used the US English-language version of the SF-36 (version 1) as one of the measures of generic health, and established mean age- and sex-standardised scores for the subscales and summary scales. We used the benchmarks established

by the CaMOS researchers to compare our findings, recognising the potential limitations of using the normative data established with the earlier version of the instrument.

Although the SF-36 instrument has been widely adopted in multiple research contexts and clinical settings, it has some limitations. The instrument was developed without input from patients, thus contravening the recommendations made by some PRO researchers and regulatory bodies that patients should inform the development, evaluation, and revisions of PRO instruments (Fayers, 2007). Discrepancies between the subscale and summary component scores have been identified, and significant correlations between the two summary components scores may indicate that the components are not independent (Taft, Karlsson, & Sullivan, 2001).

The use of the SF-36v2 is proprietary and licensed through QualityMetrics®, which provides proprietary statistical analysis. To facilitate data analysis, we used the QualityMetrics® Health Outcomes Scoring Software 4.0 User's Guide to develop IBM® SPSS®19 syntax to re-code and recalibrate the items as required, and to duplicate the scoring for each subscale (Ware & Kosinski, 2001). To ensure accuracy, we exported the data from EFM Vovici® to QualityMetrics® Software to verify the congruence between the IBM® SPSS®19 derived and the Quality Metrics® derived scores. Similarly, we developed and tested syntax for all the instruments used in the study to appropriately code, reverse score, calibrate and scale as required to produce summary scales for each measurement occasion. All subscales were rescaled between 0 and 100 as recommended, with higher scores indicating better PROs. The SF-36v2 measurement model is outlined in Figure 4-2.

Figure 4-2: SF-36v2 Measurement Model



Ware et al., 2000

Physical Health – Physical Functioning and Bodily Pain

The 10 items of the Physical Functioning (PF) subscale of the Sf-36v2 focus on the physical capacity to walk, climb stairs, and perform various activities of daily living. These items capture the ease in which people can attend to their basic physical requirements and reflect a salient domain of PROs, as discussed in the literature review. The participants selected from the response options, "yes, limited a lot", "yes, limited a little", and "no, not limited at all" to report their capacity to attend to a list of daily physical activities (e.g., vigorous or moderate activities, carrying groceries, climbing stairs, walking, kneeling, and bathing).

We hypothesised that people living with an ICD may experience pain from multiple sources, which may or may not be related to the implantation of the ICD. Two items of the SF-36v2 measure the magnitude of the pain experienced and the interference caused by pain on work or other activities. The Magnitude item included six response options (None; Very mild; Mild; moderate; Severe; Very severe), while there were five response option to the Interference item (Not at all; A little bit; Moderately; Quite a bit; Extremely). To calculate the subscale score, both items were reverse scored, and the first item (BP01: 'Pain – Magnitude') was recalibrated according to the developers' guidelines. The items were then summed to form the Bodily Pain total score. The total score syntax duplicated the developers' scoring recommendations.

Initial psychometric testing produced average inter-item correlations ranging between .56 and .70 and internal consistency coefficients of .93 and .82 for the Physical Functioning and Bodily Pain subscales, respectively (McHorney et al., 1994). In our study, we found internal consistency coefficients ranging between .88 and .93 with mean inter-item correlations between

.42 and .57 for Physical Functioning,[22] and Cronbach's alpha coefficients between .88 and .92 with bivariate inter-item correlations between .79 and .85 for Bodily Pain (see Appendix E).[23]

Mental Health – Mental Health and Vitality

We identified psychological functioning as an important component of self-reported health status in people with ICDs. In particular, we noted the relatively high prevalence and adverse effects of depression, fatigue, and anxiety on early recovery established in the literature. To capture these outcomes, we used the nine items of the two SF-36v2 subscales that relate to emotions and levels of energy or fatigue, and which are interspersed in the question ordering of the instrument. The response options for both subscales include "all of the time", "most of the time", "some of the time", "a little of the time", and "none of the time". Two items of the Vitality subscale (VT01: "full of life" and VT02: "energy") and two items of the Mental Health subscale (MH03: "peaceful" and MH05 "happy") were reverse scored before the items were summed to create total scores.

The reported average inter-item correlation for Mental Health and Vitality were .64 and .62, respectively, and the Cronbach's alpha coefficients were .90 and .87 (McHorney et al., 1994). This was consistent with our findings of Cronbach's alpha coefficients ranging from .85 to .89 for these subscales (range of mean inter-item correlation coefficients: .54-.64) (see Appendix E).

Social Health – Role Physical, Role Emotional, and Social Functioning

The findings of the literature review supported the need for careful attention being paid to social health status because the implantation of ICDs has been associated with significant social

[22] Physical Functioning is measured on a three-point ordinal scale. This explains the smaller correlations.
[23] There are two items in the Bodily Pain subscale.

isolation, diminished social functioning, and altered roles (Eckert & Jones, 2002), and social health status has not been extensively studied in this population. We viewed self-reported social health status as encompassing "understanding and communication, getting along with people, participation in society, and performance of social roles" (Cella et al., 2010, p. 1182).

The SF-36v2 four-item Role Physical subscale and the two-item Role Emotional subscale measure the extent to which physical health or emotional problems interfere with people's capacity to perform their work or other regular daily activities, including accomplishing less than wanted, not doing work as carefully as usual, or reducing the amount of time spent on activities. The options of the five-point Likert scales range from "all of the time" to "none of the time". Psychometric testing has demonstrated that the two subscales perform similarly with average inter-item correlation coefficients of .57 (Role Physical) and .61 (Role Emotional), and with Cronbach's alpha coefficients of .84 (Role Physical) and .83 (Role Emotional) (McHorney et al., 1994). In our data, the Cronbach's alpha coefficients were .94 for Role Physical (mean inter-item correlation range: .79-.82), and between .91 and .93 (mean inter-item correlation range: .77-.82) for Role Emotional. The two items of the Social Functioning subscale focus on the extent to which physical or emotional problems interfere with normal social activities, and have a reported average inter-item correlation of .74 and an Cronbach's alpha coefficient of .85 (McHorney et al., 1994). This is consistent with a similar coefficient ranging between .80 and .90 (inter-item correlation range: .66-.82) found in our study (see Appendix E).

Interpretation of Difference Scores of the SF-36

The minimal important differences (MID) in the PROs examined in our study can be informed by current research related to the interpretation of the SF-36, which remains one of the most widely used and psychometrically tested PRO instruments to date. In a study employing

triangulation methods to better understand the MID in SF-36 scores (and the Modified Chronic Heart Failure Questionnaire [CHQ]), Wyrwich et al. (2007) described the assessments of a physician expert panel, primary care outpatients with coronary artery disease or congestive heart failure, and their primary care physicians. They found that the MID varied greatly for the patient-assessed change categorisations, and that the primary care physicians' and expert panel's estimates differed substantially from those derived from patients. The physician-derived estimates were larger than those derived by patients. They concluded that the study demonstrated "little consensus and suggest[ed] that the derived estimates depend on the rater and assessment methodology" (p. 2257). Pertinent to our findings, they reported the patient-perceived mean change scores for the SF-36v2 subscales and patients' qualitative descriptions of those changes (see Table 4-3).

Table 4-3: Patients' Perceptions of the Magnitude of Change in SF-36v2 Scores (from Wyrwich et al. [2007])

SF-36v2 Subscale	Small Decline	No Change	Small Improvement	Moderate Improvement	Large Improvement
Physical Functioning	-2	0	2	6	7
Role Physical	-10	1	4	11	7
Bodily Pain	-4	2	6	7	5
Vitality	-3	1	3	6	9
Social Functioning	-10	1	3	9	5
Role Emotional	-8	0	3	7	7
Mental Health	-7	1	4	6	5

Note. Values represent absolute differences in scores (between baseline and one-year follow-up assessed bimonthly), averaged (possible scores range from 0 to 100). Patients were asked whether there had been a change in their status (i.e., "Is it better, worse, or about the same?"). Those who reported "better" or "worse" were subsequently asked to rate the change from ± 1 ("hardly any better/worse") to ± 7 ("a very great deal better/worse"). These indices were grouped: "no change" = -1, 0, and 1; "small improvement/decline" = ±2 and ± 3; "moderate improvement/decline" = ±4 and ±5; and "large improvement/decline" = ±6 and ±7. Selected data reported here. It is important to note that the inconsistencies in the magnitude of change categorised as moderate or large is likely associated with small numbers of scores (i.e., few patients reported this magnitude of improvement).

In contrast, the expert physician panel established significantly larger thresholds for minimally important differences in the change scores, indicating that patients and physicians differ in their assessments of the magnitude of change in health status that must occur to be considered important (Wyrwich et al., 2004) (see Table 4-4).

Table 4-4: Expert Physicians' Thresholds for Important Differences in SF-36v2 Scores

SF-36v2 Subscale	Minimal Change	Moderate Change	Large Change
Physical Functioning	15.00	25.00	35.00
Role Physical	18.75	31.25	50.00
Bodily Pain	20.00	40.00	60.00
Vitality	18.75	37.50	56.25
Social Functioning	25.00	50.00	75.00
Role Emotional	16.70	33.30	50.00
Mental Health	15.00	30.00	45.00

Note. Nine physicians who had published research related to heart disease patients' health-related quality of life formed the consensus panel. Values represent absolute differences in scores (possible scores range from 0 to 100) (Wyrwich et al., 2007).

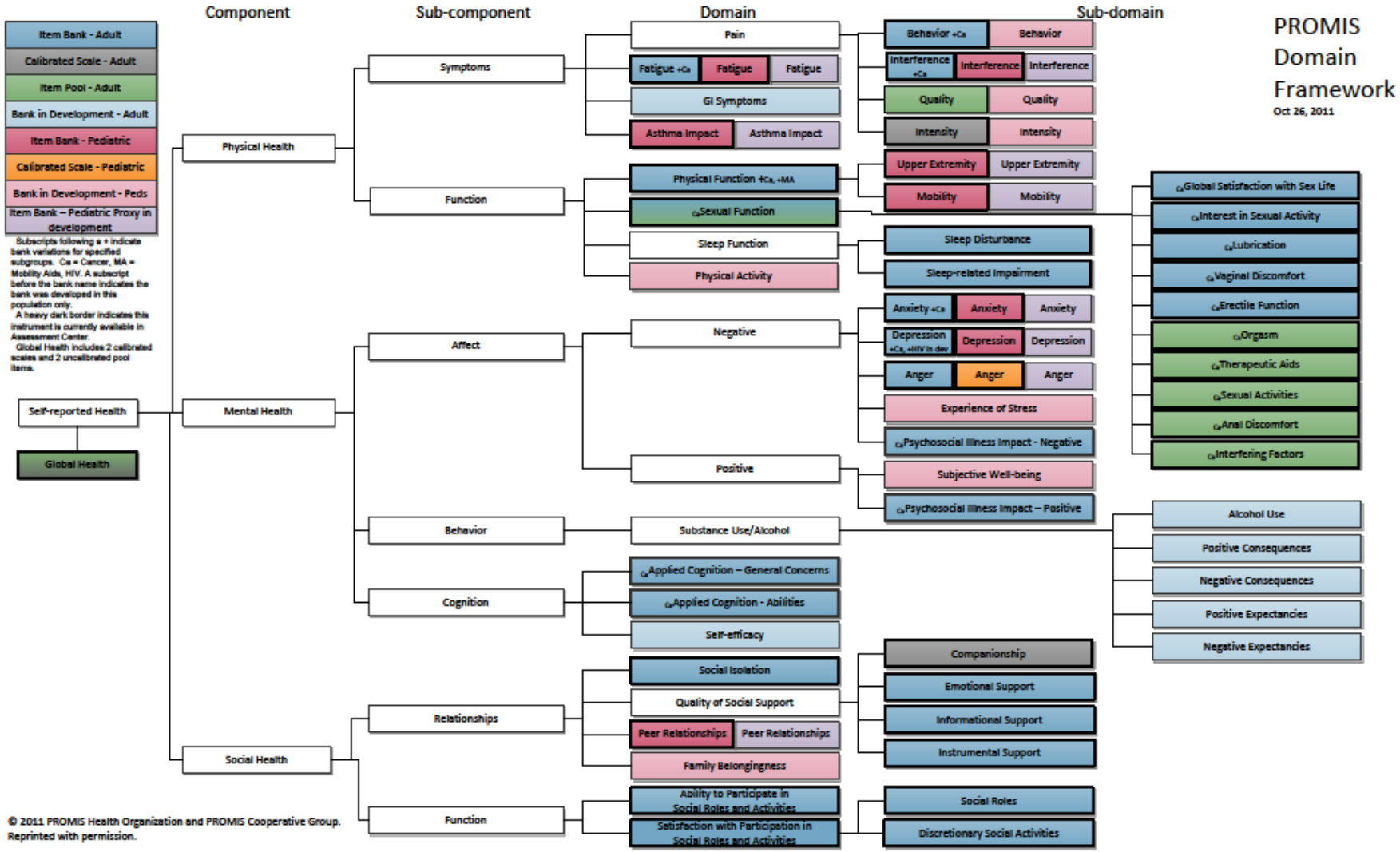
Notwithstanding the very large disparity between the change thresholds reported by patients and physicians,[24] and the very large thresholds specified by the physicians, Ware, Snow, Kosinski, and Gandek (1993) determined that a 5-point difference between groups may be socially and clinically relevant (Ware, Snow, Kosinski, & Gandek, 1993).

We restricted the comparison of our findings to the patient-perceived change scores established by Wyrwich et al. (2007). The threshold scores available did not include ranges; therefore, we estimated the change experienced in our study with the ratings provided by this group of researchers.

[24] Wyrwich et al. (2007) gave minimal weighting to the expert physician panel's estimates because they were not related to actual patient encounters.

PROMIS Short Forms: In collaboration with the U.S. National Institutes of Health (NIH) Roadmap for Medical Research Initiative, the Patient-Reported Outcomes Measurement Information System (PROMIS) is a collaborative effort of outcomes scientists from seven American institutions; it was initiated in 2004 to "revolutionize the way patient-reported outcomes tools are selected and employed in clinical research and practice evaluation" (Patient-Reported Outcomes Measurement Information System, 2009, p. 3). The researchers initially created a protocol for developing a conceptual framework and hierarchical structure to support the initiative (Cella, Gershon, Bass, & Rothrock, 2012). They adopted the broad and inclusive World Health Organization (WHO) physical, mental, and social health framework, and launched the Domain Mapping Protocol, which has become the conceptual framework underpinning item development (Cella et al., 2010). The PROMIS Domain Framework of Self-Reported Health outlines the components of physical, mental and social health, and maps the associated sub-components, domains, and sub-domains (see Figure 4-3).

Figure 4-3: PROMIS Domain Framework of Self-Reported Health



To develop item banks for computerised adaptive testing, the PROMIS researchers conducted a series of standardised item development phases, including identification of existing items, item classification and selection, item review and revision, focus group input on domain coverage, cognitive interviews about individual items, and final revision before item testing (Cella et al., 2007). Through an extensive and on-going literature review, the collaborative team identified over 7,000 existing items related to the first domains selected for the initial wave of development and testing (i.e., pain, fatigue, emotional distress, physical function, and social function) (Patient-Reported Outcomes Measurement Information System, 2009). The researchers then used processes called "binning" to group items according to similar unique features and 'winnowing' to reduce the large item pools to a smaller representative set of items (Cella et al., 2007). Following an item review with experts and revision processes designed to verify fidelity to content, clarity, and readability, the items were tested in small targeted groups. More complete testing is on-going in various clinical populations to develop item bank protocols (e.g., for depression, low back pain, arthritis, congestive heart failure, chronic obstructive lung disease, and cancer) (Patient-Reported Outcomes Measurement Information System, 2009). The initial phase produced 12 item banks capturing distinct domains and their associated short forms (see Table 4-5).

Table 4-5: The PROMIS Item Banks

Domain	Item Bank Number of Items	Short Form Number of Items
Emotional Distress – Anger	29	8
Emotional Distress – Anxiety	29	7
Emotional Distress – Depression	38	8
Fatigue	95	7
Pain – Behaviour	39	7
Pain – Impact	41	6
Physical Function	125	10
Satisfaction with Discretionary Social Activities	12	7
Satisfaction with Social Roles	14	7
Sleep Disturbance	27	8
Wake Disturbance	16	8
Global Health	–	10

Most PROMIS items employ five response options, and the wording of the response options is consistent within the item banks. The recall period is seven days (Patient-Reported Outcomes Measurement Information System, 2009). PROMIS collaborators used item response theory (IRT) to select and calibrate the items for their item banks, with the additional aims of validating computerised adaptive testing and developing short form scales (Fries, Bruce, & Cella, 2005). IRT refers to the use of complex mathematical models to understand a person's response to an item, and to link a dimension being measured with the probability of responding to a specific response option. IRT focuses on item-level information, and models the probabilistic distribution of responses depending on different theoretical assumptions and individual item responses (Cohn, Hagman, Graff, & Noel, 2011; Hays, Bjorner, Revicki, Spritzer, & Cella, 2009).

IRT provides the psychometric foundation underlying computerised adaptive testing (CAT), a test administration and analysis approach that employs algorithms to select questions from validated and calibrated pools of items tailored to the test taker, and standardises scoring to

enable the comparison of results (Turner-Bowker, DeRosa, Saris-Baglama, & Bjorner, 2012). Unlike traditional fixed-length questionnaires that administer the same questions to all test takers, regardless of individual health status, CAT questionnaires individualise the assessment, and ask each patient only the most informative questions unique to her or his own level of health, thus minimising the response burden and increasing the precision of the assessment. Each person completes a different questionnaire from a common pool of calibrated items; the computer scores the responses using standardised metrics that permit comparisons among patients (Kosinski, Bjorner, Ware, Sullivan, & Straus, 2006)

Although immensely promising for improving the clinical use of PROs, CAT was not employed in this study. There is currently no Canadian CAT system available,[25] and none has been validated for the cardiac population. Furthermore, we lacked the technological and operational resources to conduct CAT, although we acknowledge the desirability of using CAT to minimise the burden placed on patients who are asked to complete lengthy questionnaires and the gained precision in estimating patients' PRO scores. As a compromise, we employed three short forms to augment the SF-36v2 and to measure outcomes of particular interest.

The PROMIS short forms were developed from the large item banks. The findings of an extensive comparison with the overall bank and other well validated and widely accepted standard measures ("legacy items") provide evidence of good reliability across the score distributions (Cella et al., 2010). Although PROMIS provides psychometric evidence of the validity of the short forms, there are currently few clinical studies reporting their use. The PROMIS collaborators argued that:

[25] Canadian privacy legislation precludes the use of the PROMIS CAT software because the data would be stored on a file server located in the USA. British Columbia's Freedom of Information and Protection of Privacy Act was amended in 2004 in response to concerns about the US Patriot Act and the possibility that US officials could gain access to the personal information of British Columbians.

> These initial PROMIS item banks have demonstrated reliability, precision, and construct validity based on their correlation with legacy instruments. Evidence for validity in longitudinal clinical research (e.g., responsiveness to change) is yet to be demonstrated with PROMIS instruments, but clinical validation studies are underway.... However, there is no reason to believe that the PROMIS item banks and derived short-form scales will be any less responsive than the existing legacy measures. (Cella et al., 2010, p. 40)

We further discuss the three short forms that were incorporated in the study.

Physical Health – Sleep Disturbance

As discussed in Chapter 3, research has indicated that some people with ICDs have a heightened sense of vulnerability at nighttime, express anxiety about sustaining a shock during the night, and experience alterations in their sleep pattern and quality (Serber et al., 2003). To capture this domain, the participants described their sleep by completing the PROMIS Sleep Disturbance Short Form 8b, an eight-item questionnaire focused on people's perceptions of the quality and depth of their sleep (e.g., "My sleep was restless"), the adequacy of the restorative function of their sleep (e.g., "I got enough sleep" and "My sleep was refreshing"), and their difficulties getting to sleep or staying asleep (e.g., "I had difficulty falling asleep", "I had trouble staying asleep", and "I had trouble sleeping"). The eight items have five response options. Four of the items were reversed scored; all were then summed, and rescaled between 0 and 100, with lower scores indicating less sleep disturbance.[26]

The sleep disturbance item bank stems from the "Function" sub-component within the Physical Health component of the PROMIS taxonomy. It contains 27 items reflecting difficulties with sleep and the short form has a correlation of .96 with the full bank (Cella et al., 2010). A scale score of 50, of a maximum possible score of 100, is associated with a Cronbach's alpha coefficient of .94 (Patient-Reported Outcomes Measurement Information System, 2009). The

[26] The rescaling procedure was performed using the following arithmetic formula:
[(actual score – lowest possible score)/possible range] x 100.

item bank's reliability exceeds .88 across most of the score distribution (Serber et al., 2003). The full bank is correlated at r = .85 with the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1991; Cella et al., 2010). The PROMIS Sleep Disturbance Short Form 8b has been found to have greater measurement precision than either the PSQI or the Epworth Sleepiness Scale (Yu et al., 2011). In our study, the Cronbach's alpha coefficients ranged between .93 and .94, and the mean inter-item correlation coefficient ranged from .64 to .68 depending on the measurement occasion (see Appendix E).

Social Health – Satisfaction with Social Roles and Satisfaction with Discretionary Social Activities

Satisfaction with Participation in Social Roles and Satisfaction with Discretionary Social Activities are domains of the 'Function' sub-component of Social Health in the PROMIS taxonomy. The two relevant PROMIS item banks were initially constructed from the social health satisfaction item pool. The Satisfaction with Participation in Social Roles measures people's satisfaction with their ability to do things with their family, meet the needs of their dependents, perform daily routines, run errands, work, and perform household chores. The Satisfaction with Discretionary Social Activities short form focuses on the ability to "do things for fun at home", "do things for…friends", "do leisure activities", and satisfaction with "current level of activities of activities with friends" and "level of social activities".

The full item banks for these domains were the smallest of the 12 domains identified, with 12-14 items serving as indicators of each domain. Total scores of the two full item banks were correlated at .83 (Cella et al., 2010; Hahn et al., 2010). Each short form contains seven items and is correlated at .99 with its respective full-item bank (Cella et al., 2010). When correlated with items of the SF-36, which captures concepts related to social health status in the Social Functioning (extent and limitations of social activities), Role Physical, and Role

Emotional subscales, the two PROMIS instruments produced moderately-sized correlations (see Table 4-6). This may indicate that the PROMIS short forms broaden the measurement of social health status by measuring additional aspects of social functioning that are not fully captured in the SF-36 (Cella et al., 2010).

Table 4-6: Correlations between PROMIS Social Health Instrument Scores and Selected SF-36v2 Subscale Scores

	SF-36 Role Physical	SF-36 Role Emotional	SF-36 Social Functioning
PROMIS Social Role Full Item Bank	.57	.59	.58
PROMIS Discretionary Social Activities Full Item Bank	.44	.52	.53

SSR: Satisfaction with Social Roles
SDSA: Satisfaction with Discretionary Social Activities

The items of the two PROMIS short forms are scored between 1 and 5 ("not at all", "a little bit", "somewhat", "quite a bit" or "very much") for summed scores ranging from 7 to 35 which were subsequently rescaled to range from 0 to100. In our study, the Cronbach's alpha was .95 or .96 for both instruments at all measurement occasions, and the mean inter-item correlation coefficients ranged from .72 to .79 (see Appendix E).

Disease-Specific Instruments: Device-Related Anxiety and Device Acceptance

The PRO literature recommends the additional use of disease-specific instruments with generic measures to explore and capture people's context of health and illness (Fayers & Machin, 2007). We previously concluded that the unique aspects of living with an ICD relate to the nature of ICD therapy – the arrhythmia-terminating internal electric shock that converts potentially fatal ventricular arrhythmias to a perfusing rhythm (i.e., one that is sufficiently stable and organised) – and the challenges associated with living with a device that remains visible and

palpable under the skin, which can affect people's capacity to work, travel, and interact with others, and requires significant medical vigilance (Stutts, Cross, et al., 2007). To incorporate these aspects into the study, we used two instruments developed by a University of Florida, Department of Clinical Health Psychology research team to measure shock anxiety and device acceptance (Burns et al., 2005; Kuhl et al, 2006). Although other researchers have contributed similar instruments (e.g., Frizelle et al., 2006; Ricci et al., 2010), the two instruments developed the University of Florida team have undergone more psychometric testing, seem to be the most robust measures available at this time, and are congruent with issues raised in our clinical practice. Nevertheless, evidence of the reliability and validity of the tools is limited because of the relative infancy of this focus of research.

Mental Health – Florida Shock Anxiety Scale

The participants completed the Florida Shock Anxiety Scale (FSAS) (Kuhl et al., 2006) at each post-implantation observation. Initial evaluation of the FSAS was conducted at a large American centre with 72 ICD patients who had had ICDs implanted for at least three months. The FSAS items were derived from the literature and the combined experiences of electrophysiologists, psychologists, and a graduate student in clinical and health psychology. The 10 items reflect ICD-related anxiety (e.g., "I am afraid of being alone when the ICD fires", "I worry about the ICD not firing sometimes when it should", and "I am afraid to touch others for fear that I will shock them when the ICD fires"). The FSAS items are scored between 1 and 5 ("not at all", "rarely", "some of the time", "most of the time" or "all of the time") for a total summed score ranging between 10 and 50 (Kuhl et al., 2006).

Early psychometric testing demonstrated that 6 of the 10 items had moderate-sized inter-item correlations (> .50), and an oblique exploratory factor analysis revealed two separate

factors, labelled "consequence" (α = .88) and "trigger" (α = .74) factors. More recently, a study of the scale's factor structure, reliability, and validity confirmed good inter-item reliability with a Cronbach's alpha coefficient of .89, and discriminant validity demonstrated by negative correlations with single-item measures of emotional well-being, sense of security, perceived general health status, and quality of life. Confirmatory factor analysis identified a relatively well-fitting model with two factors, consistent with previous research, which were strongly inter-correlated. The FSAS was found to be sensitive to the number of shocks experienced, with greater numbers of shocks associated with greater shock-related anxiety. The authors concluded that "the FSAS is a reliable and valid measurement of the construct of shock anxiety" (Ford et al., 2012, p. 6).

Keren et al. (2011) recommended removing the last item ("I do not engage in sexual activity because it will cause my ICD to fire") because it is frequently unanswered and does not significantly affect the reliability of the scale. A total score was derived from the remaining nine items, which was subsequently rescaled to range between 0 and 100. We obtained a Cronbach's alpha coefficient of .90 to .91 on the original 10-item scale and the revised 9-item scale with unchanged mean inter-item correlation coefficients ranging from .47 to .52 (see Appendix E).

Social Health – Florida Patient Acceptance Survey

The Florida Patient Acceptance Survey (FPAS) was developed from an original bank of 47 items identified through literature reviews, surveys, and interviews with clinicians and patients (Burns et al., 2005). Following initial validation and factor analysis, a 15-item scale was developed, with ratings provided on 5-point Likert response scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"), and higher scores indicating greater acceptance. A factor analysis revealed that the items contributed to four subscales: (a) Return to function (four items:

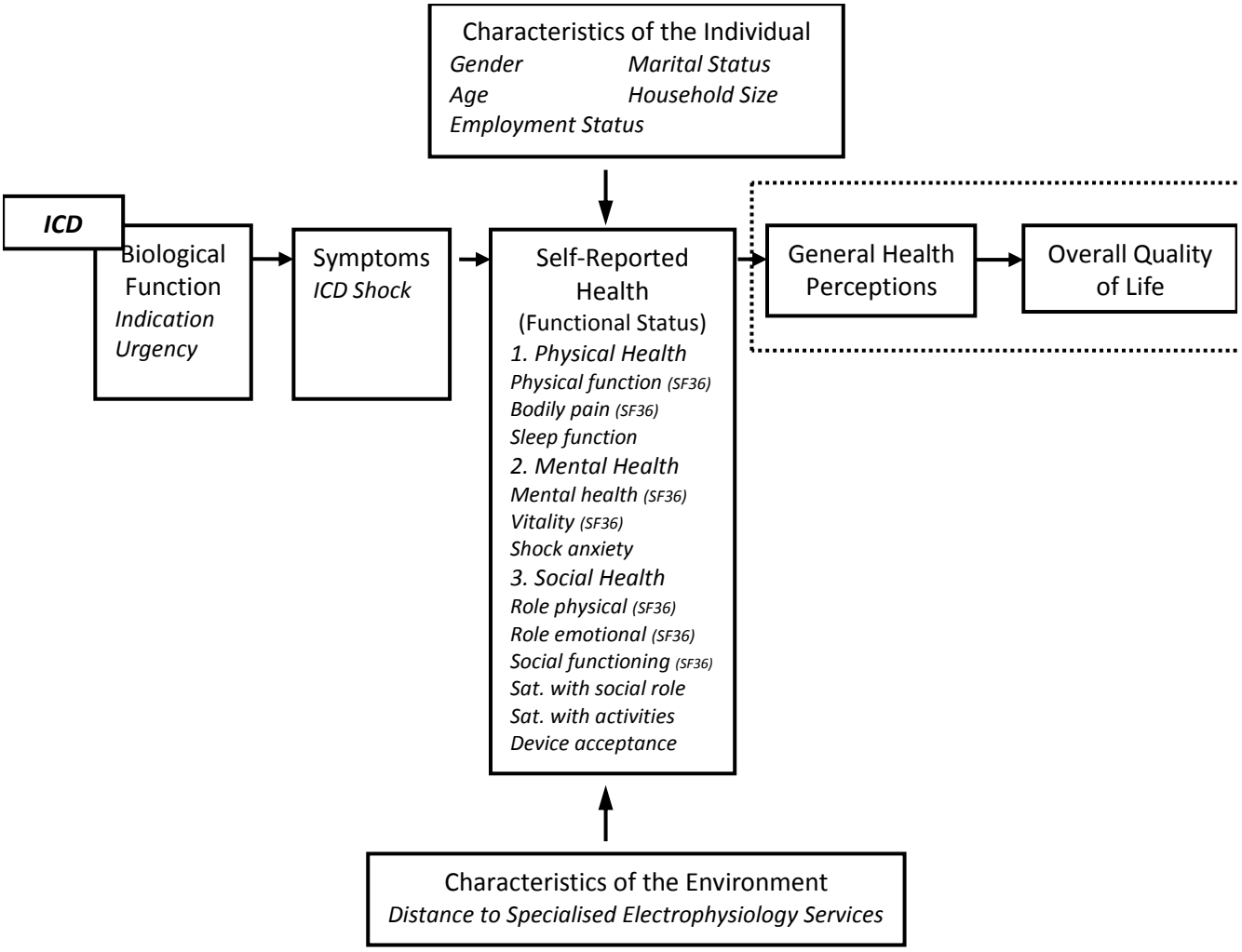
"I am not able to do things for my family the way I used to", "I am confident about my ability to return to work if I want to", "I am concerned about resuming my daily physical activities", and "I have returned to a full life"); (b) Device-related distress (five items: "When I think about the device I avoid doing things I enjoy", "I avoid my usual activities because I feel disfigured by my device", "It is hard for me to function without thinking about my device", "Thinking about the device makes me depressed", and "I am careful about hugging or kissing my loved ones"); (c) Positive appraisal (four items: "The positive benefits of this device outweigh the negatives", "I would receive this device again", "I am safer from harm because of my device", and "My device was my best treatment option"); and (d) Body image concerns (two items: "I feel less attractive because of my device" and "I feel that others see me as disfigured by my device"). The summed score of the 15 retained items was rescaled to a score ranging between 0 and 100 (Burns et al., 2005).

The reliability and validity evidence of the FPAS is limited, although the instrument reflects issues and concerns in the current ICD PRO literature (Stofmeel, Post, Kelder, Grobbee, & van Hemel, 2001). Initial studies established a Cronbach's alpha coefficient of .83. Confirmatory factor analysis identified four consistent factors: Return to life ($\alpha = .89$), Device-related distress ($\alpha = .79$), Positive appraisal ($\alpha = .82$), and Body image concerns ($\alpha = .74$) (Burns et al., 2005; Chair et al., 2011; Pedersen, Spindler, Johansen, Mortensen, & Sears, 2008). Recent confirmatory analysis recommended the removal of three items ("I am careful when hugging and kissing my loved ones", "I feel that others see me as disfigured by my device", and "I feel less attractive because of my device") to improve the instrument's performance (the Cronbach's alpha coefficient when the items were removed ranged from .76 to .83). Removing the items reduced the number of factors to three (i.e., Device related distress, Positive appraisal, and

Return to function); the factor related to body image concerns did not persist (Versteeg et al., 2012). We conducted our analyses using the 12-item instrument with summed scores rescaled to range from 0 to 100. We obtained a Cronbach's alpha coefficient ranging from .84 to .88 on the original 15-item and the revised 12-item scale, with mean inter-item correlation coefficients ranging from .26 to .31 for the original scale, and .32 to .39 for the 12-item scale (See Appendix E).

The specification of the study's theoretically-driven framework of predictor and outcome variables with their associated measurements is illustrated in Figure 4-4.

Figure 4-4: Established Conceptual Framework with Predictor and Outcome Variables Specified



→ : Hypothesised dominant causal relationship

····· : Components not included in this study

SF36: SF-36v2

Shock anxiety: Florida Shock Anxiety Scale

Sat. With social role: PROMIS Satisfaction with Social Role Short Form

Sat. With activities: PROMIS Satisfaction with Social Discretionary Activities Short Form

Shock Anxiety: Florida Shock Anxiety Scale

Device Acceptance: Florida Patient Acceptance Survey

Questionnaire Format

A pilot trial of the questionnaire with eight people demonstrated that the participants could answer all the questions within 20 to 30 minutes, and that they found the directions and wording of the items acceptable. Minor changes to the format were made in response to the feedback received. The questionnaires also were reviewed by three advanced practice nurses and a clinical psychologist who provided advice about the format and clarity of the questionnaires. To comply with the recommendations of the Research Ethics Board, the respondents were provided the option of selecting "no answer" to most items.[27]

The ordering of the instruments within the questionnaire, and the timing of their measurement occasions are outlined in Table 4-7. See Appendix D for the questionnaire employed at baseline.

Table 4-7: Order of Study Instruments in the Questionnaires

Order	Instrument Name	Measurement Occasion
1	Short Form-36 v2 Health Survey	0, 1, 2 and 3
2	PROMIS Satisfaction with Participation in Social Roles scale (Short form)	0, 1, 2 and 3
3	PROMIS Satisfaction with Participation in Discretionary Social Activities scale (Short form)	0, 1, 2 and 3
4	PROMIS Sleep Disturbance scale (Short form)	0, 1, 2 and 3
5	Florida Patient Acceptance Survey (Post-implantation)	1, 2 and 3
6	Florida Shock Anxiety Scale (Post-implantation)	1, 2 and 3

Note: 0 = Baseline; 1 = 1-month; 2 = 2-month; 3 = 6-month

[27] This is particularly relevant for web-based questionnaires that typically force a response before a respondent can advance to a subsequent question. It is recognised that participants have the right to refuse to answer questions. To avoid annoying the participants, having them give arbitrary or deliberately false answers in order to proceed, or having them stop answering altogether, a "no response" option was provided.

4.2.5 Data Analysis Procedures

Data Preparation and Screening

To maintain consistency, data from the respondents who completed the paper-based questionnaires were entered on the study's Enterprise Feedback Management Vovici® web site, in a manner identical to the data completion of the web-based respondents. The data were exported to IBM® SPSS® 19. The data were systematically verified, screened for incorrect responses, data entry errors, and missing responses, and cleaned. The SF-36v2 data were prepared for export to the Quality Metrics® software to replicate our analyses and to conduct additional analyses.

To manage the data without losing cases, we imputed values of the individual missing items so that subscale and scale scores could be computed for all cases. We used the IBM® SPSS®19 Missing Value Analysis™ (MVA) module. The imputation procedures provide an analysis of the patterns of missing data to conduct the eventual imputation of missing values (PASW®, 2010a).

Using IBM® SPSS®19 MVA, we analysed the pattern of missing values in the items used to construct the scales, and produced a graphic summary of all missing values for the scale items with at least one missing value, for the participants with at least one missing value on a scale item, and for the missing scale items for all participants.

To conduct the imputation of missing data, we created a new data set, and used the "Automatic Method" default, which automatically chooses an imputation method based on the pattern of missing values identified by the scan of the data. For example, the module uses the monotone method if the data show a monotone pattern of missing values.[28] For our data set, a

[28] A monotone pattern exists if the variables can be ordered such that, if a variable has a valid value, all of the preceding variables in the data set also have valid values.

fully conditional specification was automatically selected, which conducted 10 iterations on all of the selected outcome variables.[29] The imputation was run separately for each observation (i.e., baseline and subsequent observation measurements). All variable roles were defined as "Impute and Use as Predictor" in delineating the model constraints. The variables were identified as "scale" variables (i.e., interval or ratio), and modelled with linear regression. Constraints were imposed to ensure that only discrete values within the original scale range were produced. For each iteration and for each variable, the fully conditional specification method fit a univariate (single dependent variable) model that used all of the other available variables in the model as predictors, then imputed missing values for the variable being fit until the maximum number of iterations was reached. The imputed values at the maximum iteration were saved to a new data set. All missing data were successfully imputed.[30]

Standardised Scaling

To facilitate the interpretation of the findings, the scores of all scales were rescaled to a standardised 0-100 possible range.[31] The original directionality of the scales was maintained. For all scales except the PROMIS Sleep Disturbance short form and the Florida Shock Anxiety Scale, lower scores indicated worse PROs, and higher scores, better PROs. In the case of the Sleep Disturbance short form, lower scores indicated less sleep disturbance, whereas higher scores indicated more sleep disturbance, or a worse PRO. Lower scores on the Florida Shock

[29] A fully conditional specification method is an iterative Markov chain Monte Carlo (MCMC) method that is used when the pattern of missing data is arbitrary (monotone or non-monotone).

[30] We imputed a value once, rather than the conventional five or more times. The proportion of missing values was very small, and given that the possible values were discrete, ranged between three to six actual values, depending on the response options of the item, and occurred at the item level and not the scale level, the inferences made were very likely accurate. This approach negated the need to analyse multiple datasets. Given the complexity of the modelling undertaken, we minimised the statistical effort required by imputing only one data set; the imprecision that may have been introduced is likely inconsequential.

[31] As mentioned earlier, the rescaling procedure was performed using the following arithmetic formula: [(actual score – lowest possible score)/possible range] x 100.

Anxiety Scale indicated lower anxiety, and higher scores, higher anxiety. For the reader's reference, the findings should be interpreted with the relative directionality of the scores described in Table 4-8.

Table 4-8: Scaling and Directionality of the Patient-Reported Outcomes Scores

	Score of 0	Score of 100	Desirable Score
SF-36v2 subscales	Worst function	Best function	High score
PROMIS Satisfaction with Social Role	Least satisfaction	Greatest satisfaction	High score
PROMIS Satisfaction with Social Activities	Least satisfaction	Greatest satisfaction	High score
PROMIS Sleep Disturbance	Least disturbance	Greatest disturbance	Low score
Florida Patient Acceptance Survey	Low acceptance	High acceptance	High score
Florida Shock Anxiety Scale	Low anxiety	High anxiety	Low score

Descriptive Statistics and Univariate Analysis of Predictor Variables

We produced univariate descriptive statistics to describe the sample and the four sets of predictor variables (characteristics of the individual and the environment, biological function, and symptoms) as well as the 12 PROs. We constructed a series of box plots to depict the median values, outliers, and the 25^{th} and 75^{th} percentiles for each PRO, at each occasion. The whiskers of the box plots are extended to 1.5 times the height of the boxes (the interquartile range) or, if no participant had a value in that range, to the minimum and maximum values observed (PASW®, 2010b). Outliers (values that were between 1.5 and 3 times the interquartile range) and extreme values (values that were more than 3 times the interquartile range) are represented beyond the whiskers. We also graphed the marginal means and their standard deviations for each observation in line graphs. We reported the means, standard deviations, and medians. We referenced the Canadian normative mean age- and sex-standardised scores for the seven

subscales of the SF-36v2 (Hopman et al., 2000).[32] Canadian normative data were not available for the three PROMIS short forms, the Florida Shock Anxiety Scale, and the Florida Patient Acceptance Survey for comparison with our data.

Importance of the Findings

We previously discussed the pivotal importance of establishing and documenting the conceptual framework, content validity, and psychometric properties of the PRO instruments, to ensure that the endpoints being measured represent actual changes in health status. In addition to this well established framework, determining the minimal important difference (MID) to enable interpretation of the findings is emerging as a helpful means to complement the assessment of instrument responsiveness and most important, to determine the meaning and relevance of the research findings (Revicki, Hays, Cella, & Sloan, 2008). The MID refers to a minimally important change from baseline for a patient (Kirby et al., 2010). Revicki et al. (2008) defined this difference as "the smallest change in score that can be regarded as important" and advised that "there is not necessarily a single MID value for a PRO instrument across all applications and patient samples" (p. 103). They recognised that "the current situation for determining the MID is fluid and evolving, and there is no clear consensus as to the recommended, best-practice approach" (p. 103). Some researchers prefer the term "minimal clinically important difference", which contrasts with "minimal statistical important difference" and stresses the clinical context (i.e., the patient-reported aspect) of the assessment (Copay et al., 2007; Gatchel & Mayer, 2010; Kirby et al., 2010). For the purposes of this discussion, we consider these terms to be interchangeable, and use MID as a term that conveys the concept of the purported minimal difference in health status that is important, or would be important, to patients.

[32] The norms were obtained from the CaMOS study, which enrolled randomly sampled, urban-dwelling adults aged 25 years or more (Hopman et al., 2000).

The current scientific debate about what constitutes important differences in PROs is primarily found in the methodological literature, and is relatively absent in the clinical literature (Gerlinger & Schmelter, 2011; Kirby et al., 2010; Ringash et al., 2007; Wyrwich et al., 2005). There are two broad methods for identifying the MID: (a) an anchor-based method, which uses external indicators such as clinical anchors (i.e., laboratory measures, physiological measures, or clinicians' ratings) or patient anchors (i.e., global ratings or previously demonstrated MIDs in similar target populations) and (b) a distribution-based method, which considers statistical significance, sample variability, and measurement precision (i.e., effect sizes, standardised response means, and standard errors of measurement) (Crosby, Kolotkin, & Williams, 2003; Revicki et al., 2007). Current recommendations include a triangulation of approaches with consideration of multiple, relevant, patient-based and clinical anchors, and the support of distribution-based methods to interpret the results (Gerlinger & Schmelter, 2011; Revicki et al., 2008).

Several researchers have proposed a minimum threshold of 1% to 20% improvement, with an emerging consensus that a 10% difference in scores may represent a reasonable indicator of minimally important change, from a patient's perspective (Gerlinger & Schmelter, 2011; Hopman et al., 2006; Kosinski, Zhao, Dedhiya, Osterhaus, & Ware, 2000; Ringash et al., 2007). We selected a threshold of 10%, and adopted the recommendation provided by Osoba (2007) that "a change of 10% of the scale breadth [possible range] be taken as representing a definite change that is perceptible to patients and excludes false "positive" scores" (p. 9).

Distribution-based methods provide an expression of the observed change in a standardised metric that enable comparisons, but do not provide direct information about the MID (Revicki et al., 2008). In this case, the MID is based on the distribution of observed scores

in a sample (Guyatt et al., 2002). Using empirical evidence from previous studies, physiological findings, and statistical theory, some researchers have suggested that the 0.50 standard deviation estimate may reflect the criterion of change meaningful to patients (Norman, Sloan, & Wyrwich, 2003; Wyrwich, Tierney, & Wolinsky, 1999). MIDs also have been reported to be as small as 0.25 to 0.33 SD units in oncology (Cella, Eton, Lai, Peterman, & Merkel, 2002; Eton et al., 2004; Yost et al., 2005). We adopted a distribution-based 0.30 SD criterion as a meaningful indicator of the MID in the PROs of people with an ICD.

Individual Growth Modelling

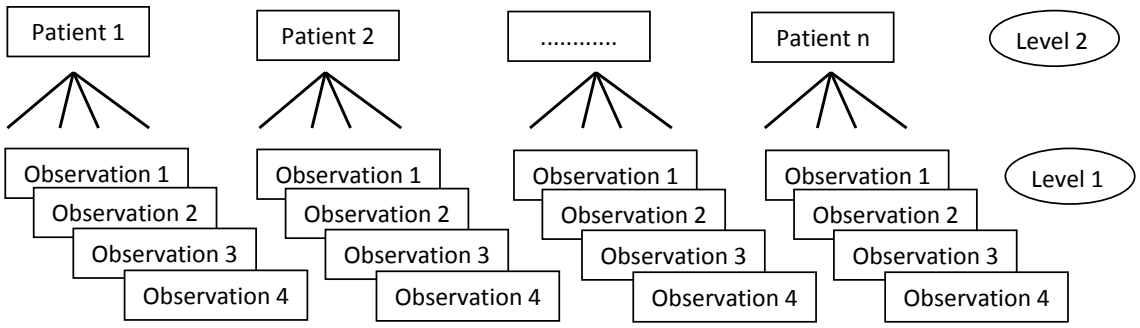
To best answer the research questions posed in this study, we conducted individual growth model (IGM) analyses. Individual growth modelling allows researchers to estimate individual change over time, determine the shape of the change curves, explore systematic differences in change, and examine the associations between covariates and group differences, if any, in the initial status and rate of growth or change of the outcome of interest (Shek & Ma, 2011). The use of IGMs is a relatively new, powerful, and flexible approach that allows researchers to use all available data to analyse the interaction effects between time and other between-subject factors, and cross-level interactions (e.g., the effects of between-subject variables on individual growth trajectories), and to estimate regression parameters from the individual growth models by treating the intercepts and slopes as random effects (Graves & Frohwerk, 2009; Kwok, West, & Green, 2007; Kwok et al., 2008; Miner & Clarke-Stewart, 2008).

IGMs fit within the recently developed multilevel models (MLM) of change aimed at studying individual and group change and the rate of change in multi-wave longitudinal studies (Cillessen & Borch, 2006). MLMs, also known as hierarchical linear models (HLM), random

coefficient models, mixed effects or mixed models, and clustered or random coefficient models, have become an increasingly important analytical approach in many research fields, including education, psychology, and the health sciences (Cillessen & Borch, 2006; Kwok et al., 2008).

Mixed models refer to the use of both fixed and random effects in the same analysis. Fixed effects have levels that are of primary interest, such as repeated measurement (time). Random effects are drawn from a larger set of levels, such as subject effects, contain measurement error, and are intended to generalise to a larger population of possible values with a defined probability distribution (Seltman, 2012). Fixed and random effects correspond to a hierarchy of levels with the repeated measurements occurring among all of the lower level units for each particular upper level unit. The Level 1 model describes how each person changes over time. Each Level 1 measurement is nested within a particular research participant, who constitutes the Level 2 data. The Level 2 model describes how these changes differ across people (Singer & Willett, 2003). The lower level measurements (time) that are within the same upper level unit (subjects) are correlated when all of their measurements are compared with the mean of all measurements for a given test, but are often uncorrelated when compared with a personal mean or regression line (Locascio & Atri, 2011). Figure 4-5 provides a graphical representation of the IGM concept of nested measures and hierarchical analysis (Beaumont, 2011).

Figure 4-5: Clustered Observations in an Individual Growth Model



IGMs allow researchers to assume that there are various measured and unmeasured aspects of the upper level units that affect all of the lower level measurements similarly for a given unit (Seltman, 2012). In addition, a variety of possible variance-covariance structures for the relationships among the lower level units can be tested to identify the best fitting model (Heck, Thomas, & Tabata, 2010).

By specifying different sets of models, IGMs examine change and the predictive effect when additional variables are added to a model (Singer & Willett, 2003). In mixed models, the focus is not whether there are differences in the between- and within-subjects' levels of a factor, but to what extent the variance of the responses is influenced by this factor compared with the total variability of the data. IGMs present numerous advantages over more traditional methods of investigating change (Raudenbush & Bryk, 2002). IGMs provide more precise estimates of individual growth over time and greater statistical power to detect predictors of individual differences in change, even with relatively small samples (Greene & Way, 2005). IGMs do not require balanced data across different waves of data, and can accommodate variation in the number and spacing of measurements (Shek & Ma, 2011). The modelling technique allows researchers to study both intra- and inter-individual differences in the change parameters (i.e.,

slopes and intercepts), thus exploring the patterns of change and the effects at both the individual and group levels, while estimating the change parameter with greater precision when the number of time waves is greater than two. This improves the reliability of the change parameters by reducing the standard errors of the within-subject change in the parameter estimates. IGMs are more powerful than other methods in examining the effects associated with repeated measures because they model the covariance matrix (i.e., fitting the true covariance structure to the data, rather than imposing a certain type of structure). The error covariance structure of the repeated measurements can be specified to allow researchers to examine true change and determinants of this structure (Shek & Ma, 2011).

We used the Linear Mixed Models program in IBM® SPSS® 19, which assumes that the outcome variable is linearly related to the fixed factors, random factors, and covariates entered in a model. The fixed effects component models the mean of the outcome variable, and estimates a variance parameter, which represents the spread of the random intercepts around the common intercepts. The random effects component models the covariance structure of the outcome variable. Multiple random effects are considered independent of each other, and separate covariance matrices are computed for each; however, model terms specified on the same random effect can be correlated. The repeated measure component ("Time") models the covariance structure of the residuals. The outcome variable is also assumed to come from a normal distribution.

To develop a mixed model, the researcher must decide and specify the nature of the hierarchy of the data, the fixed and random effects, and the covariance structures tested. Several related models are usually considered, and require a model selection process to choose among related models (Seltman, 2012).

An individual growth model analysis is ideally suited to answering the research questions posed in this study because it can estimate the average trajectory of change as well as individual trajectories and predictors of membership if the trajectories are found to vary. IGM allows the explicit examination of inter-individual (between subjects) differences in intra-individual (within subjects) change, and readily estimates both linear and non-linear change (Chen & Cohen, 2006). To conduct the analysis, we employed the steps outlined by Heck, Thomas, and Tabata (2010).

Two-Level Model of Individual Change

To examine change within and between people using IBM® SPSS® 19 Mixed, we organised the data vertically using the VARSTOCASES routine that is contained in the IBM® SPSS® 19 *Restructure Data Wizard.* The restructuring process created four records for each participant, each representing a distinct occasion of measurement for each individual in the sample, thus nesting the observations within each participant. We created an index variable to capture the timing of each occasion. The linear time variable ("Time") was coded 0 for baseline, 1 for one month, 2 for two months, and 3 for six months of follow-up. As recommended by Heck et al. (2010), this coding pattern identified the intercept in the model as the participants' initial (baseline) test score on the selected measures. For indicators measured at four occasions,[33] a quadratic time variable ("Quadtime") was also defined to capture any changes (acceleration or deceleration) in the rate of change that might occur. Quadtime was correspondingly coded 0, 1, 4 and 9.

The final restructured data set had a horizontal line for each occasion for each participant (i.e., four data rows for a participant who completed all study measures). The repeated

[33] The Florida Shock Anxiety Scale and the Florida Patient Acceptance Survey questionnaires were not completed at baseline (i.e., prior to ICD implantation) and thus had three measurement occasions (1-month, 3-months, and 6-months).

measurements of the selected instruments were nested within an individual variable (participant identification number). We retained all of the participants, including those who did not complete the four measures. IGM can statistically accommodate variation in the number of cases at various time points (Wittekind, Raeder, & Grote, 2010).

At Level 1, each person's successive measurements were defined by an individual growth trajectory and random error. At Level 2, we examined differences in these trajectories between groups of people.

We assumed that each individual's status at each measurement occasion was a function of systematic growth (change) plus random error. Because we coded the first observation as 0, we interpreted the intercept parameter as the participants' true score at the beginning of the study (pre-implantation), and the point where the growth trajectory crossed the *Y* axis. The slope parameters represented the change in the participants over each interval. The linear component described the rate of change per unit of time, and the quadratic component was interpreted as a change in the rate of change (acceleration or deceleration).

The second component of the Level 1 model was the investigation of covariance structures to examine the variation in measuring each individual at each occasion and explored the error associated with measuring each individual's true trajectory of change, or the difference between the observed and the true trajectory (Heck et al., 2010; Trautwein, Gerlach, & Lüdtke, 2008). Each measurement occasion included residual terms. We investigated various covariance structures to describe the distribution of error, and examined whether the properties imposed on the error covariance structure of the model fit the data well. Previous research has shown that the estimated variances of the parameter estimates are likely to be biased and inconsistent when repeated measurements are taken on the same participant across time, especially in the setting of

unequally spaced and unbalanced data, thus failing to account for heteroscedasticity (Shek & Ma, 2011). This can affect the precision of estimating the appropriate model. The process of variance-covariance testing can improve model prediction and statistical inferences, especially when examining random effects. To this end, we tested five types of Level 1 covariance structures that are recommended in the literature (West, 2009; Wittekind et al., 2010):

- Unstructured covariance matrix (UN): Does not make assumptions in error structure.
- Diagonal covariance matrix (D): Assumes heterogeneous variances for each measurement occasion and no covariances between occasions.
- Compound symmetry matrix (CS): Assumes equal variances and equal covariances across occasions.
- Scaled identity covariance matrix (SI): Assumes a constant variance for occasions.
- First-order auto-regressive error covariance matrix (AR1): Assumes that the residuals are correlated from occasion to occasion within people (i.e., that the correlations between the two adjacent time points decline across measurement occasions), but are independent across people.

We compared the information criteria obtained with each covariance structure, and identified the smallest values for the most commonly cited fit criterion, Akaike's Information Criterion (AIC) (Singer & Willett, 2003; West, 2009; Wittekind et al., 2010). We followed Heck et al.'s (2010) recommendation to select the smallest AIC, regardless of the number of parameters, to determine the most suitable covariance structure.

Model 1: Unconditional Model

The purpose of developing the first model was to define the shape of the participants' trajectories of change and to determine whether the initial intercepts and random slopes depicting

change over time varied across the participants. In contrast to ANOVA, individual growth models do not automatically assume that the population-level fixed effects represent all the subjects. Because the change curve is fitted to each person's outcome, it allows for the possibility that the participants' change curves differ reliably from the grand mean change curve (Singer & Willett, 2003). To this end, we treated "Time" and "Quadtime" as covariates in the model. We included the intercepts and obtained parameter estimates and confidence intervals for the fixed effects, and Wald tests and confidence intervals for the parameters of the covariance matrices. We used restricted maximum likelihood (REML) estimation (see Table 4-9).

Table 4-9: Model 1 Specification

Model Requirement	Model Component	Specification
Specification of subjects and repeated	Subjects	Study identification
	Repeated	
Mixed model	Outcome variables	One of 12 patient-reported outcomes
	Covariates	Time Quadratic time *(if the indicator was measured on all four occasions)*
Fixed effects	Main effects (with intercept and Type III sum of squares)	Time Quadratic time *(if the indicator was measured on all four occasions)*
Random effects	Covariance type (with intercept)	Investigation of covariance structures: • Unstructured (UN) • Diagonal (D) • Compound symmetry (CS) • Scaled identity (SI) • First order autoregressive (AR1)
	Main effects	Time
	Subjects groupings	Combinations: Study identification
Estimation	Restricted maximum likelihood (REML)	Maximum iterations: 100 Maximum step-halvings: 5 Log-likelihood convergence: Absolute value (0) Parameter convergence: Absolute value (0.000001) Hessian convergence: Absolute value (0) Maximum scoring steps: 1 Singularity tolerance: 0.000000000001

We report the total number of parameters estimated, including three fixed effects (intercept, time [0, 1, 2, 3], quadtime [0, 1, 4, 9] – if the outcome was measured on four occasions), three random parameters (intercept and time slope variances, and the covariance between the intercept and slope), and the residual (Level 1 – within people) variance. The effects are summarised as β parameters with their associated standard errors. The intercept represents the sample mean at baseline (Time 0), "Time" is the estimate of the linear growth rate between each measurement occasion, and "Quadtime" is the estimate of quadratic growth. The significance of each effect was tested with a *t*-test (the ratio of the unstandardised estimate to its

standard error). The 95% confidence intervals are provided for each parameter. All figures are rounded to the second decimal place.

We report the Level 1 "Residual" variance that summarises the "population variability in the average individual's (outcome) estimates around her or his own true trajectory" (Heck et al., 2010, p. 170). The null hypothesis is that the population parameter for this variance is 0 (Singer & Willett, 2003). Therefore, tests for evaluating variance components "provide information about whether there is remaining residual outcome variation to be explained by other variables at either Level 1 or Level 2" after controlling for random variation in sample means at baseline (intercepts), the linear growth rate (time) and quadratic growth (quadtime) (Heck et al., 2010, p. 170). According to Heck et al. (2010), the variance component table can be "more difficult to interpret than the fixed effects, since their coefficients have little absolute meaning and graphic aids are not helpful" (p. 170).

We report the Wald test, which calculates a *Z* statistic (the ratio of the estimate to its standard error) associated with a significance level that tests whether the residuals associated with people and occasions are independent and normally distributed (Heck et al., 2010; Tabachnick & Fidell, 2007).

Finally, we report the Level 2 variance components, which summarise the variability in the intercepts and change trajectories using the overall best fit covariance matrix:

- (1,1): Variance estimate of random intercept
- (2,1): Variance estimate of covariance between slope and intercept
- (2,2): Variance estimate of random linear slope.

To inform further model building, we summarised the effects (linear and quadratic growth), and the covariance parameters (variances in the intercepts, slopes and their covariances)

for the various covariance structures examined to identify the parameters to retain in further multivariable model building. Only variables with statistically significant ($p < .05$) effects and residual variances in the slope were retained for the next step of the analysis (Model 2).

Model 2: Addition of Between-Subjects Predictors

As discussed earlier, we hypothesised that various characteristics of the person and the environment, components of biological functioning, and symptoms affected the participants' PROs, and their rate of change, and could serve to identify membership in particular trajectories of change. The aim of testing a second model was to explore whether the rate of change varied across people in a systematic way and whether key variables of interest explained the residual variances in the rates of the participants' change (research question #3) (Chen & Cohen, 2006). The theoretically-derived predictors included in model 2 development are outlined in Table 4-10.

Table 4-10: Examined Level 2 Between-Subjects Predictors

Category	Predictor Variables	Values
Characteristics of the individual	Sex/gender	(0) Male or (1) Female
	Age	Continuous variable in years
	Marital status	(0) Single; (1) Married or common-law; or (2) Divorced, separated, or widowed
	Household size	(0) Lives alone, (1) Lives with one person, or (2) Live with two or more people
	Employment status	(0) Working/caring for family or (1) Retired or recovering from illness
Characteristics of the environment	Distance to electrophysiologist (EP) services	(0) Residence within 100 km of EP services or (1) Residence beyond 100 km of EP service or ferry crossing required
Biological function of the individual	Indication for ICD implantation	(0) Primary prevention or (1) Secondary prevention
	Urgency	(0) Elective out-patient or (1) In-patient
Symptoms	Self-reported ICD shock history	(0) No self-reported ICD shock during follow-up or (1) One or more self-reported ICD shocks during follow-up

We conducted a series of analyses to examine the relationships between each of the 12 PROs and each predictor to determine which variables should be retained for subsequent model building. We retained the variable if the probability was less than .10 for the main effect. We then added a cross-level interaction term (time*predictor variable) to explore whether the effects of these Level 2 variables (between-people) on the Level 1 slope coefficients (within-people: time) explain the variability in rates of change for different participant sub-groups, if residual variance was present. To avoid an excessive risk of making a Type I error in this exploratory study, we retained the interaction term if $p < .10$ in the model. We report the complete findings of the multivariable models with all retained main effects and interaction terms. The specifications of Model 2 are outlined in Table 4-11.

Table 4-11: Model 2 Specification

Model Requirement	Model Component	Specification
Specification of subjects and repeated	Subjects	Study identification
	Repeated	Time QuadTime *(depending on findings of Model 1)*
Mixed model	Outcome variable	One of 12 patient-reported outcomes
	Covariates	One model for each covariate: • Sex/gender • Age • Marital status • Household size • Employment status • Distance to electrophysiologist services • Indication for ICD implantation • Urgency • Self-reported ICD Shock history Time QuadTime *(depending on findings of Model 1)*
	Cross-level interactions	Analysis of interaction terms of time*predictor variable
Fixed effects	Main effects (with intercept and Type III sum of squares)	Time with QuadTime *(depending on findings of Model 1)*
Random effects	Covariance type (with intercept)	Covariance structure with best fit indices
	Main effect	Time
	Subjects groupings	Combinations: Study identification
Estimation	Restricted maximum likelihood (REML)	Maximum iterations: 100 Maximum step-halvings: 5 Log-likelihood convergence: Absolute value (0) Parameter convergence: Absolute value (0.000001) Hessian convergence: Absolute value (0) Maximum scoring steps: 1 Singularity tolerance: 0.000000000001

Model Evaluation

The aim of the study's individual growth model development was to find models that used the least number of parameters while providing the best fit to answer the questions posed in this study (Kwok et al., 2007; Singer & Willett, 2003).

The following table summarises the analytical approaches taken to answer the research questions (see Table 4-12).

Table 4-12: Summary of the Analytical Approaches to the Research Questions

Question 1, Part 1: Is there a change in PROs in the first six months following ICD implantation?

Univariate descriptive statistics: the mean, standard deviation and median of each scale's total score at each measurement occasion.

Graphical representations:

- Box plots with the median values, outliers, and the 25^{th} and 75^{th} percentiles for each PRO, at each occasion. The whiskers of the box plots are extended to 1.5 times the height of the boxes (the interquartile range) or, if no participant had a value in that range, to the minimum and maximum values observed. Outliers (values that were between 1.5 and 3 times the interquartile range) and extreme values (values that were more than 3 times the interquartile range) were represented beyond the whiskers.
- Line graphs with the marginal means and their standard deviations for each PRO, at each occasion.
- For the SF-36v2 subscales, the addition of a reference line indicating the Canadian urban dwelling (25 years and older) mean age- and sex-standardised scores (and standard deviation) from CaMOS normative data (Hopman et al., 2000). Comparison of the mean scores of the SF-36v2 scores at each occasion with the CaMOS normative data in a series of bar graphs.

Question 1, Part 2: If there is a change, what is the direction of the change trajectory?

For each PRO, calculation of the following change scores:

- Absolute mean difference: The difference in means between the six-month follow-up measure and baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$).
- Relative mean difference (%): The difference in means between the six-month follow-up measure and baseline, relative to the baseline, presented as a percentage (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $mean_{(baseline)}$ * 100).
- Relative mean difference (standard deviation): The absolute mean difference divided by the standard deviation observed at baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $standard\ deviation_{(baseline)}$).

Question 2: Is the change the same for different groups of people?

- Exploratory examination of individual changes and direction of change with a random sample of linear individual growth trajectories for each PRO.

Model 1: *Unconditional Model*

- Level 1: Analysis of each person's successive measurements as defined by an individual growth trajectory [intercept (baseline) and slope (individual change over each interval)] and random error. Exploration of linear and quadratic change.
- Level 1 parameters reported:
    - Three fixed effects: Intercept, Time, QuadTime.
    - Three random parameters: Intercept variance, Time/Slope variance, Covariance between intercept and slope.
    - Residual: Level 1 within people variance (population variability in the average individual's outcome estimates around his/her own trajectory.
    - Wald test with *Z* statistic to test whether the residuals associated with people and occasions are independent and normally distributed.
- Level 2: Analysis of differences in these trajectories between groups of people. Comparison of five covariance structures to identify the matrix with the best fit.
- Level 2 parameters reported:
    - Variance estimate of random intercepts (1,1)
    - Variance estimate of covariance between slope and intercepts (2,1)
    - Variance estimate of random linear slope (2,2).
    - We retained variables with statistically significant ($p < .05$) effects and residual variance in the slope for further model development.
- Summary of the unconditional model estimate of the fixed effects and covariance parameters.

Question 3: Can these differences in the change trajectories be explained by different individual and environmental characteristics?

Model 2: *Conditional Model*

- Level 1: Within-people (Time).
- Level 2: Between-people (Predictor variables).
- Bivariate examination of between-subjects predictors: Analysis of the relationships between each PRO and each predictor.
- Addition of cross-level interaction terms (time*predictor variable) to determine which variables should be retained for further model building (Significance level of main effect: $p < .10$).
- Summary of the Time*Predictor interaction effects on temporal change and graphical representation of change trajectories by statistically significant subgroups.
- Multivariable model of PROs associated with more than one statistically significant Time*Predictor interaction.

5. Findings

After discussing the participant recruitment process, the extent of missing data, and the descriptive statistics of the sample, we present the findings associated with each research question.

5. 1. Participant Recruitment

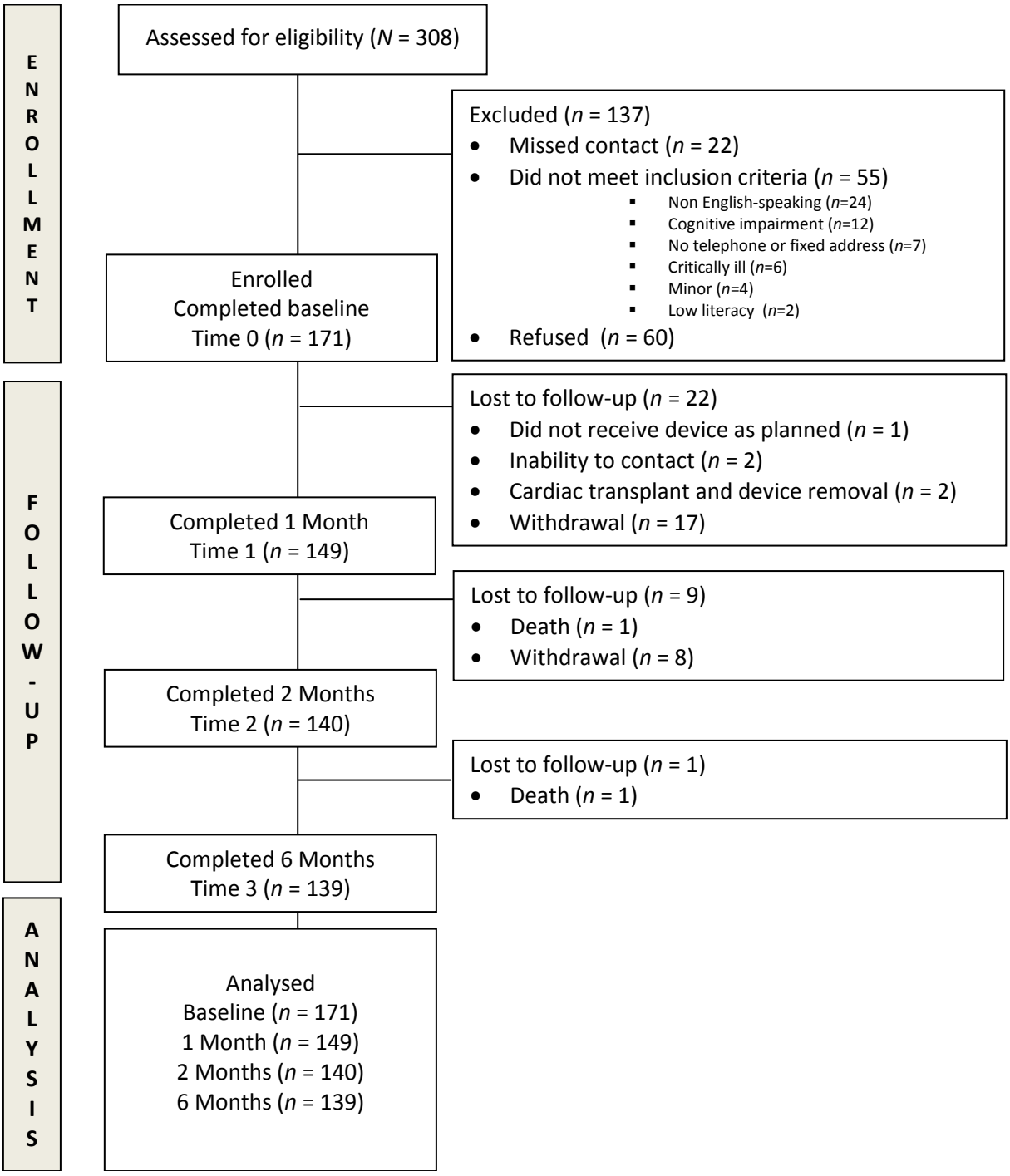
Between April 1, 2010 and June 30, 2011, 308 consecutive patients were referred for ICD implantation at the study centres and, of these, we recruited 171 (55.5%) participants. The flow of participant recruitment and retention is depicted in Figure 5-1. Because of the complexities of the recruitment process, 22 (7.1%) potential participants referred for ICD were not screened and were thus missed. Of the people approached and assessed for eligibility, 55 (17.9%) did not meet the inclusion criteria because they were: (a) not able to speak or read English [*n* = 24], (b) cognitively impaired following cardiac arrest [*n* = 12], (c) unable to be contacted for follow-up or had no telephone [*n* = 7], (d) critically ill [*n* = 6], (e) minors [*n* = 4], or (f) illiterate [*n* = 2]. Sixty (19.5%) people refused to participate or failed to return the baseline questionnaire. Among the 231 people who were successfully contacted and found to be eligible, the participation rate was 74.0% (*n* = 171). Of the enrolled participants, 117 (68.4%) chose to complete the study questionnaires using the paper version, and 54 (31.6%) used the web-based format.

Thirty-two of the 171 (18.7%) participants who completed the baseline questionnaire were lost to follow-up over the course of the study, with the greatest attrition [*n* = 22] (12.9%) occurring between the pre-procedure measure (baseline) and the first follow-up (one month post-implantation). By the third and last follow-up, at six months after implantation, 139 (81.3%) participants remained. The reasons for loss to follow-up over the course of the study included: (a) cardiac transplantation and removal of device [*n* = 2], (b) change in therapy recommendation

with no device implantation [*n* = 1], (c) death [*n* = 2], (d) inability to establish contact [*n* = 2], and (e) voluntary withdrawal from study [*n* = 25]. Of the people who chose to withdraw voluntarily, the reasons, recorded for 11 participants, were: (a) burden of family or work obligations [*n* = 5], (b) burden of questionnaire (i.e., length, complexity, or time required to complete) [*n* = 3], (c) dissatisfaction with care received at implanting centre [*n* = 2], and (d) loss of interest [*n* = 1]. The reasons the remaining participants who were lost to follow-up were not captured because they declined to respond to telephone or written contact.

The final study sample included 171 (100%) participants (T0), 149 (87.1%) (T1), 140 (81.9%) (T2), and 139 (81.3%) (T3), for each observation. The selected format for questionnaire completion was web-based for 53 participants (31.0%) and paper-based for 118 participants (69.0%). There was no cross-over in the participants' selected format over the course of the study.

Figure 5-1: Flow Chart of Participant Recruitment and Retention



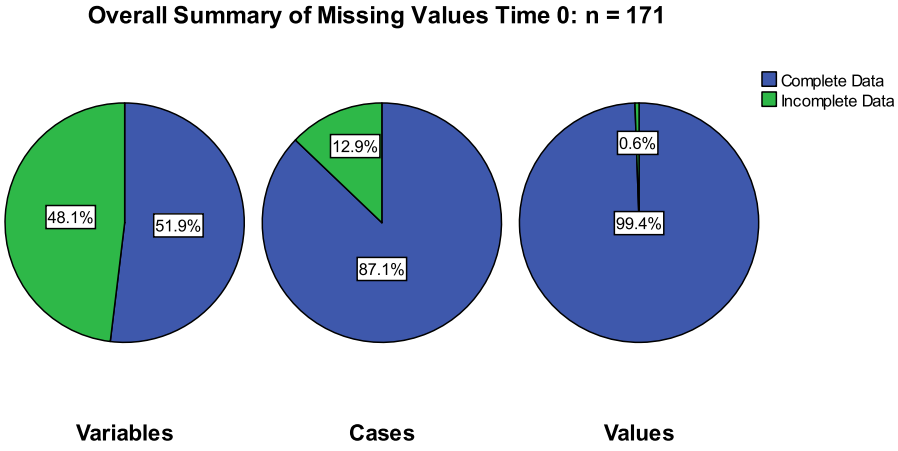
5.2. Missing Data

At the time of ICD implantation, the available medical records varied in their degree of completeness. At the end of enrollment, the medical records review was systematically repeated for all participants to confirm their medical histories and course of hospitalisation. Although this additional step succeeded in improving data quality, there remained significant missing data in various clinical factors, including the New York Heart Association Functional Class (n = 24 missing, 14.0%). Self-reported demographic information, including educational attainment, employment status, household size, marital status, and income was obtained at the time of baseline assessment. These data were complete, except for the item related to income, to which 25 (14.6%) respondents chose not to respond.

Missing data analysis at the item level for each PRO instrument was performed using IBM® SPSS® 19 Missing Values Analysis (MVA). The graphical representation of the overall missing data at the item level, at each observation, is shown in Figure 5-2. Missing responses accounted for 0.6%, 1.6%, 1.5%, and 1.0% of the total responses at baseline, 1-month, 2-month, and 6-month respectively. The greatest incidence of missing data in the PRO questionnaires related to the questions about sexual activity in the Florida Patient Acceptance Survey (Item 13: "I have returned to a normal sex life") and the Florida Shock Anxiety Scale ("I do not engage in sexual activity because it will cause my ICD to fire"), which were not included in the summed scores, as recommended by the authors of the initial validation reports of the two instruments (Burns et al., 2005; Kuhl et al., 2006; Versteeg et al., 2012). As recommended in the initial validation of the two instruments, we retained these items in the study in spite of the poor response pattern, but systematically excluded them in the total score calculation (Burns et al., 2005; Versteeg et al., 2012).

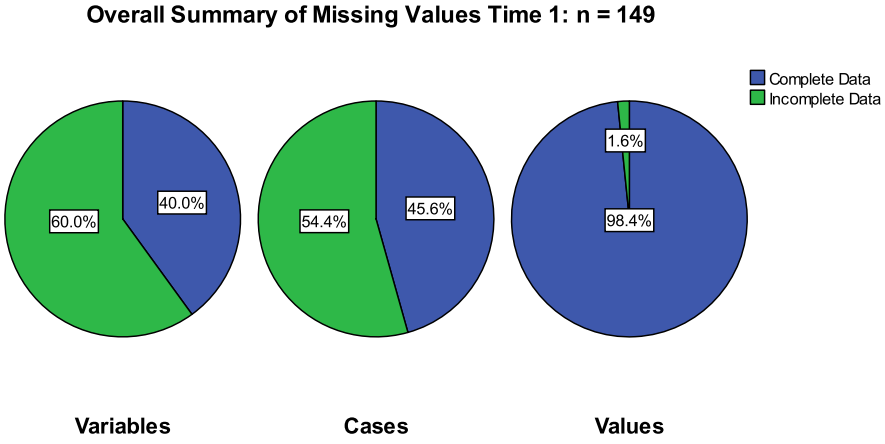
Figure 5-2: Summary of Missing Values for all (Sub)Scale Items at Each Observation

Baseline (Time 0)



Note. The *Variables* chart shows that 25 (48.1%) of the 52 PRO scale items had at least one missing value.
The *Cases* (participants) chart shows that 22 (12.9%) of the 171 participants had at least one missing value on a PRO scale item.
The *Values* chart shows that 49 (0.6%) of the 8,892 PRO data points (171 participants x 52 PRO scale items) were missing.

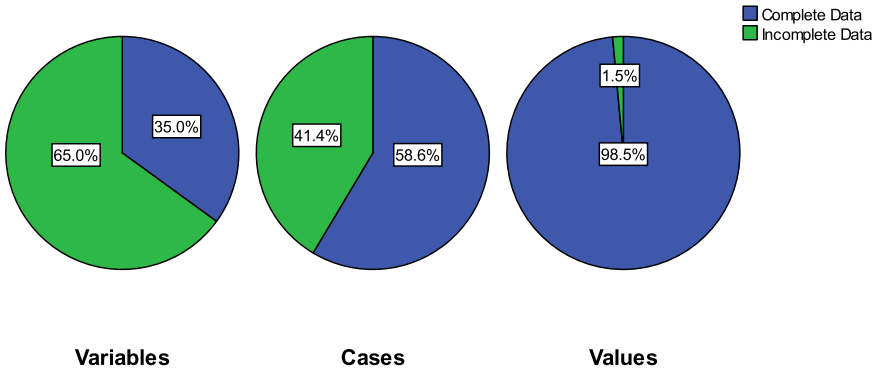
1 Month (Time 1)



Note. The *Variables* chart shows that 48 (60.0%) of the 80 PRO scale items had at least one missing value.
The *Cases* (Participants) chart shows that 81 (54.4%) of the 149 cases had at least one missing value on a PRO scale item.
The *Values* chart shows that 190 (1.6%) of the 11,920 PRO data points (149 participants x 80 PRO scale items) were missing.

2 Months (Time 2)

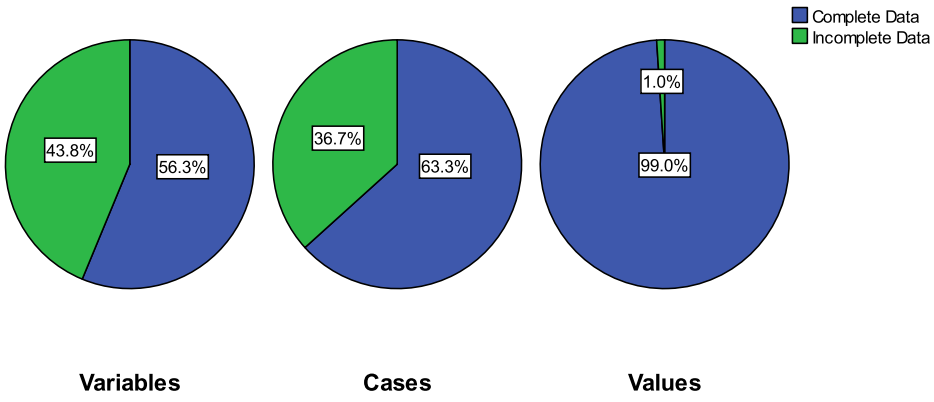
Overall Summary of Missing Values Time 2: n = 140



Note. The *Variables* chart shows that 52 (65.0%) of the 80 PRO scale items had at least one missing value.
The *Cases* (Participants) chart shows that 58 (41.4%) of the 140 participants had at least one missing value on a PRO scale item.
The *Values* chart shows that 165 (1.5%) of the 11,200 PRO data points (140 participants x 80 PRO scale items) were missing.

6 Months (Time 3)

Overall Summary of Missing Values Time 3: n = 139



Note. The *Variables* chart shows that 35 (43.8%) of the 80 PRO scale items had at least one missing value.
The *Cases* (Participants) chart shows that 51 (36.7%) of the 139 participants had at least one missing value on a PRO scale item.
The *Values* chart shows that 114 (1.0%) of the 11,120 PRO data points (139 cases x 80 PRO scale items) were missing.

As we described in the previous chapter, we conducted a single imputation procedure for missing scale data with IBM® SPSS® 19, to impute values for the missing data at the item level prior to constructing the summed scale scores.

5.3. Actual Timing of Questionnaire Completion

The median time between the participants' completion of the baseline questionnaire to their date of ICD implantation was 5.8 days, ranging from 12 days before to 8 days after. Most (*n* = 148; 86.5%) returned their baseline questionnaire prior to their surgery, but 23 (13.5%) participants were unable to complete the survey before the implantation because of the constraints of the clinical flow during their admission.[34] Those who completed their baseline questionnaire after implantation did so between 1 and 8 days after surgery (Mean = 4.6 days, SD = 0.6). We aimed to receive the completed follow-up questionnaires within 7 days of the due date, and achieved this goal with 81.9% (*n* = 122) of the participants at one month, 85.0% (*n* = 119) at two months, and 89.9% (*n* = 125) at 6 months. The delay in the follow-up ranged from 8 days to 23 days after the actual due date (Mean = 14.1 days, SD = 3.9).

5.4. Description of the Sample

5.4.1. Participants' Demographics

As discussed in the preceding chapter, we hypothesised that the participants' age, sex/gender, marital status, household size, employment status, and distance needed to travel to access specialised electrophysiology medical care were of interest because they could inform the design of targeted clinical programs if found to be important. Furthermore, we conducted the

[34] ICD surgery is routinely performed with same-day admission and discharge, and involves multiple clinical processes. During patient enrollment, clinical requirements (i.e., diagnostic testing, patient teaching, anaesthesiology consultation) always superseded research activity. We were sometimes constrained to instruct the patient to return the questionnaire by mail within 72 hours of discharge. Careful instruction was given to follow the guidelines provided in the questionnaire to think back to the referent pre-operative time when answering the questions.

study with a theoretically-driven interest in sex/gender analysis to address the current paucity of evidence describing women's experiences in living with an ICD, and the potential sex/gender considerations in the interventions required to improve women's and men's outcomes.

The sample (N = 171) consisted of 128 men (74.9%). The participants ranged in age from 18 to 81 years (Mean = 58.7 years, SD = 14.5). The age groups were disproportionately represented, with 10 (5.9%) people aged 39 years or younger, 83 (48.5%) people were between 40 and 65 years of age, 61 (35.7%) people were between 66 and 75 years of age, and 17 (9.9%) were 76 years of age or older. Most of the participants (n = 124; 72.5%) were married or lived in a common-law relationship, and lived with at least one other person (n = 135, 79.0%). Over one quarter of the participants (n = 49; 28.7%) had completed a post-secondary diploma or degree, while almost 30% (n = 51, 29.8%) had not attained further education after high school. Table 5-1 further delineates the demographic characteristics of the sample.

Table 5-1: Demographic Characteristics of the Participants by Sex/Gender

Characteristic	Women n = 43 (25.1%)		Men *n* = 128 (74.9%)		All *N* = 171 (100%)	
	n	(%)	*n*	(%)	*n*	(%)
Age (*Mean, (SD*))	58.7	(14.5)	62.0	(13.4)	61.2	(13.7)
Age group (*years)*						
39 or younger	4	(9.3)	6	(4.7)	10	(5.8)
40 – 65	23	(53.5)	60	(46.9)	83	(48.5)
66 – 75	11	(25.6)	50	(39.1)	61	(35.7)
76 or older	5	(11.6)	12	(9.4)	17	(9.9)
Marital status						
Single	7	(16.3)	8	(6.3)	15	(8.8)
Married or common-law	23	(53.5)	101	(78.9)	124	(72.5)
Divorced, separated, or widowed	13	(30.2)	19	(14.8)	32	(18.7)
Number of people in household						
Alone	14	(32.6)	22	(17.2)	36	(21.1)
Lives with 1 person	20	(46.5)	71	(55.5)	91	(53.2)
Lives with 2 or more people	9	(20.9)	35	(27.3)	44	(25.7)
Level of education						
High school	16	(37.2)	35	(27.3)	51	(29.8)
Some trade, college, or university	18	(41.9)	45	(35.2)	63	(36.8)
Post-secondary diploma or degree	8	(18.6)	41	(32.0)	49	(28.7)
Other (e.g., less than high school or other education program)	1	(2.3)	7	(5.5)	8	(4.7)
Current main activity						
Employed	21	(48.8)	49	(38.3)	70	(40.9)
Not employed	22	(51.2)	79	(61.7)	101	(59.1)
Household income						
Less than $39,999 per year	17	(39.5)	42	(32.8)	59	(34.5)
Between $40,000 and $69,999 per year	7	(16.3)	29	(22.7)	36	(21.1)
Between $70,000 and $99,999 per year	9	(20.9)	19	(14.8)	28	(16.4)
More than $100,000 per year	5	(11.6)	19	(14.8)	24	(14.0)
Missing	5	(11.6)	19	(14.8)	24	(14.0)

Note. All characteristics except age were self-reported.
Percentages rounded to first decimal place; may not add to 100% because of rounding.

Most of the participants (*n* = 117, 68.4%) were referred to an electrophysiologist from Vancouver Coastal Health or the Fraser Health Authority, the two regional healthcare administrative jurisdictions closest to the implanting centres (see Table 5-2). One hundred and

ten participants (64.3%) lived within relatively close proximity of an implanting centre, and 61 participants (35.7%) were required to travel more than 100 km, or take a ferry, to obtain electrophysiology medical care.

Table 5-2: Referring Health Authority of the Participants by Sex/Gender

Characteristic	Women n = 43 (25.1%)	Men *n* = 128 (74.9%)	All *N* = 171 (100%)
	n (%)	*n* (%)	*n* (%)
Health authority			
Vancouver Coastal Health	10 (23.3)	36 (28.1)	46 (26.9)
Fraser Health	20 (46.5)	49 (38.3)	69 (40.4)
Interior Health	6 (14.0)	24 (18.8)	30 (17.5)
Northern Health	6 (14.0)	14 (10.9)	20 (11.7)
Vancouver Island Health	1 (2.3)	1 (0.8)	2 (1.2)
Out of province	0 (0.0)	4 (3.1)	4 (2.3)

Percentages rounded to first decimal place; may not add to 100% because of rounding.

5.4.2. Participants' Health Status

At the time of their ICD implantation, 99 participants (57.9%) were admitted for surgery as elective out-patients, whereas 72 participants (42.1%) were already admitted to the implanting centre hospital or transferred by ambulance from a referring community hospital. One hundred twelve participants (65.5%) had a primary indication for an ICD; they were at risk of sudden cardiac death associated with severe heart failure. The remaining 59 participants (34.5%) received a device for secondary prevention following a significant ventricular arrhythmia event. Most of the participants who received an ICD for primary prevention had poor functional status because of their heart failure, as determined by the New York Heart Association (NYHA) Classification: 51 (44.7%) participants were Class II (mild) and 38 (33.3%) were Class III

(moderate).[35] Most of the participants in the secondary prevention group were mildly (Class I: *n* = 21; 36.8% and Class II: *n* = 16; 28.1%) symptomatic with heart failure.

Approximately one third of the participants had had a previous coronary revascularisation procedure, either percutaneous coronary intervention (*n* = 50; 29.2%) or cardiac surgery (*n* = 54; 31.6%). In addition to a history of coronary artery disease, the most prevalent co-existing conditions were hypertension (*n* = 77; 45.0%), atrial fibrillation (*n* = 55; 32.2%), and hypercholesterolaemia (*n* = 54; 31.6%). In addition, 14 (8.2%) participants had a history of malignancy and 21 (12.3%) had a documented history of depression. Most of the participants (*n* = 158; 92.4%) had been prescribed beta blocking or angiotensin-converting enzyme inhibitor (*n* = 119; 69.6%) medications, and 21 (12.3%) participants were taking the anti-arrhythmic agent, amiodarone. The participants' baseline cardiac status, by sex/gender and ICD indication, is summarised in Table 5-3.

[35] Class II patients experience mild symptoms (e.g., mild shortness of breath or angina) and have slight limitation during ordinary activity. Class III patients have marked limitation in activity because of their symptoms, and this occurs even during less-than-ordinary activity (e.g., walking a short distance such as 20 to 100 metres). They are comfortable only when they are at rest (Bennett, Riegel, Bittner, & Nichols, 2002).

Table 5-3: The Participants' Baseline Health Status by Indication for Cardioverter/Defibrillator Implantation and Sex/Gender

Characteristic	Primary Prevention *n* = 114 (66.7%)				Secondary Prevention *n* = 57 (33.3%)				All *N* = 171 (100%)			
	Women *n* = 25 (21.9%)		Men *n* = 89 (78.1%)		Women *n* = 18 (31.6%)		Men *n* = 39 (68.4%)		Women *n* = 43 (25.1%)		Men *n* = 128 (74.9%)	
	n	*(%)*	*n*	*(%)*	*n*	*(%)*	*n*	*(%)*	*n*	*(%)*	*n*	*(%)*
Urgency												
Elective out-patient	14	(56.0)	69	(77.5)	6	(33.3)	10	(25.6)	20	(46.5)	79	(61.7)
Urgent in-patient	11	(44.0)	20	(22.5)	12	(66.7)	29	(74.4)	23	(53.5)	49	(38.3)
Ejection fraction, Mean (SD)	29.7	(9.2)	31.4	(10.9)	56.9	(13.0)	44.4	(15.0)	41.1	(17.3)	35.4	(13.7)
NYHA Classification												
I	7	(28.0)	12	(13.5)	8	(44.4)	13	(33.3)	15	(34.9)	25	(19.5)
II	8	(32.0)	43	(48.3)	2	(11.1)	14	(35.9)	10	(23.3)	57	(44.5)
III	8	(32.0)	30	(33.7)	2	(11.1)	3	(7.7)	10	(23.3)	33	(25.8)
Unknown	2	(8.0)	4	(4.5)	6	(33.3)	9	(23.1)	8	(18.6)	13	(10.2)
Previous cardiac procedures[a]												
Percutaneous coronary intervention	9	(36.0)	26	(29.2)	2	(11.1)	13	(33.3)	11	(25.6)	39	(30.5)
Cardiac surgery	3	(12.0)	40	(44.9)	4	(22.2)	7	(17.9)	7	(16.3)	47	(36.7)
Co-existing cardiac conditions[a]												
Coronary artery disease	11	(44.0)	59	(66.3)	5	(27.8)	19	(48.7)	16	(37.2)	78	(60.9)
Atrial fibrillation	5	(20.0)	30	(33.7)	7	(38.9)	13	(33.3)	12	(27.9)	43	(33.6)
Hypertension	10	(40.0)	42	(47.2)	6	(33.3)	19	(48.7)	16	(37.2)	61	(47.7)
Hypercholesterolaemia	8	(32.0)	32	(36.0)	3	(16.7)	17	(43.6)	11	(25.6)	43	(33.6)
Diabetes	5	(20.0)	31	(34.8)	2	(11.1)	12	(30.8)	7	(16.3)	43	(33.6)
Cancer	2	(8.0)	8	(9.0)	1	(5.6)	3	(7.7)	3	(7.0)	11	(8.6)
Depression	3	(12.0)	9	(10.1)	4	(22.2)	5	(12.8)	7	(16.3)	14	(10.9)

Characteristic	Primary Prevention *n* = 114 (66.7%)				Secondary Prevention *n* = 57 (33.3%)				All *N* = 171 (100%)			
	Women *n* = 25 (21.9%)		Men *n* = 89 (78.1%)		Women *n* = 18 (31.6%)		Men *n* = 39 (68.4%)		Women *n* = 43 (25.1%)		Men *n* = 128 (74.9%)	
	n	*(%)*	*n*	*(%)*	*n*	*(%)*	*n*	*(%)*	*n*	*(%)*	*n*	*(%)*
Cardiac medications[a]												
Amiodarone	3	(12.0)	6	(6.7)	3	(16.7)	9	(23.1)	6	(14.0)	15	(11.7)
Beta-blockers	24	(96.0)	84	(94.4)	6	(33.3)	34	(87.2)	40	(93.0)	118	(92.2)
Angiotensin-converting enzyme (ACE) inhibitor	23	(20.1)	67	(75.3)	6	(33.3)	23	(59.0)	29	(67.4)	90	(70.3)
Digoxin	4	(3.5)	14	(15.7)	1	(5.6)	5	(12.8)	5	(11.6)	19	(14.8)
Diuretics	18	(15.8)	60	(67.4)	3	(16.7)	17	(43.6)	21	(48.8)	77	(60.2)
Lipid lowering	12	(10.5)	70	(78.7)	4	(22.2)	23	(59.0)	16	(37.2)	93	(72.7)
Warfarin	6	(5.3)	23	(25.8)	4	(22.2)	8	(20.5)	10	(23.3)	31	(24.2)
Patient-reported health status[b]												
Excellent	0	(0.0)	1	(1.1)	0	(0.0)	1	(2.6)	0	(0.0)	2	(1.6)
Very good	2	(8.0)	6	(6.7)	4	(22.2)	2	(5.1)	6	(14.0)	8	(6.3)
Good	9	(36.0)	23	(25.8)	7	(38.9)	16	(41.0)	16	(37.2)	39	(30.5)
Fair	3	(12.0)	42	(47.2)	4	(22.2)	13	(33.3)	7	(16.3)	55	(43.0)
Poor	11	(44.0)	17	(19.1)	3	(16.7)	7	(17.9)	14	(32.6)	24	(18.8)

Note: NYHA = New York Heart Association functional class.

Percentages rounded to first decimal place; may not add to 100% because of rounding.

[a]Does not sum to 100% because of exclusion of negative reports. No imputation performed.

[b]Scoring on SF-36v2 General Health item: *"In general, would you say your health is: excellent, very good, good, fair, poor?"*

To capture the burden of coronary ischaemia, at each post-implantation measurement occasion, the participants reported the number of times, on average, that they had experienced chest pain, chest tightness, or angina, in the past four weeks. The majority did not report any symptoms of ischaemia (see Table 5-4).

Table 5-4: Frequency of Ischaemic Symptoms during Post-Implantation Follow-Up

Frequency	1 Month N = 149 (100%)		2 Months N = 140 (100%)		6 Months N = 139 (100%)	
	n	(%)	*n*	(%)	*n*	(%)
None in the past 4 weeks	103	(69.1)	84	(60.0)	89	(64.0)
Less than once a week	23	(15.4)	33	(23.6)	25	(18.0)
1 – 2 times per week	14	(9.4)	15	(10.7)	14	(10.1)
3 or more times per week	9	(6.1)	8	(5.7)	11	(7.9)

Note. Percentages rounded to first decimal place; may not add to 100% because of rounding.

The participants reported the frequency of their visits to a physician and of any emergency department or hospital admissions since the completion of the preceding questionnaire.[36] Twelve (8.1%) participants did not report seeing a physician in the initial month following ICD implantation, although they were instructed to do so at the time of discharge. One hundred (67.0%) participants had seen a physician once or twice in the first month following implantation, and 37 (24.9%) had seen a physician three or more times. The frequency of physician visits decreased over time; by the six-month follow-up assessment, 20 (14.4%) of the participants reported seeing a physician three or more times.

In the first month following implantation of their ICD, most of the participants (*n* = 129; 86.6%) had not visited an emergency department (ED) or been admitted to a hospital. This pattern of

[36] Discharge and follow-up guidelines prescribe medical follow-up, the frequency of which does not necessarily reflect patients' clinical requirements. Nonetheless, the participants' use of medical resources may provide some insight into their burden of disease and symptom management needs.

resource utilisation persisted over the duration of follow-up with 12.1% and 10.0% reporting one or more emergency department or hospital admissions, within the previous four weeks, at two and six months, respectively (see Table 5-5).

Table 5-5: Frequency of Physician and Emergency Department Visits or Hospital Admissions during Post-Implantation Follow-Up

Frequency	1 Month N = 149 (100%)		2 Months N = 140 (100%)		6 Months N = 139 (100%)	
	n	(%)	*n*	(%)	*n*	(%)
Physician visits						
None	12	(8.1)	20	(14.3)	32	(23.0)
One	56	(37.5)	55	(39.3)	52	(37.4)
Two	44	(29.5)	37	(26.4)	34	(24.5)
Three or more *(Range: 3-10)*	37	(24.9)	28	(20.0)	20	(14.4)
Missing					1	(0.7)
Emergency department visits or hospital admissions						
None	129	(86.6)	123	(87.9)	125	(89.9)
One	15	(10.1)	15	(10.7)	7	(5.0)
Two or more *(Range 2-5)*	5	(3.4)	1	(0.7)	3	(2.1)
Missing			1	(0.7)	4	(2.9)

Note. Percentages rounded to first decimal place; may not add to 100% because of rounding.

Very few of the participants reported experiencing ICD shocks during the course of the study. The self-reported incidence rates of having had at least one ICD shock in the first months following implantation were: 6.7% (n = 10) at one month, 4.3% (n = 6) at two months, and 2.9% (n = 4) at six months.

In the following section, we present the findings related to the participants' ratings of their health status with respect to the selected PROs under study, at the group level, and over time. To facilitate the presentation of findings, we have consistently applied an ordering and

colour-coding of the PROs, which are grouped as follows: physical health status (coded blue), mental health status (coded green), and social health status (coded red) (see Table 5 6).

Table 5-6: The Sequence and Colour-Coding of the Reported Findings

Order	Patient Reported Outcome	Colour
	Physical Health Status	Blue
1	SF-36v2 Physical Functioning	
2	SF-36v2 Bodily Pain	
3	Sleep Disturbance	
	Mental Health Status	Green
4	SF-36v2 Mental Health	
5	SF-36v2 Vitality	
6	Shock Anxiety	
	Social Health Status	Red
7	SF-36v2 Role Physical	
8	SF-36v2 Role Emotional	
9	SF-36v2 Social Functioning	
10	Satisfaction with Participation in Social Roles	
11	Satisfaction with Participation in Discretionary Social Activities	
12	Patient Acceptance of Implantable Cardiac Device Therapy	

5.5. Question 1: The Presence and Direction of Change: Grouped Data

The first research question focused on determining whether ICD recipients experience change in their PROs, over time and, if such change were to be identified, on describing the direction of the change. To begin to answer this question, we examined the distributions and descriptive statistics of the scores of each selected PRO (i.e., means, standard deviations, and medians) at each measurement occasion. For the SF-36v2 subscales, we referenced the mean age- and sex-standardised Canadian normative scores (Hopman et al., 2000).

5.5.1. Physical Health Status

On average, the participants showed improvement, over time, on the three physical health status PROs with an absolute improvement, from baseline to the six-month follow-up, of 11.0

points in the mean score of the 100-point Physical Functioning scale, 4.6 points for Bodily Pain, and 7.7 points for Sleep Disturbance.[37] The relative improvement, or percent change, from baseline status to the 6-month measure was 20.5%, 7.2%, and 15.3%, respectively, for the three PROs.[38] The absolute mean differences, over the 6-month period, represented an improvement of 0.39, 0.16, and 0.31 standard deviations, of the baseline scores, respectively.[39]

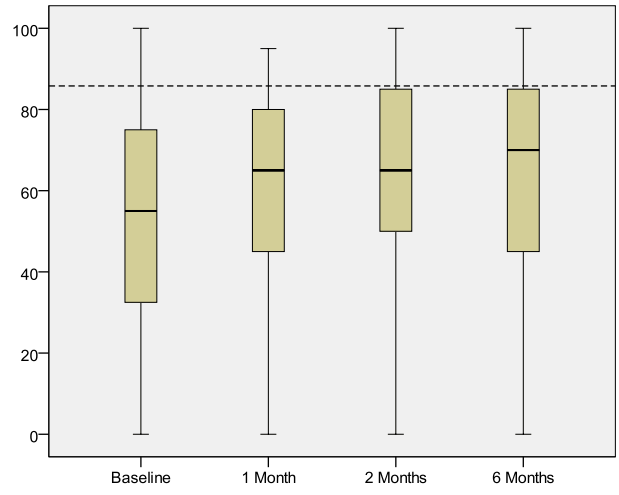
The improvement in scores was relatively steady, over the follow-up period, for physical functioning. The pattern of change was somewhat different for bodily pain with an initial 8.2% worsening in the first month following surgery, and then improved scores (i.e., less pain reported, on average) at both the two- and six-month assessments. Sleep disturbance improved in the first month, and remained relatively unchanged for the subsequent two measures. The descriptive statistics and graphs for the physical health status PROS are provided in Tables 5-7 to 5.9.

[37] Absolute mean difference is defined as the difference in means between the six-month follow-up measure and baseline (i.e., $mean_{(6\ months)} - mean_{(baseline)}$).
[38] Relative mean difference as a percentage is defined as the difference in means between the six-month follow-up measure and baseline, relative to the baseline, presented as a percentage (i.e., $mean_{(6\ months)} - mean_{(baseline)} / mean_{(baseline)} * 100$).
[39] Relative mean difference as a standard deviation is defined as the absolute mean difference divided by the standard deviation observed at baseline (i.e., $mean_{(6\ months)} - mean_{(baseline)} / standard\ deviation_{(baseline)}$).

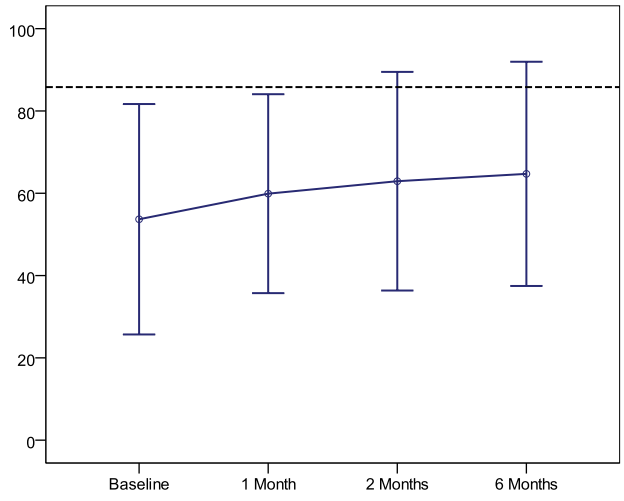
Table 5-7: Descriptive Statistics of, and Change in, SF-36v2 Physical Functioning: Grouped Data

Physical Health Status							
SF-36v2 Physical Functioning							
	Baseline	**At 1 Month**	**At 2 Months**	**At 6 Months**	**Absolute Mean Difference[a]**	**Relative Mean Difference (%)[b]**	**Relative Mean Difference (SD)[c]**
N	171	149	140	139			
Mean	53.7	59.9	62.9	64.7	11.0	20.5	0.39
SD	28.0	24.2	26.6	27.3			
Median	55.0	65.0	65.0	70.0			

Box Plots



Means with ± 1 SD



Note: Original item scaling 1-3; 10 items.

Original score scale: 10-30.

[a]The difference in means between the six-month follow-up measure and baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$).

[b]The difference in means between the six-month follow-up measure and baseline, relative to the baseline, presented as a percentage (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $mean_{(baseline)}$ * 100).

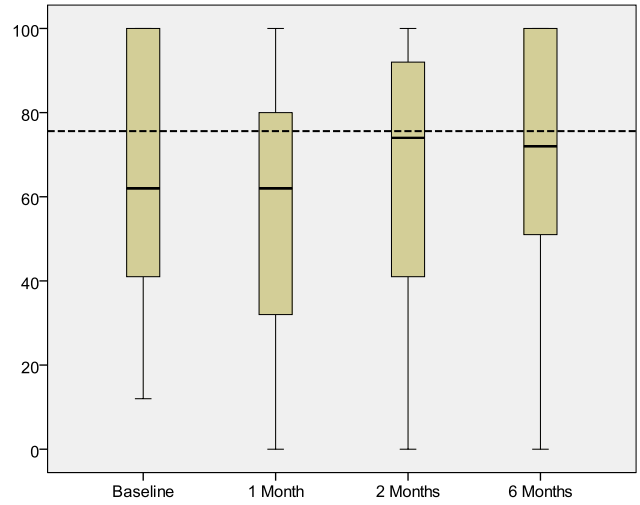
[c]The absolute mean difference divided by the standard deviation observed at baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $standard\ deviation_{(baseline)}$).

- - - - : Canadian urban dwelling adult (25 years and older) mean age- and sex-standardised scores [*M* = 85.8; *SD* = 20.0;] from CaMOS normative data (Hopman at al., 2000).

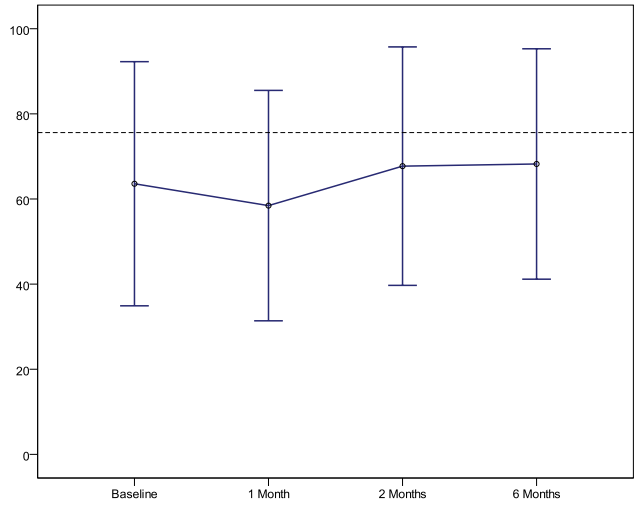
Table 5-8: Descriptive Statistics of, and Change in, SF-36v2 Bodily Pain: Grouped Data

Physical Health Status							
SF-36v2 Bodily Pain							
	Baseline	**At 1 Month**	**At 2 Months**	**At 6 Months**	**Absolute Mean Difference[a]**	**Relative Mean Difference (%)[b]**	**Relative Mean Difference (SD)[c]**
N	171	149	140	139			
Mean	63.6	58.4	67.7	68.2	4.6	7.2	0.16
SD	28.7	27.1	28.0	27.1			
Median	62.0	62.0	74.0	72.0			

Box Plots



Means with ± 1 SD



Note: Original item scaling 1-6; 2 items.

Original score scale: 2-12.

[a]The difference in means between the six-month follow-up measure and baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$).

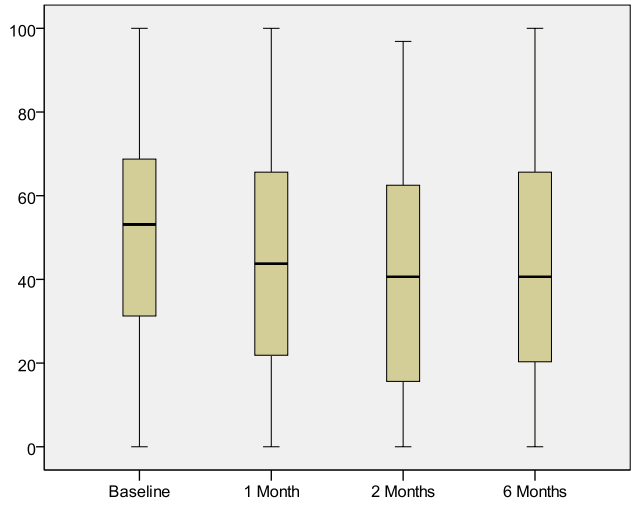
[b]The difference in means between the six-month follow-up measure and baseline, relative to the baseline, presented as a percentage (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $mean_{(baseline)}$ * 100).

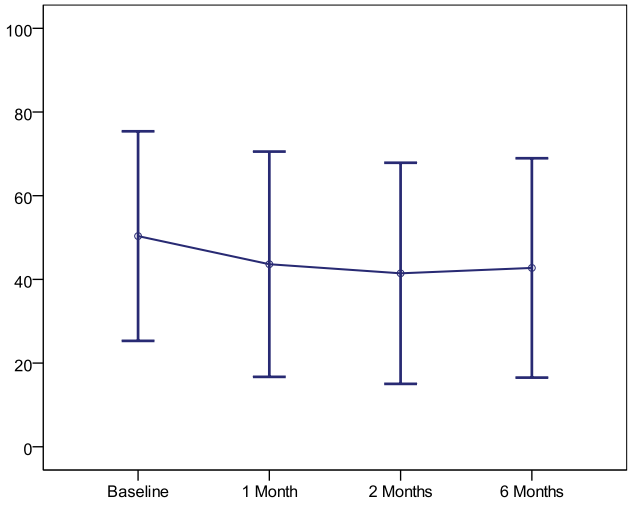
[c]The absolute mean difference divided by the standard deviation observed at baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $standard\ deviation_{(baseline)}$).

- - - - : Canadian urban dwelling adult (25 years and older) mean age- and sex-standardised scores [*M* = 75.6; *SD* = 23.0] from CaMOS normative data (Hopman at al., 2000).

Table 5-9: Descriptive Statistics of, and Change in, Sleep Disturbance: Grouped Data

Physical Health Status							
Sleep Disturbance							
	Baseline	**At 1 Month**	**At 2 Months**	**At 6 Months**	**Absolute Mean Difference[a]**	**Relative Mean Difference (%)[b]**	**Relative Mean Difference (SD)[c]**
N	171	149	140	139			
Mean	50.4	43.6	41.5	42.7	- 7.7	- 15.3	- 0.31
SD	25.0	26.9	26.4	26.2			
Median	53.1	43.8	40.6	40.6			
Box Plots					**Means with ± 1 SD**		





Note: Original item scaling 1-5; 8 items; Lower scores indicate less sleep disturbance.

Original score scale: 8-40. (High score indicates worse function).

[a]The difference in means between the six-month follow-up measure and baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$).

[b]The difference in means between the six-month follow-up measure and baseline, relative to the baseline, presented as a percentage (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $mean_{(baseline)}$ * 100).

[c]The absolute mean difference divided by the standard deviation observed at baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $standard\ deviation_{(baseline)}$).

5.5.2. Mental Health Status

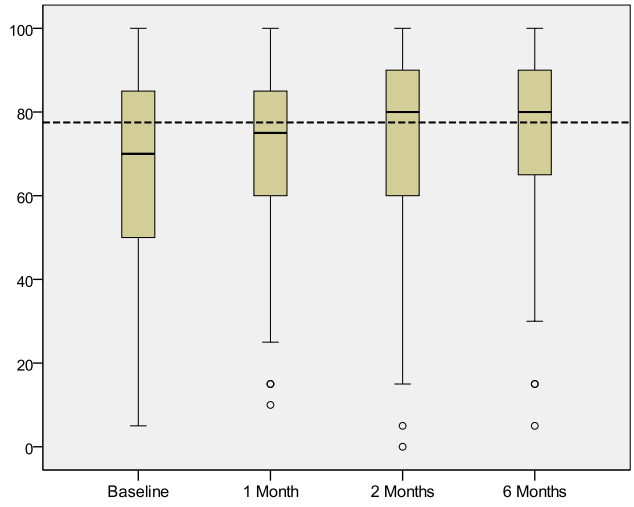
The scores on the SF-36v2 Mental Health and Vitality subscales were measured on four occasions, whereas device-related anxiety was measured on three occasions in the post-implantation phase. There was improvement observed in all three PROs over the course of the study. The absolute differences in the mean scores between the first and last occasions were 7.6 for Mental Health, 8.4 for Vitality, and 4.1 for Shock Anxiety, which represented a relative improvement, or percentage change, of 11.4%, 19.1%, and 19.4%, respectively. The 6-month scores reflected a 0.35, 0.37, and 0.20 standard deviation change from the baseline scores for the three respective PROs.

The distributions and patterns of change for the mental health status PROs are presented in Table 5-10 to 5-12.

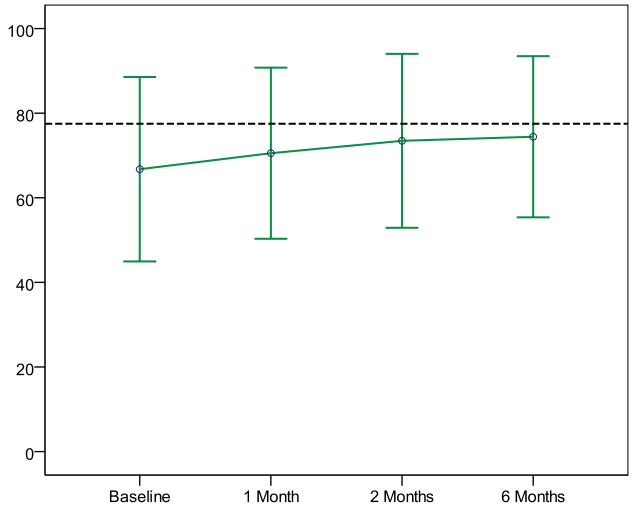
Table 5-10: Descriptive Statistics of, and Change in, SF-36v2 Mental Health: Grouped Data

Mental Health Status							
SF-36v2 Mental Health							
	Baseline	**At 1 Month**	**At 2 Months**	**At 6 Months**	**Absolute Mean Difference[a]**	**Relative Mean Difference (%)[b]**	**Relative Mean Difference (SD)[c]**
N	171	149	140	139			
Mean	66.8	70.5	73.5	74.4	7.6	11.4	0.35
SD	21.8	20.2	20.6	19.1			
Median	70.0	75.0	80.0	80.0			

Box Plots



Means with ± 1 SD



Note: Original item scaling 1-5; 5 items.

Original score scale: 5-25.

[a]The difference in means between the six-month follow-up measure and baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$).

[b]The difference in means between the six-month follow-up measure and baseline, relative to the baseline, presented as a percentage (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $mean_{(baseline)}$ * 100).

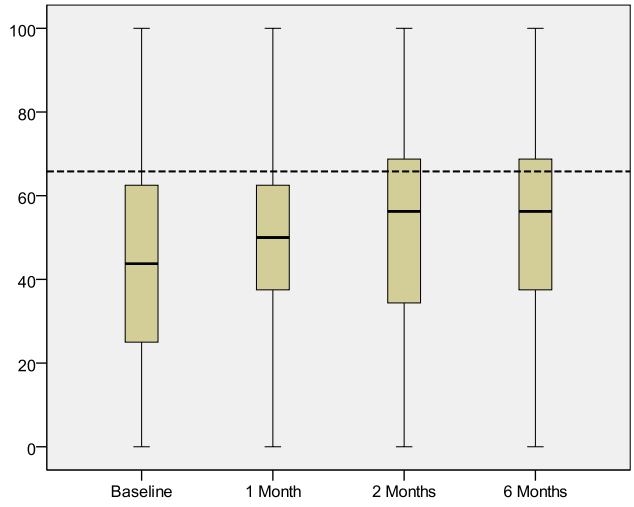
[c]The absolute mean difference divided by the standard deviation observed at baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $standard\ deviation_{(baseline)}$).

- - - - : Canadian urban dwelling adult (25 years and older) mean age- and sex-standardised scores [*M* = 77.5; *SD* = 15.3] from CaMOS normative data (Hopman at al., 2000).

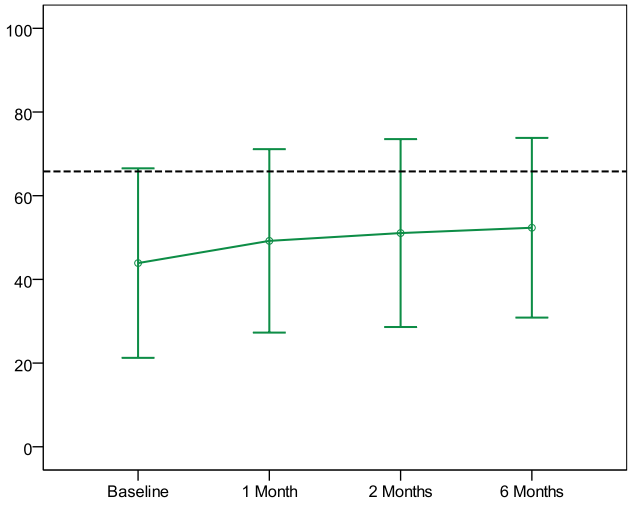
Table 5-11: Descriptive Statistics of, and Change in, SF-36v2 Vitality: Grouped Data

Mental Health Status							
SF-36v2 Vitality							
	Baseline	**At 1 Month**	**At 2 Months**	**At 6 Months**	**Absolute Mean Difference[a]**	**Relative Mean Difference (%)[b]**	**Relative Mean Difference (SD)[c]**
N	171	149	140	139			
Mean	43.9	49.2	51.1	52.3	8.4	19.1	0.37
SD	22.7	21.9	22.5	21.5			
Median	43.8	50.0	56.3	56.3			

Box Plots



Means with ± 1 SD



Note: Original item scaling 1-5; 4 items.

Original score scale: 4-20.

[a]The difference in means between the six-month follow-up measure and baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$).

[b]The difference in means between the six-month follow-up measure and baseline, relative to the baseline, presented as a percentage (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $mean_{(baseline)}$ * 100).

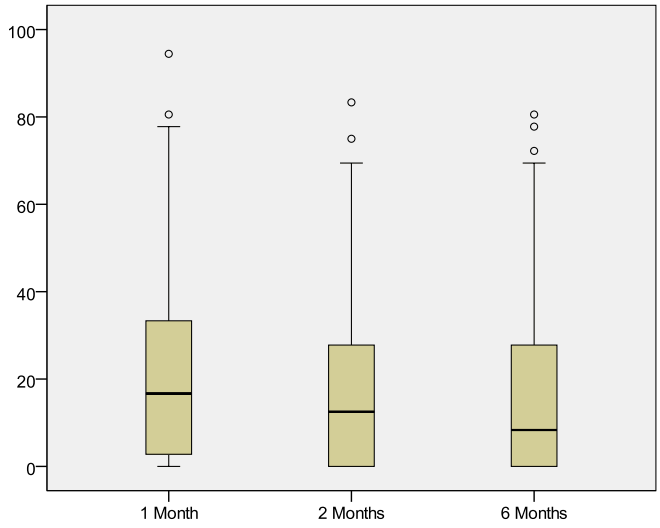
[c]The absolute mean difference divided by the standard deviation observed at baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $standard\ deviation_{(baseline)}$).

- - - - : Canadian urban dwelling adult (25 years and older) mean age- and sex-standardised scores [*M* = 65.8; *SD* = 18.0] from CaMOS normative data (Hopman at al., 2000).

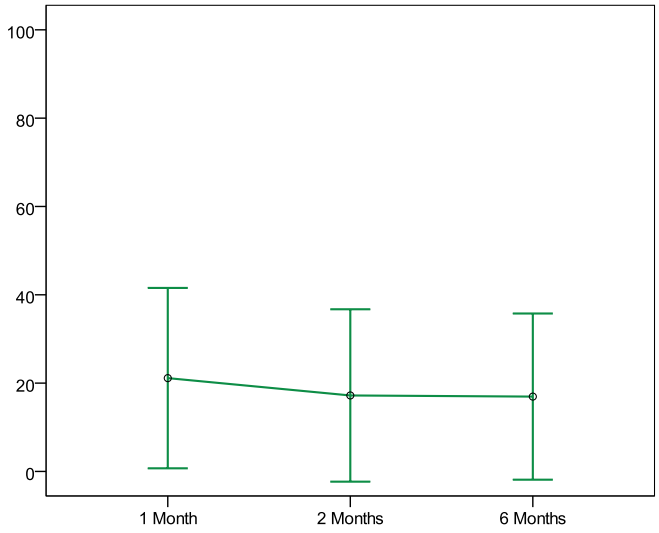
Table 5-12: Descriptive Statistics of, and Change in, Shock Anxiety: Grouped Data

Mental Health Status						
Shock Anxiety						
	At 1 Month	**At 2 Months**	**At 6 Months**	**Absolute Mean Difference[a]**	**Relative Mean Difference (%)[b]**	**Relative Mean Difference (SD)[c]**
N	149	140	139			
Mean	21.1	17.2	17.0	- 4.1	- 19.4	- 0.20
SD	20.5	19.5	18.8			
Median	16.7	12.5	8.3			

Box Plots



Means with ± 1 SD



Note: Original item scaling 1-5; 9 items.

Original score scale: 4-45. (High score indicates worse function).

[a]The difference in means between the six-month follow-up measure and baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$).

[b]The difference in means between the six-month follow-up measure and baseline, relative to the baseline, presented as a percentage (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $mean_{(baseline)}$ * 100).

[c]The absolute mean difference divided by the standard deviation observed at baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $standard\ deviation_{(baseline)}$).

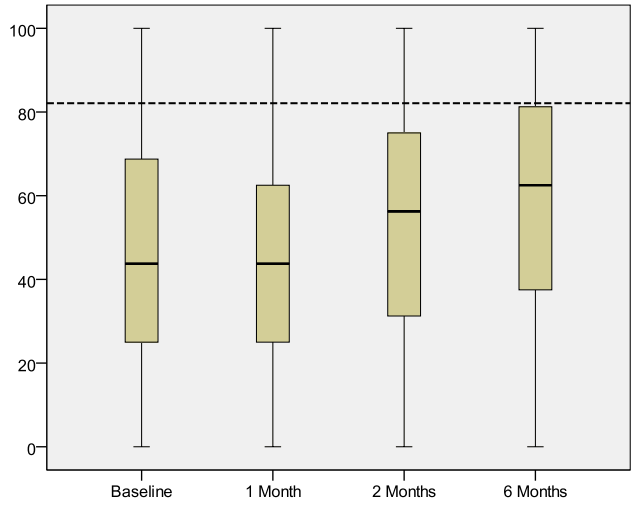
5.5.3. Social Health Status

The scores of the six indicators of social health status improved with time. For the three SF-36v2 subscales, the absolute differences in mean scores between the first and last measurement occasions were 15.8 points on the 100-point scale for Role Physical, 7.3 for Role Emotional, and 14.3 for Social Functioning, while the relative percentage changes in these scores were 35.3%, 11.6%, and 23.7%, respectively. The two PROMIS short-form measures of social health status exhibited similar changes with an absolute change in mean scores between the first and last measurement occasions of 16.4 points for Satisfaction with Participation in Social Roles, and 11.9 points for Satisfaction with Participation in Discretionary Social Activities, which were relative improvements of 33.3% and 23.5%, respectively. The mean scores of the Florida Patient Acceptance Survey improved between the first and second months, and remained consistent at the six-month measurement. The percentage change between the first and last measure was 6.9% (0.27 SDs). The only extreme value recorded was observed in the 6-month follow-up scores of the Patient Acceptance of Implantable Cardiac Device Therapy; a participant who did not exhibit a similar pattern in the other PROs of social health status. The distributions and patterns of change for the social health status PROs are presented in Tables 5-13 to 5-18.

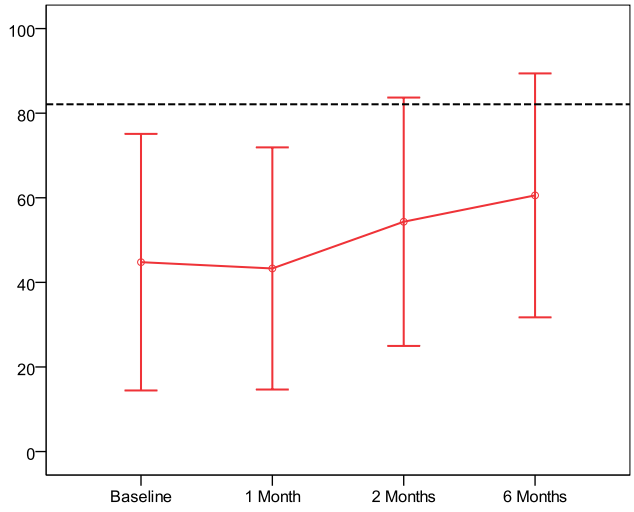
Table 5-13: Descriptive Statistics of, and Change in, SF-36v2 Role Physical: Grouped Data

Social Health Status							
SF-36v2 Role Physical							
	Baseline	At 1 Month	At 2 Months	At 6 Months	Absolute Mean Difference[a]	Relative Mean Difference (%)[b]	Relative Mean Difference (SD)[c]
N	171	149	140	139			
Mean	44.8	43.3	54.3	60.6	15.8	35.3	0.52
SD	30.3	28.6	29.4	28.8			
Median	43.8	43.8	56.3	62.5			

Box Plots



Means with ± 1 SD



Note: Original item scaling 1-5; 4 items.

Original score scale: 4-20.

[a]The difference in means between the six-month follow-up measure and baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$).

[b]The difference in means between the six-month follow-up measure and baseline, relative to the baseline, presented as a percentage (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $mean_{(baseline)}$ * 100).

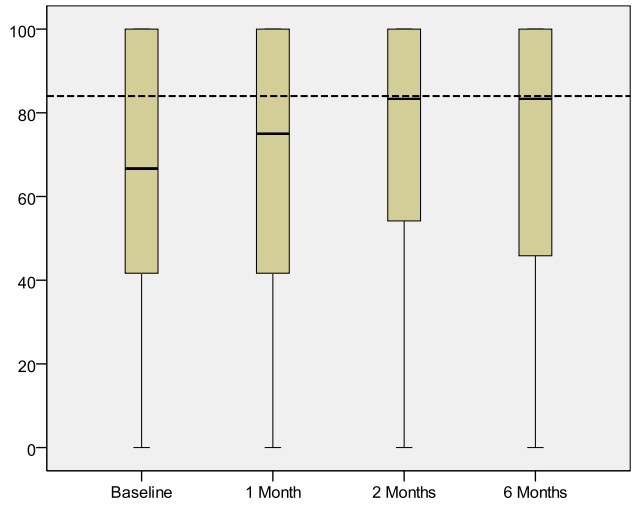
[c]The absolute mean difference divided by the standard deviation observed at baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $standard\ deviation_{(baseline)}$).

- - - - : Canadian urban dwelling adult (25 years and older) mean age- and sex-standardised scores [*M* = 82.1; *SD* = 33.2] from CaMOS normative data (Hopman at al., 2000).

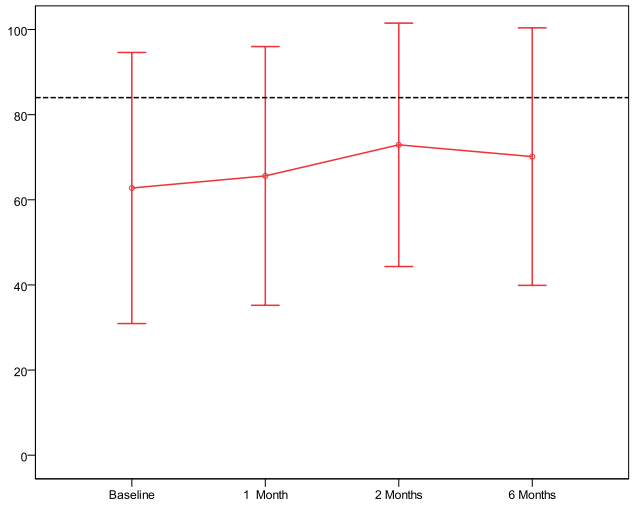
Table 5-14: Descriptive Statistics of, and Change in, SF-36v2 Role Emotional: Grouped Data

Social Health Status							
SF-36v2 Role Emotional							
	Baseline	**At 1 Month**	**At 2 Months**	**At 6 Months**	**Absolute Mean Difference[a]**	**Relative Mean Difference (%)[b]**	**Relative Mean Difference (SD)[c]**
N	171	149	140	139			
Mean	62.8	65.6	72.9	70.1	7.3	11.6	0.23
SD	31.8	30.4	28.6	30.3			
Median	66.7	75.0	83.3	83.3			

Box Plots



Means with ± 1 SD



Note: Original item scaling 1-5; 3 items.

Original score scale: 3-15.

[a]The difference in means between the six-month follow-up measure and baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$).

[b]The difference in means between the six-month follow-up measure and baseline, relative to the baseline, presented as a percentage (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $mean_{(baseline)}$ * 100).

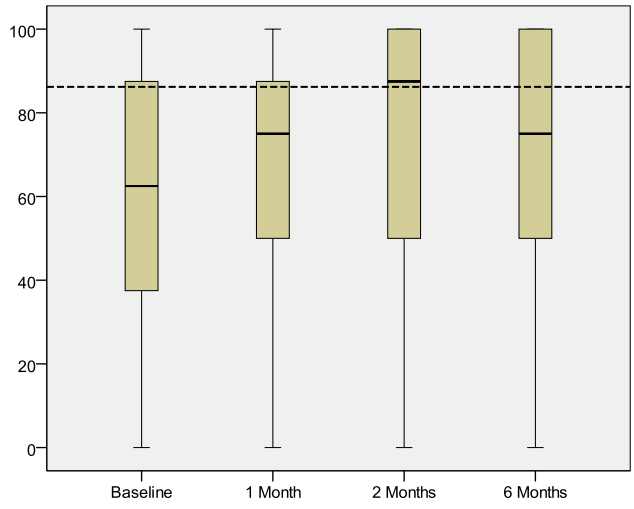
[c]The absolute mean difference divided by the standard deviation observed at baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $standard\ deviation_{(baseline)}$).

- - - - : Canadian urban dwelling adult (25 years and older) mean age- and sex-standardised scores [*M* = 82.1; *SD* = 33.2] from CaMOS normative data (Hopman at al., 2000).

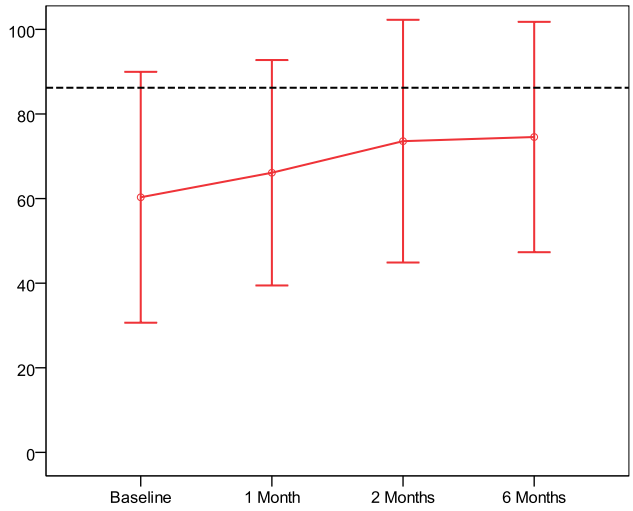
Table 5-15: Descriptive Statistics of, and Change in, SF-36v2 Social Functioning: Grouped Data

Social Health Status							
SF-36v2 Social Functioning							
	Baseline	**At 1 Month**	**At 2 Months**	**At 6 Months**	**Absolute Mean Difference[a]**	**Relative Mean Difference (%)[b]**	**Relative Mean Difference (SD)[c]**
N	171	149	140	139			
Mean	60.3	66.1	73.6	74.6	14.3	23.7	0.48
SD	29.7	26.7	28.7	27.2			
Median	62.5	75.0	87.5	75.0			

Box Plots



Means with ± 1 SD



Note: Original item scaling 1-5; 2 items.

Original score scale: 2-10.

[a]The difference in means between the six-month follow-up measure and baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$).

[b]The difference in means between the six-month follow-up measure and baseline, relative to the baseline, presented as a percentage (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $mean_{(baseline)}$ * 100).

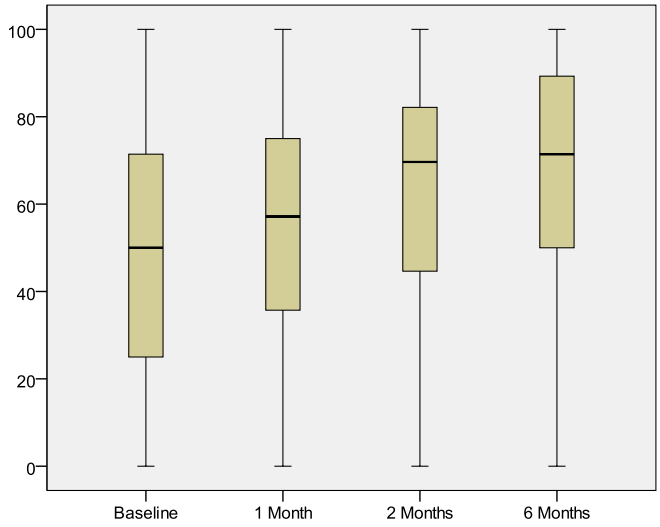
[c]The absolute mean difference divided by the standard deviation observed at baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $standard\ deviation_{(baseline)}$).

- - - - : Canadian urban dwelling adult (25 years and older) mean age- and sex-standardised scores [*M* = 82.1; *SD* = 33.2] from CaMOS normative data (Hopman at al., 2000).

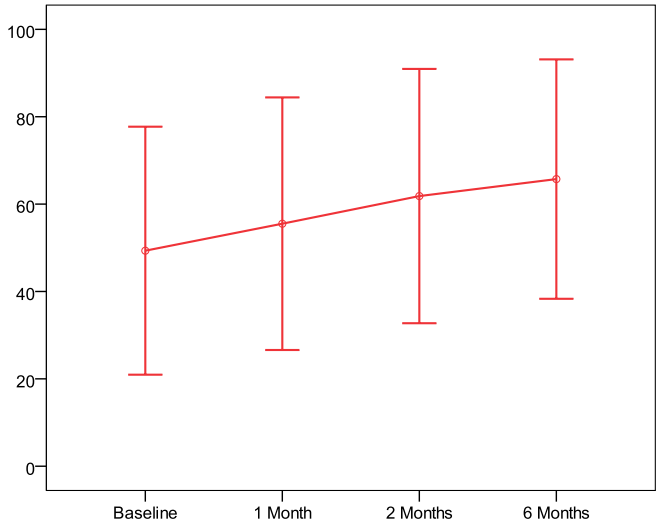
Table 5-16: Descriptive Statistics of, and Change in, Satisfaction with Participation in Social Roles: Grouped Data

Social Health Status							
Satisfaction with Participation in Social Roles							
	Baseline	**At 1 Month**	**At 2 Months**	**At 6 Months**	**Absolute Mean Difference[a]**	**Relative Mean Difference (%)[b]**	**Relative Mean Difference (SD)[c]**
N	171	149	140	139			
Mean	49.3	55.5	61.8	65.7	16.4	33.3	0.58
SD	28.4	28.9	29.1	27.4			
Median	50.0	57.1	69.6	71.4			

Box Plots



Means with ± 1 SD



Note: Original item scaling 1-5; 7 items.

Original score scale: 7-35.

[a]The difference in means between the six-month follow-up measure and baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$).

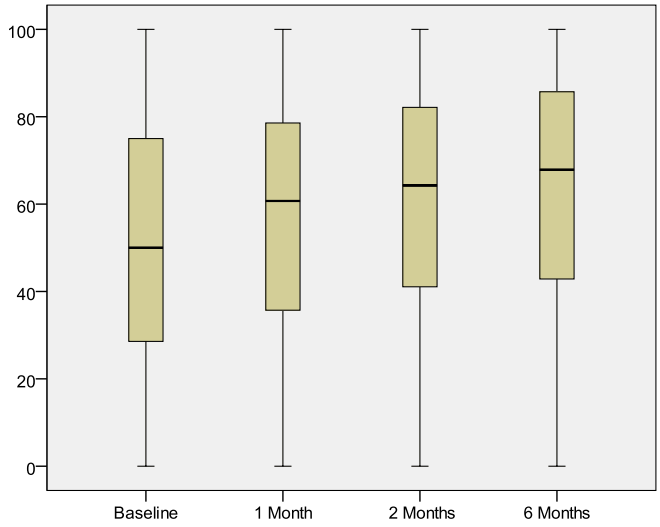
[b]The difference in means between the six-month follow-up measure and baseline, relative to the baseline, presented as a percentage (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $mean_{(baseline)}$ * 100).

[c]The absolute mean difference divided by the standard deviation observed at baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $standard\ deviation_{(baseline)}$).

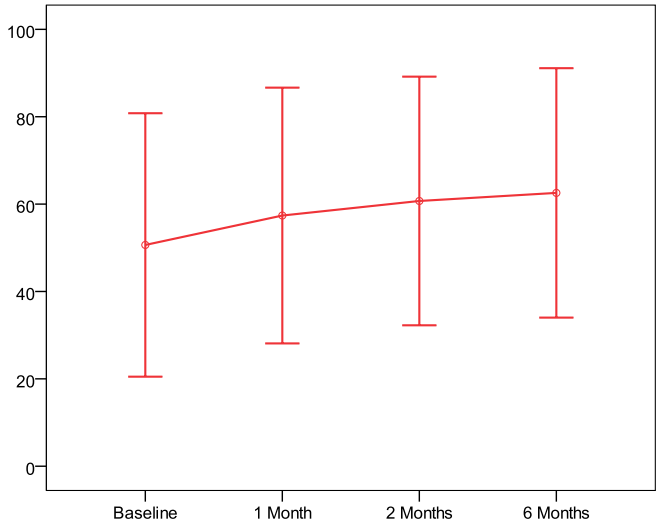
Table 5-17: Descriptive Statistics of, and Change in, Satisfaction with Participation in Discretionary Social Activities: Grouped Data

Social Health Status							
Satisfaction with Participation in Discretionary Social Activities							
	Baseline	**At 1 Month**	**At 2 Months**	**At 6 Months**	**Absolute Mean Difference[a]**	**Relative Mean Difference (%)[b]**	**Relative Mean Difference (SD)[c]**
N	171	149	140	139			
Mean	50.7	57.4	60.7	62.6	11.9	23.5	0.39
SD	30.2	29.3	28.5	28.6			
Median	50.0	60.7	64.3	67.9			

Box Plots



Means with ± 1 SD



Note: Original item scaling 1-5; 7 items.

Original score scale: 7-35.

[a]The difference in means between the six-month follow-up measure and baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$).

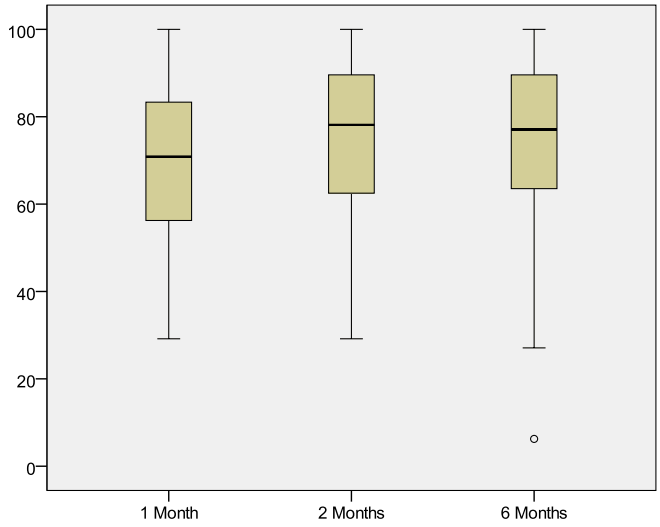
[b]The difference in means between the six-month follow-up measure and baseline, relative to the baseline, presented as a percentage (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $mean_{(baseline)}$ * 100).

[c]The absolute mean difference divided by the standard deviation observed at baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $standard\ deviation_{(baseline)}$).

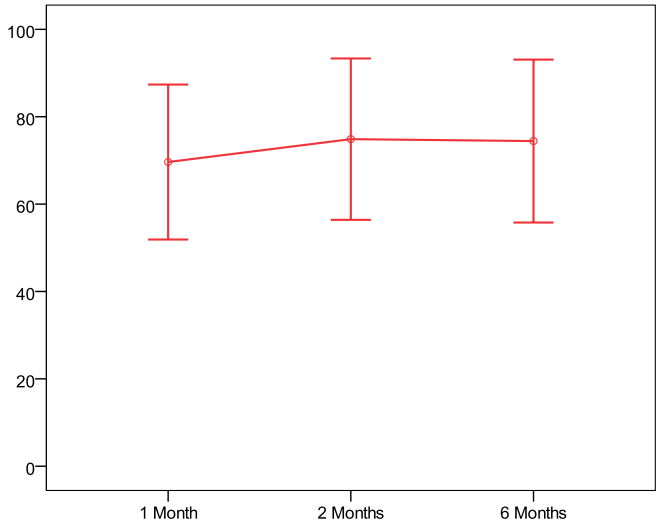
Table 5-18: Descriptive Statistics of, and Change in, Patient Acceptance of Implantable Cardiac Device Therapy: Grouped Data

Social Health Status						
Patient Acceptance of Implantable Cardiac Device Therapy						
	At 1 Month	**At 2 Months**	**At 6 Months**	**Absolute Mean Difference[a]**	**Relative Mean Difference (%)[b]**	**Relative Mean Difference (SD)[c]**
N	149	140	139			
Mean	69.6	74.9	74.4	4.8	6.9	0.27
SD	17.7	18.5	18.7			
Median	70.8	78.1	77.1			

Box Plots



Means with ± 1 SD



Note: Original item scaling 1-5; 12 items.

Original score scale: 12-60.

[a]The difference in means between the six-month follow-up measure and baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$).

[b]The difference in means between the six-month follow-up measure and baseline, relative to the baseline, presented as a percentage (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $mean_{(baseline)}$ * 100).

[c]The absolute mean difference divided by the standard deviation observed at baseline (i.e., $mean_{(6\ months)}$ - $mean_{(baseline)}$ / $standard\ deviation_{(baseline)}$).

5.5.4. Outlier Scores

The SF-36v2 Mental Health subscale and the Florida Shock Anxiety Scale (mental health PROs), and the Florida Patient Acceptance of Implantable Cardiac Device Therapy scale (social health PRO) were the only PROs measured that contained outliers. Three people were outliers on the SF-36v2 mental health PRO exclusively, on at least one measure, three others were outliers on the shock anxiety exclusively, and one person was an outlier on the Florida Patient Acceptance of Implantable Cardiac Device Therapy scale on at least one measure. Two were outliers on the SF-36v2 mental health subscale and the Florida Patient Acceptance of Implantable Cardiac Device Therapy scale. The summary of outlier cases is presented in Table 5-19.

Table 5-19: Participants with Outlier Scores at each Measurement Occasion

	Baseline	At 1 Month	At 2 Months	At 6 Months
Mental Health	Participant 1	Participant 2	Participant 2	Participant 1
	Participant 2	Participant 3	Participant 3	Participant 4
	Participant 3			Participant 5
Shock Anxiety	N/A	Participant 2	Participant 7	Participant 3
		Participant 6	Participant 8	Participant 6
Patient Acceptance of ICD Therapy				Participant 9

A detailed review of the demographic and medical history associated with each outlying case is presented in Table 5-20. We omitted Participant 9, who was an outlier on the last measurement occasion of the Florida Patient Acceptance Survey from all subsequent analyses related to this PRO because the score was sharply incongruent with the other scores. Except for this case on the Florida Patient Acceptance Survey, we retained these cases in the analyses

because there were too few to influence the results, and were likely to be correct values. In examining, their characteristics, it is apparent that they are of the target population, and represent the complexity of some people's lives.

Table 5-20: Description of Demographic Characteristics and Medical Histories of Participants who had Outlying PRO Scores

#	Age	Sex/ Gender	Marital Status	House hold Size	Employment Status	Distance to EP Services	Indication	Urgency	Shock History	Ejection Fraction	NYHA Class
1	59	Female	Married	2	Not employed	Less than 100 km	Primary prevention	Elective	No	30%	II
2	55	Male	Divorced	1	Not employed	Less than 100 km	Primary prevention	Elective	No	30%	III
3	58	Female	Divorced	1	Not employed	More than 100 km	Secondary prevention	Urgent	No	Normal	I
4	66	Male	Married	2	Not employed	Less than 100 km	Primary prevention	Elective	No	29%	III
5	73	Male	Married	2	Not employed	More than 100 km	Primary prevention	Elective	No	34%	II
6	51	Female	Single	1	Employed	More than 100 km	Secondary prevention	Elective	No	Normal	Unknown
7	48	Male	Married	3	Employed	Less than 100 km	Secondary prevention	Elective	No	Normal	Unknown
8	80	Male	Married	2	Not employed	Less than 100 km	Primary prevention	Elective	No	28%	III

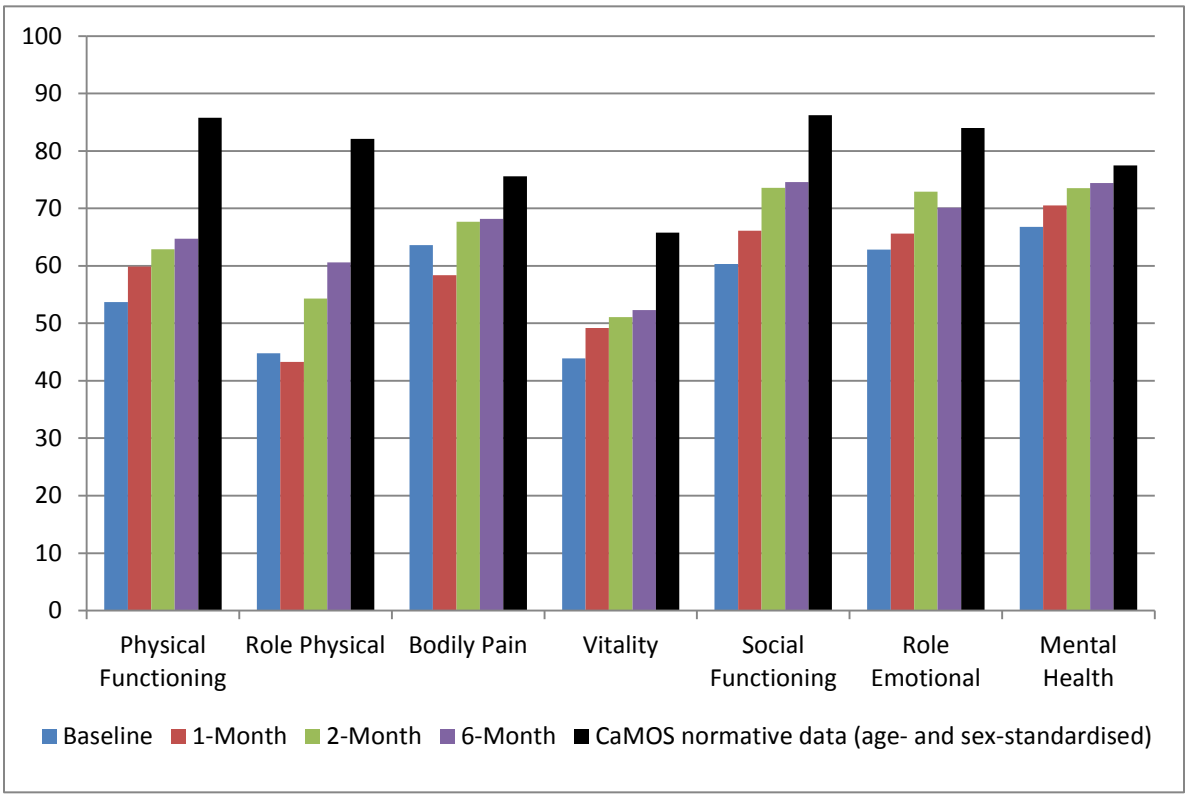
5.5.5. Summary of Grouped Data

In summary, and to answer the first question posed in this study, we found evidence of change in PROs in the first six months after receiving an ICD. As a group, the participants demonstrated improvement. Over time, in all 12 PROs assessed, we found improved absolute score changes, on the standardised scales between 0 and 100, ranging from minimal improvement of 4.1 to 4.8 points (i.e., Shock Anxiety, SF-36v2 Bodily Pain, and Patient Acceptance of Implantable Cardiac Device Therapy) to substantial improvement of 14.3 to 16.4 points (i.e., SF-36v2 Social Functioning, SF-36v2 Role Physical, and Satisfaction with Participation in Social Roles). The average absolute change in mean scores, over the six months, among the 12 PROs was 9.5 points, with an average relative mean difference or improvement of 18.1%, exceeding the 10% minimal important difference discussed in the previous chapter. This change represented, on average, a 0.35 standard deviation change.

The participants, on average, had relatively lower scores on all the SF-36v2 subscales compared with the Canadian urban-dwelling population aged 25 years or more in the CaMOS population (Hopman et al., 2000), and did not match the national mean during the first six months after receiving an ICD. With the exception of the 2- and 6-month assessments of their mental health status, the differences between the participants' scores and the CaMOS population exceeded the 5-point threshold indicative of clinical and social significance suggested by Ware et al. (1993). Indeed, the differences between the participants' best average scores and the Canadian means were 10 points or greater on all of the subscales except SF-35v2 Bodily Pain and SF-35v2 Mental Health subscales. The gap was largest for the SF-35v2 Physical Functioning subscale (21.1 to 32.1 point difference across the four measurement occasions), and the SF-35v2 Role Physical subscale (21.5 to 37.5 point difference), and smallest for the SF-35v2 Bodily Pain

subscale (7.4 to 17.2 point difference), and the SF-35v2 Mental Health subscale (3.1 to 10.7 point difference). Figure 5-3 illustrates a comparison of the participants' mean scores, at each measurement occasion, and the mean age- and sex-standardised scores of the CaMOS sample of Canadians aged 25 years and older, who all resided within a 50 km radius of nine Canadian cities.

Figure 5-3: Means of the SF-36v2 Subscales for the Study Sample and the Canadian Multicentre Osteoporosis Study (CaMOS) Sample



CaMOS: Canadian Multicentre Osteoporosis Study (Hopman et al. (2000)).
Note: Canadian SF-36v2 normative data were obtained from a cohort study of 9,423 randomly selected Canadian men and women aged 25 years or more living within a 50-km radius of 9 Canadian cities.

The change in the mean scores on the SF-36v2 subscales obtained in our study, between baseline and the last follow-up measurement occasion at six months after ICD implantation, ranged between 4.6 and 15.8 points. According to the benchmarks delineated by Wyrwich et al.

(2007), the magnitude of change was moderate to large or large for all the subscales except the SF-36v2 Bodily Pain subscale, in which the change would be considered small in magnitude (see Table 5-21).

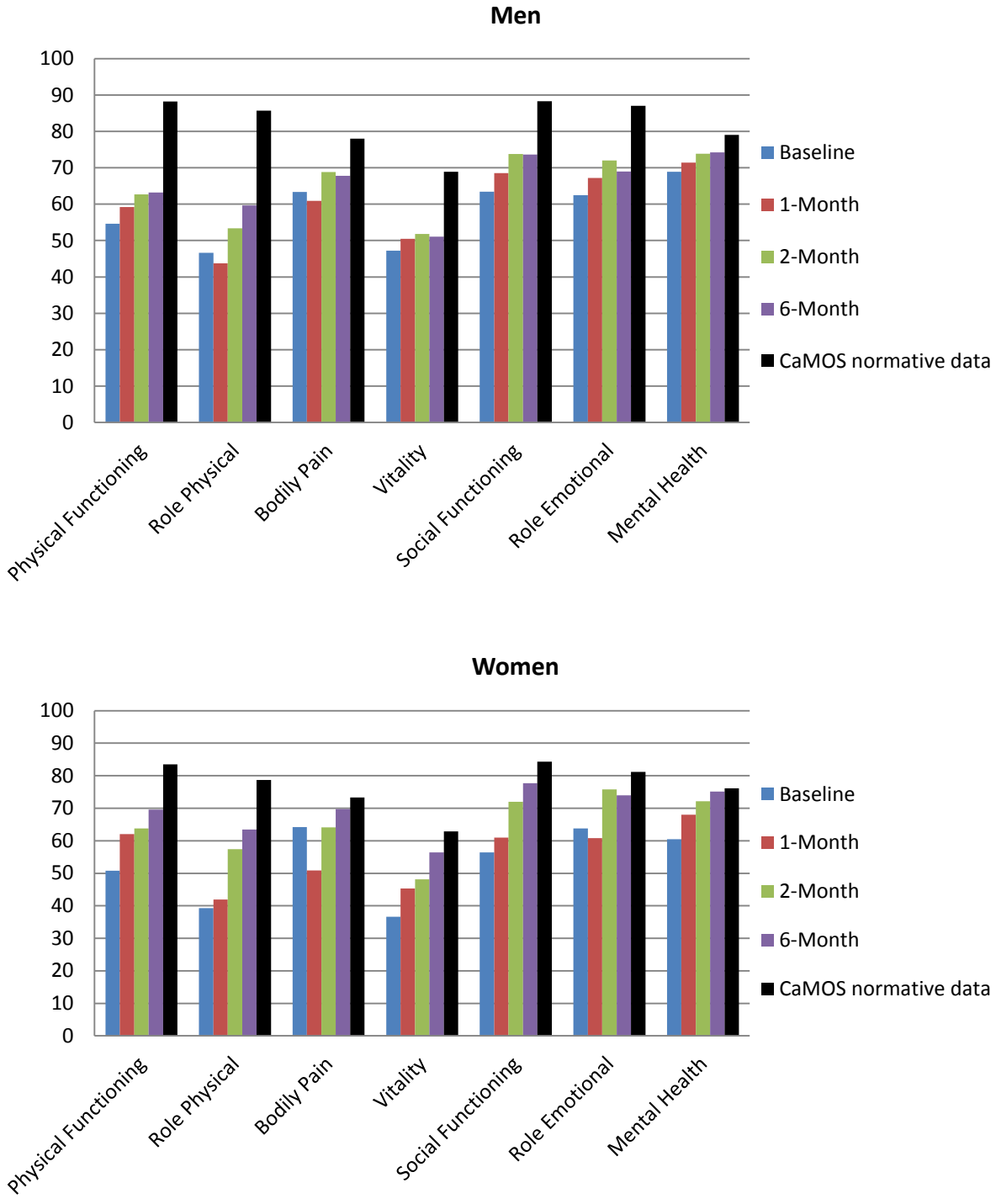
Table 5-21: Mean SF-36v2 Change Scores of the Participants Classified by Established Patient-Assessed Qualitative Descriptors of Change

SF36-v2	Between Baseline and 1 Month		Between 1 Month and 2 Months		Between 2 Months and 6 Months		Between Baseline and 6 Months	
	Change Score	Qualitative Descriptor	Change Score	Qualitative Descriptor	Change Score	Qualitative Descriptor	Change Score	Qualitative Descriptor
Physical Functioning	6.2	Mod.	3.0	Small	1.8	Small	11.0	Large
Role Physical	-1.5	No Chg	11.0	Mod./Large	6.3	Small	15.8	Large
Bodily Pain	-5.2	Small	9.3	Mod./Large	0.5	No Chg	4.6	Small
Vitality	5.3	Mod.	1.9	No Chg	1.2	No Chg	8.4	Large
Social Functioning	5.8	Mod./Large	7.5	Mod./Large	1.0	No Chg	14.3	Large
Role Emotional	2.8	Small	7.3	Mod./Large	-2.8	No Chg	7.3	Mod./Large
Mental Health	3.7	Small	3.0	Small	0.9	No Chg	7.6	Mod./Large

Note. Change Scores are the differences in mean scores. Qualitative Descriptor is defined as patients' perceptions of the magnitude of change, from Wyrwich et al. (2007), and reported in Table 6-1. No Chg = no change; Small = small improvement; Mod. = moderate improvement; Large = large improvement. Negative values indicative of worsening.

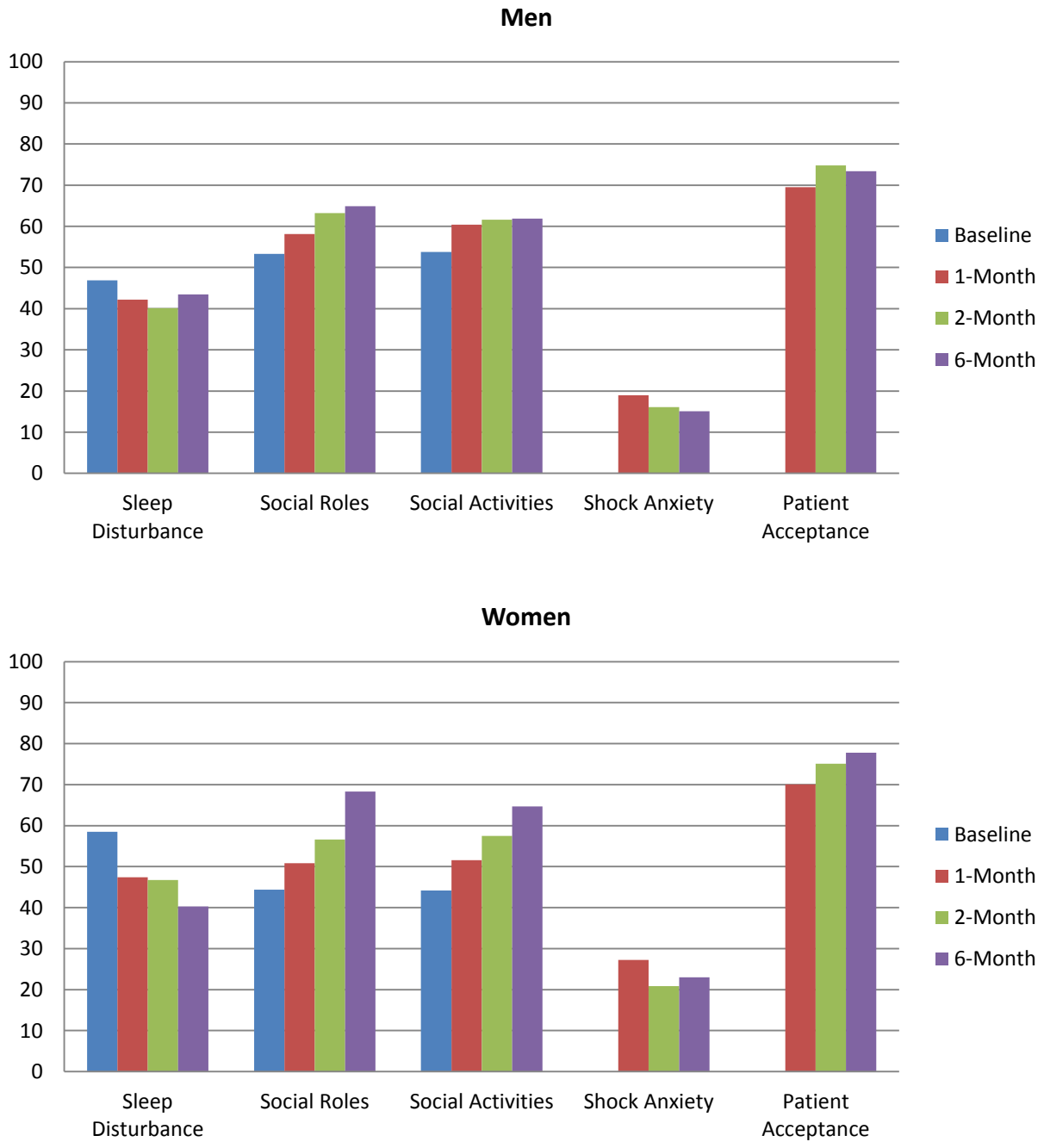
Given our interest in a sex/gender analysis, and in keeping with the analyses of the CaMOS group (Hopman et al., 2007), we examined the differences between men and women in their mean scores of the SF-36v2 subscales. We compared them with the mean age- and sex-standardised scores of the men and women who participated in the CaMOS study. We also examined the differences between men and women in the mean scores of the other PROs. (see Figure 5-4 and Figure 5-5).

Figure 5-4: Mean Scores of the Study SF-36v2 Subscales and the Age- and Sex-Standardised Scores of the Men and Women who Participated in the Canadian Multicentre Osteoporosis Study (CaMOS)



Note: Canadian SF-36v2 normative data was obtained from a cohort study of 9,423 randomly selected Canadian men and women aged 25 years or more living within a 50-km radius of 9 Canadian cities. CaMOS: Canadian Multicentre Osteoporosis Study, Hopman et al. (2000).

Figure 5-5: Mean Scores of the PROMIS Short Forms and the ICD-Specific PROs for Men and Women



Note: The Shock Anxiety and Patient Acceptance of Cardiac Device Therapy were measured in the post-implantation follow-up only.
Social Roles = Satisfaction with Social Roles; Social Activities = Satisfaction with Discretionary Social Activities; Patient Acceptance = Patient Acceptance of Cardiac Device Therapy.

To examine the patterns of individual change using a linear time variable ("Time") and a quadratic time variable for indicators measured at four occasions ("Quadtime"), we report the findings of a two-level growth model. In the following section, we present the findings of the first model developed to test whether the intercepts and slopes varied across individuals.

5.6. Question 2: Variation in Individual Change

5.6.1. Examination of Individual Change and Direction of Change

To examine the change and direction of change more closely, and to explore the shape of the change occurring among individuals, over time, we plotted the linear trajectories of change of a subset (29.8%; $n = 51$) of randomly selected cases for each of the PROs (see Figures 5-8 to 5-10). The graphs reveal individual trajectories of change for each PRO, and demonstrate the diversity in individual patterns of change, with some participants maintaining unchanged scores over the four measurement occasions, while others showing various patterns of improvement or worsening over time. This variation was most striking in the Social Health PROs, especially SF-36v2 Role Physical, SF-36v2 Role Emotional, SF-36v2 Social Functioning, and Satisfaction with Participation in Social Roles, while less visible in the Shock Anxiety scale.

Figure 5-6: A Random Sample of Linear Individual Growth Trajectories: Physical Health Status

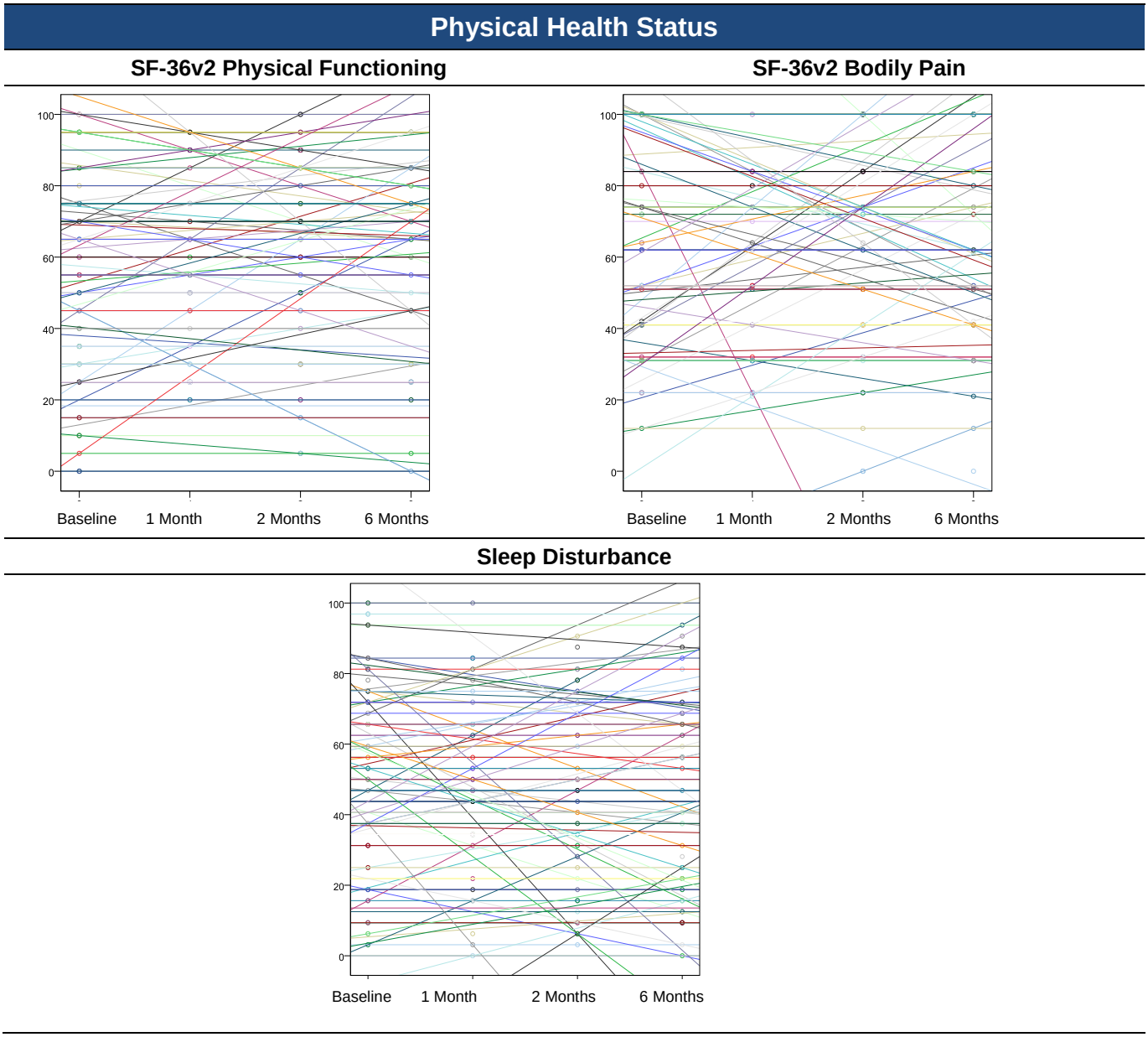


Figure 5-7: A Random Sample of Linear Individual Growth Trajectories: Mental Health Status

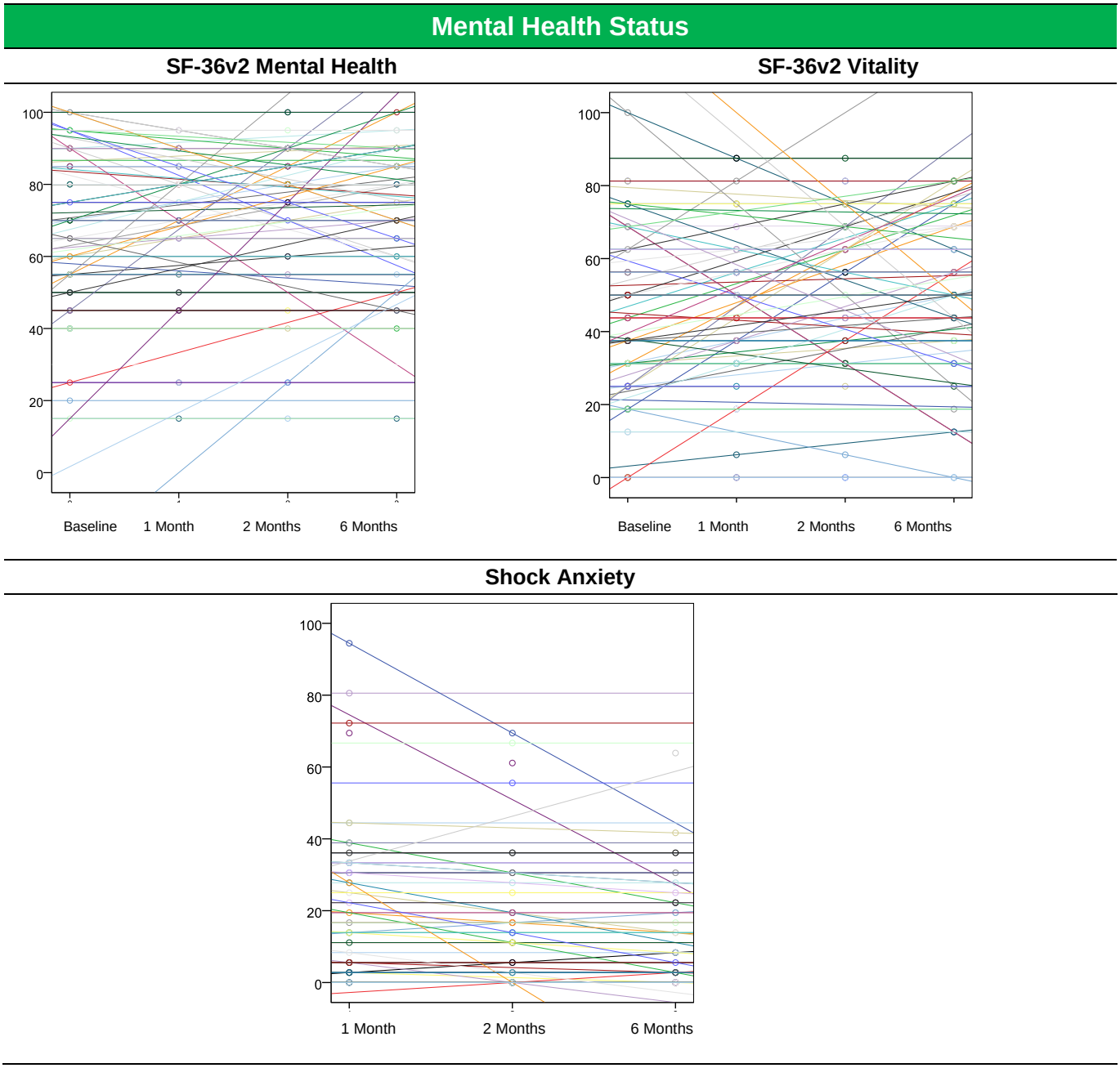
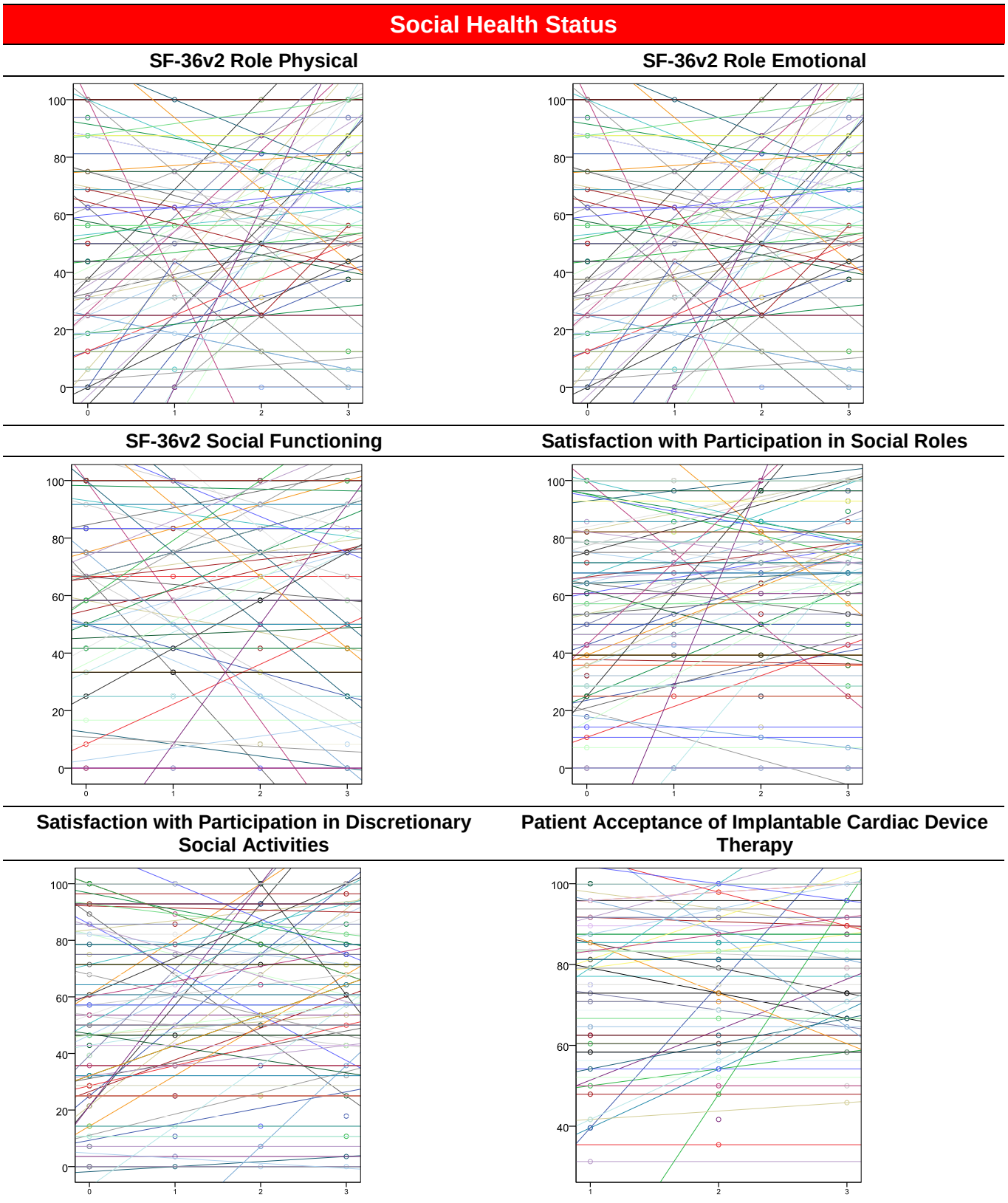


Figure 5-8: A Random Sample of Linear Individual Growth Trajectories: Social Health Status



5.6.2. Specification of the Individual Growth Model (Model 1)

To determine the most reasonable specifications of the individual growth models (Model 1), we conducted a comparison of five covariance structures to identify the Level 1 covariance matrix that best fit the distribution of the residual terms, as measured by the Akaike Information Criterion (AIC). As shown in Table 5-22, an unstructured covariance structure, which does not make assumptions about the error structure, had the lowest AIC in 7 of the 12 PROs, whereas the remaining PROs were best specified with a diagonal covariance matrix, which assumes heterogeneous variances for each measurement occasion and no covariances between occasions.

Table 5-22: A Comparison of Various Level 1 Covariance Structures

	Unstructured		Diagonal		Compound Symmetry		Scaled Identity		First-Order Autoregressive	
	AIC	Par	AIC	Par	AIC	Par	AIC	Par	AIC	Par
Physical Health Status										
PH	**5291.92**[a]	7	5297.606	6	5435.58	6	5434.09	5	5435.58	6
BP	5477.00	7	**5475.07**[a,b]	6	5561.11[b]	6	5577.18	5	5561.11[b]	6
SLP	5295.38	7	**5293.39** [a,b]	6	5398.12[b]	6	5403.40	5	5398.12[b]	6
Mental Health Status										
MH	**4986.55**[a]	7	4986.70	6	5155.72[b]	6	5161.11	5	5155.72	6
VT	**5091.21**[a]	7	5092.82	6	5234.82	6	5232.96	5	5234.82	6
SA	**3500.22**[a]	7	3511.76[b]	6	3604.79[b]	6	3622.97	5	3604.79[b]	6
Social Health Status										
RP	5506.86	7	**5504.98**[a]	6	5605.49[b]	6	5620.05	5	5605.49[b]	6
RE	**5531.58**[a]	7	5531.61	6	5648.14[b]	6	5655.75	5	5648.14[b]	6
SF	**5476.10**[a]	7	5477.22	6	5593.11[b]	6	5584.50	5	5577.19[b]	6
SSR	5418.41	7	**5417.24**[a]	6	5543.71[b]	6	5550.32	5	5543.71[b]	6
SDSA	**5424.53**[a]	7	5426.60	6	5575.12[b]	6	5577.26	5	5575.12[b]	6
PA	3491.38	7	**3489.53**[a]	6	3532.74[b]	6	3545.58	5	3532.74[b]	6

Note. AIC: Akaike Information Criterion; Par: Number of parameters; PH: SF-36v2 Physical Functioning; BP: SF-36v2 Bodily Pain; SLP: Sleep Disturbance; MH: SF-36v2 Mental Health; VT: SF-36v2 Vitality; SA: Shock Anxiety; RP: SF-36v2 Role Physical; RE: SF-36v2 Role Emotional; SF: SF-36v2 Social Functioning; SSR: Satisfaction with Participation in Social Roles; SDSA: Satisfaction with Discretionary Social Activities; PA: Patient Acceptance of Implantable Cardiac Device Therapy.
[a]Smallest AIC for measure of functional status (in boldface).
[b]The final Hessian matrix was not positive definite although all convergence criteria were satisfied. The MIXED procedure continued despite the warning. The validity of the subsequent results could not be ascertained.

Based on these findings, we initially specified an unstructured covariance matrix for most of the PRO indicators, and a diagonal covariance matrix for the five models that assessed the change in SF-36v2 Bodily Pain, Sleep Disturbance, SF-36v2 Role Physical, Satisfaction with Participation in Social Roles, and Patient Acceptance. In contrast with models that specified unstructured covariance matrices, the specification of a diagonal covariance matrix, for these latter five PROs, did not change the parameter estimates, narrow the 95% confidence intervals, or alter the statistical significance of the estimates of the fixed effects. Thus, we elected to

specify an unstructured covariance matrix for all 12 PROs in the testing of Model 1, with the proviso that other covariance structures would be tested if the model did not converge.

Unconditional growth models were constructed to examine the average growth, or temporal change, in the population, as well as the between-person variance in growth measured by the variation in intercepts and random time slopes across individuals. As we discussed in the previous chapter, we obtained estimates of effects to identify significant differences in intercepts and slopes for each outcome, and estimates of the covariance parameters to explore the unexplained residual variance and covariance for each outcome. For indicators measured at four occasions, we estimated seven parameters, including three fixed effects [intercept, time (i.e., 0, 1, 2 and 3), and quadratic time (i.e., 0, 1, 4, 9)], three random parameters (the intercept and time slope variances and the covariance between the intercept and slope), and the residual (within individuals) variance. Because Shock Anxiety and Patient Acceptance of Implantable Cardiac Device Therapy were measured only in the post-implantation follow-up (i.e., Times 1, 2, and 3), we excluded a quadratic time term, and estimated six parameters.

In the following tables, the fixed effects are summarised as β parameters with their associated standard errors. The intercepts represent the sample mean at the first measurement of the PRO, "Time" is the estimate of the linear growth rates between each measurement occasion, and "Quadtime" is the estimate of quadratic growth. The statistical significance of each fixed effect was determined with a *t*-test (the ratio of the unstandardised estimate to its standard error); the 95% confidence intervals are provided for each parameter. We highlight the variance in slope when the statistical significance level was $p < .10$.

5.6.3. Physical Health Status

There were statistically significant ($p < .05$) parameters in the models of the three physical health status PROs. For the observed intercept,[40] the estimate for baseline status for SF-36v2 Physical Functioning was 53.8, with a linear gain of 6.6 points per measurement occasion (which is statistically significant at $p < .05$). The rate of change, over time, was not statistically significant for SF-36v2 Bodily Pain. Sleep Disturbance displayed significant change with an initial score (intercept) of 50.3 and change of -7.8 points per measurement occasion (i.e., improved scores), and a quadratic growth rate of 1.8, indicating a pattern of deceleration in improvement, over the 6-month follow-up period.

At Level 1 (within-subjects), the estimates of the variance components demonstrated the presence of significant population variability in the average participant's PRO estimates around her or his true change trajectory; this is apparent with statistically significant residual variances (Wald test Z values with p-values < .10). At Level 2 (between subjects), the variance components indicated variability in the change trajectories. Convergence was not achieved with either diagonal or unstructured covariance matrices for the SF-36v2 Bodily Pain model, in spite of increasing the number of iterations from 100 to 1000, and step-halvings from 10 to 100. The covariance between the Level 2 residuals for the initial status intercept and the slope was statistically significantly correlated only for the SF-36v2 Physical Functioning indicator, meaning that the participants' rate of change was associated with their baseline status. We retained the PROs, SF-36v2 Physical Functioning and Sleep Disturbance for the conditional model development phase of the study to explore whether our postulated predictors could explain the differences in the individual trajectories of change. The unconditional models for the

[40] The observed intercept is also referred to as the "true" intercept. It represents the value recorded for a participant at the first measurement occasion for the PRO. The estimated intercept is the mean of all the observed intercepts of the individual trajectories.

physical health status PROs are presented in Table 5-23 to 5-25, and the summary of the estimates of the fixed effects and covariance parameters is presented in Table 5-26.

Table 5-23: Unconditional Model – SF-36v2 Physical Functioning

Physical Health Status							
SF-36v2 Physical Functioning							
Estimates of Fixed Effects							
Parameter	Estimate	Standard Error	*df*	*t*	Sig.	95% CI	
						Lower	**Upper**
Intercept	53.79	2.06	190.03	26.15	< .05	49.73	57.84
Time	6.59	1.78	374.45	3.70	< .05	3.08	10.10
Estimates of Covariance Parameters							
Parameter		**Estimate**	**Standard Error**	**Wald *Z***	**Sig.**	**95% CI**	
						Lower	**Upper**
Residual		179.14	15.02	11.92	< .10	151.99	211.15
Intercept + time	UN (1,1)	551.69	74.92	7.36	< .10	422.77	719.93
	UN (2,1)	-49.37	19.88	-2.48	< .10	-88.33	-10.41
	UN (2,2)	33.17	8.74	3.80	< .10	19.79	55.60

Note. *df* = degrees of freedom; sig. = significance.
Highlighted area: The variance in slope when the statistical significance level was $p < .10$.
UN: Unstructured covariance matrix
(1,1): Variance estimate of random intercepts
(2,1): Variance estimate of covariance between slope and intercepts
(2,2): Variance estimate of random linear slope

Table 5-24: Unconditional Model – SF-36v2 Bodily Pain

Physical Health Status							
SF-36v2 Bodily Pain							
Estimates of Fixed Effects							
Parameter	**Estimate**	**Standard Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Intercept	62.60	2.10	202.83	29.87	< .05	58.47	66.74
Time	-3.27	2.37	443.77	-1.38	.17	-7.93	1.39
QuadTime	1.74	.76	436.75	2.27	< .05	0.24	3.24
Estimates of Covariance Parameters							
Parameter		**Estimate**	**Standard Error**	**Wald *Z***	**Sig.**	**95% CI**	
						Lower	**Upper**
Residual		341.60	23.36	14.62	< .10	298.75	390.59
Intercept + time	UN (1,1)	424.04	73.89	5.74	< .10	301.35	596.67
	UN (2,1)	4.07	16.59	.25	.81	-28.45	36.58
	UN (2,2)	.04	.00	Iteration was terminated but convergence was not achieved			

Table 5-25: Unconditional Model – Sleep Disturbance

Physical Health Status							
Sleep Disturbance							
Estimates of Fixed Effects							
Parameter	**Estimate**	**Standard Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Intercept [β_{00}]	50.32	1.88	197.35	26.70	< .05	46.60	54.03
Time [β_{10}]	-7.82	1.87	358.84	-4.18	< .05	-11.50	-4.14
QuadTime [β_{20}]	1.83	.59	293.97	3.10	< .05	0.67	3.00
Estimates of Covariance Parameters							
Parameter		**Estimate**	**Standard Error**	**Wald *Z***	**Sig.**	**95% CI**	
						Lower	**Upper**
Residual		203.89	17.09	11.93	< .10	173.01	240.29
Intercept + time	UN (1,1)	412.04	62.30	6.61	< .10	306.37	554.16
	UN (2,1)	1.33	16.71	.08	.94	-31.42	34.08
	UN (2,2)	18.72	7.94	2.36	< .10	8.16	42.97

Note. *df* = degrees of freedom; sig. = significance.
Highlighted area: The variance in slope when the statistical significance level was $p < .10$.
UN: Unstructured covariance matrix
(1,1): Variance estimate of random intercepts
(2,1): Variance estimate of covariance between slope and intercepts
(2,2): Variance estimate of random linear slope

Table 5-26: Summary of the Unconditional Model Estimates of the Fixed Effects and Covariance Parameters (Physical Health Status)

Physical Health Status					
Patient-Reported Outcome	**FIXED EFFECTS**		**COVARIANCE PARAMETERS**		
	Linear Growth (Time)	Quadratic Growth (QuadTime)	Variance in Random Intercept (1,1)	Covariance between Intercept and Slope (2,1)	Variance in Random Slope (2,2)
SF-36v2 Physical Functioning	✓	X	✓	✓	✓
SF-36v2 Bodily Pain	X	X	✓	X	X
Sleep Disturbance	✓	✓	✓	X	✓

Note. ✓ = statistically significant parameter (i.e., fixed effect is $p < .05$ and covariance parameter is $p < .10$). X = statistically non-significant parameter.
Highlighted area: The variance in slope when the statistical significance level was $p < .10$.

5.6.4. Mental Health Status

There were statistically significant differences in the participants' baseline status and linear growth in the three mental health PROs. The estimated intercept for the SF-36v2 Mental Health scores was 66.7, with a statistically significant gain of 4.2 points, on a 0 to 100 scale, for each measurement occasion. Similarly, the intercept for the 36v2 Vitality model was 44.0, with a statistically significant rate of change of 5.0 points at each measure. On average, the participants experienced a linear decline in shock anxiety, with a decrease of 2.1 points each measurement occasion ($p < .05$). The addition of a quadratic time term to explore any possible acceleration or deceleration in the growth curves did not yield significant results.

At Level 1, there were statistically significant residual variances ($p < .10$) within-subjects for the three measures, indicating population variability in the average individual's estimated scores around her or his observed change pattern. At Level 2 (between-subjects), there was statistically significant variance in the random intercepts for the three mental health status PROs.

Only the SF-36v2 Vitality model, however, had statistically significant residual variance in the linear slope (it also demonstrated covariance between the Level 2 residuals for initial status (the intercept) and growth). The findings of the unconditional models and an overall summary for the mental health status PROs are provided in Tables 5-27 to 5-29 and summarised in Table 5-30.

Table 5-27: Unconditional Model – SF-36v2 Mental Health

Mental Health Status							
SF-36v2 Mental Health							
Estimates of Fixed Effects							
Parameter	**Estimate**	**Standard Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Intercept [β_{00}]	66.73	1.63	189.87	40.98	< .05	63.52	69.94
Time [β_{10}]	4.17	1.44	344.35	2.90	< .05	1.34	6.99
Estimates of Covariance Parameters							
Parameter		**Estimate**	**Standard Error**	**Wald *Z***	**Sig.**	**95% CI**	
						Lower	**Upper**
Residual		122.93	10.32	11.91	< .10	104.27	144.92
Intercept + time	UN (1,1)	335.54	47.16	7.12	< .10	254.75	441.95
	UN (2,1)	-14.96	10.84	-1.38	.17	-36.22	6.29
	UN (2,2)	4.80	4.12	1.16	.24	0.89	25.86

Note. *df* = degrees of freedom; sig. = significance.
UN: Unstructured covariance matrix
(1,1): Variance estimate of random intercepts
(2,1): Variance estimate of covariance between slope and intercepts
(2,2): Variance estimate of random linear slope

Table 5-28: Unconditional Model – SF-36v2 Vitality

Mental Health Status							
SF-36v2 Vitality							
Estimates of Fixed Effects							
Parameter	**Estimate**	**Std. Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Intercept [β_{00}]	44.01	1.72	189.68	25.54	<.05	40.61	47.41
Time [β_{10}]	5.02	1.53	362.05	3.29	<.05	2.02	8.03
Estimates of Covariance Parameters							
Parameter		**Estimate**	**Std. Error**	**Wald *Z***	**Sig.**	**95% CI**	
						Lower	**Upper**
Residual		134.19	11.29	11.89	<.10	113.79	158.24
Intercept + time	UN (1,1)	379.07	52.76	7.18	<.10	288.56	497.96
	UN (2,1)	-24.18	13.70	-1.77	<.10	-51.03	2.67
	UN (2,2)	17.33	5.78	3.00	<.10	9.02	33.32

Table 5-29: Unconditional Model – Shock Anxiety

Mental Health Status							
Shock Anxiety							
Estimates of Fixed Effects							
Parameter	**Estimate**	**Standard Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Intercept [β_{00}]	22.67	2.01	152.88	11.26	<.05	18.69	26.65
Time [β_{10}]	-2.08	.59	142.97	-3.52	<.05	-3.24	-.91
Estimates of Covariance Parameters							
Parameter		**Estimate**	**Standard Error**	**Wald *Z***	**Sig.**	**95% CI**	
						Lower	**Upper**
Residual		94.93	11.22	8.46	<.10	75.31	119.67
Intercept + time	UN (1,1)	381.91	74.28	5.14	<.10	260.86	559.12
	UN (2,1)	-26.95	20.89	-1.29	.20	-67.90	14.00
	UN (2,2)	1.90	8.15	.23	.82	.00	8450.19

Note. *df* = degrees of freedom; sig. = significance.
Highlighted area: The variance in slope when the statistical significance level was $p < .10$. UN: Unstructured covariance matrix
(1,1): Variance estimate of random intercepts
(2,1): Variance estimate of covariance between slope and intercepts
(2,2): Variance estimate of random linear slope

Table 5-30: Summary of the Unconditional Model Estimates of the Fixed Effects and Covariance Parameters (Mental Health Status)

Mental Health Status					
	FIXED EFFECTS		COVARIANCE PARAMETERS		
	Linear Growth (Time)	Quadratic Growth (QuadTime)	Variance in Intercept (1,1)	Variance in Covariance (2,1)	Variance in Slope (2,2)
SF-36v2 Mental Health	✓	X	✓	X	X
SF-36v2 Vitality	✓	X	✓	✓	✓
Shock Anxiety	✓	N/A	✓	X	X

Note. ✓ = statistically significant parameter (i.e., fixed effect is $p < .05$ and covariance parameter is $p < .10$). X = statistically non-significant parameter. N/A: Not applicable.
Highlighted area: The variance in slope when the statistical significance level was $p < .10$.

5.6.5. Social Health Status

Consistent with the previously examined PROs, the participants demonstrated improvements in their social health status PROs over time. The rate of change was statistically significant for the SF-36v2 Role Emotional (6.4 points over each observation), SF-36v2 Social Functioning (7.7 points), Satisfaction with Participation in Social Roles (6.2 points), Satisfaction with Participation in Discretionary Social Activities (7.3 points), and Patient Acceptance of Implantable Cardiac Device Therapy (2.3 points) subscales.

An unstructured covariance matrix resulted in a model that failed to converge with the default 100 iterations, and with an attempt to increase to 1,000 iterations, and thus the covariance parameters for the SF-36v2 Role Physical subscale, and their corresponding test statistics and confidence intervals could not be computed. To address this issue, we specified a diagonal covariance matrix and were able to reach convergence, albeit with extremely wide confidence intervals.

At Level 1, there was statistically significant residual variability in the average participant's score around her or his trajectory for the six social health status PRO models. The models for SF-36v2 Role Emotional, SF-36v2 Social Functioning, Satisfaction with Participation in Social Roles, and Satisfaction with Participation in Discretionary Social Activities all displayed evidence of variability in the rates of change. In addition, there was evidence of unexplained residual variance in the covariance of the intercept and slope of the model for Satisfaction with Participation in Discretionary Social Activities. The findings are presented in Table 5-31 to 5-36 and summarised in Table 5-37.

Table 5-31: Unconditional Model – SF-36v2 Role Physical

Social Health Status							
SF-36v2 Role Physical							
Estimates of Fixed Effects							
Parameter	**Estimate**	**Standard Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Intercept [β_{00}]	44.09	2.23	260.14	19.76	< .05	39.70	48.48
Time [β_{10}]	-.39	2.38	386.12	-.16	.87	-5.07	4.29
QuadTime [β_{20}]	2.01	.77	346.46	2.61	< .05	.50	3.51
Estimates of Covariance Parameters (Diagonal Covariance Matrix)							
Parameter		**Estimate**	**Standard Error**	**Wald *Z***	**Sig.**	**95% CI**	
						Lower	**Upper**
Residual		343.56	26.40	13.01	< .10	295.51	399.41
Intercept +	Var: Intercept	522.00	70.78	7.38	< .10	400.18	680.90
time	Var: Time	1.29	7.67	.17	.87	.00	142525.6

Note. *df* = degrees of freedom; sig. = significance.
UN: Unstructured covariance matrix
(1,1): Variance estimate of random intercepts
(2,1): Variance estimate of covariance between slope and intercepts
(2,2): Variance estimate of random linear slope

Table 5-32: Unconditional Model – SF-36v2 Role Emotional

Social Health Status							
SF-36v2 Role Emotional							
Estimates of Fixed Effects							
Parameter	**Estimate**	**Standard Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Intercept [β_{00}]	62.20	2.37	196.15	26.26	< .05	57.53	66.87
Time [β_{10}]	6.41	2.33	352.60	2.75	< .05	1.82	11.00
Estimates of Covariance Parameters							
Parameter		**Estimate**	**Standard Error**	**Wald *Z***	**Sig.**	**95% CI**	
						Lower	**Upper**
Residual		322.44	26.98	11.95	< .10	273.67	379.90
Intercept + time	UN (1,1)	650.30	98.81	6.58	< .10	482.81	875.88
	UN (2,1)	-35.82	26.70	-1.34	.18	-88.15	16.51
	UN (2,2)	20.21	11.53	1.75	< .10	6.61	61.80

Table 5-33: Unconditional Model – SF-36v2 Social Functioning

Social Health Status							
SF-36v2 Social Functioning							
Estimates of Fixed Effects							
Parameter	**Estimate**	**Standard Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Intercept [β_{00}]	59.98	2.21	199.16	27.19	<.05	55.63	64.33
Time [β_{10}]	7.67	2.27	354.71	3.38	<.05	3.21	12.12
Estimates of Covariance Parameters							
Parameter		**Estimate**	**Standard Error**	**Wald *Z***	**Sig.**	**95% CI**	
						Lower	**Upper**
Residual		303.86	25.41	11.96	< .10	257.92	357.99
Intercept + time	UN (1,1)	540.94	85.33	6.34	< .10	397.08	736.92
	UN (2,1)	-40.35	24.62	-1.64	.10	-88.61	7.91
	UN (2,2)	21.09	11.06	1.91	< .10	7.54	58.94

Note. *df* = degrees of freedom; sig. = significance.
Highlighted area: The variance in slope when the statistical significance level was $p < .10$. UN: Unstructured covariance matrix
(1,1): Variance estimate of random intercepts
(2,1): Variance estimate of covariance between slope and intercepts
(2,2): Variance estimate of random linear slope

Table 5-34: Unconditional Model – Satisfaction with Participation in Social Roles

Social Health Status							
Satisfaction with Participation in Social Roles							
Estimates of Fixed Effects							
Parameter	**Estimate**	**Standard Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Intercept [β_{00}]	49.25	2.18	194.32	22.57	< .05	44.95	53.56
Time [β_{10}]	6.17	2.09	350.78	2.95	< .05	2.06	10.28
Estimates of Covariance Parameters							
Parameter		**Estimate**	**Standard Error**	**Wald *Z***	**Sig.**	**95% CI**	
						Lower	**Upper**
Residual		257.96	21.64	11.92	< .10	218.85	304.07
Intercept + time	UN (1,1)	566.93	84.06	6.74	< .10	423.95	758.13
	UN (2,1)	-18.95	21.55	-.88	.38	-61.18	23.28
	UN (2,2)	15.92	9.21	1.73	< .10	5.12	49.46

Table 5-35: Unconditional Model – Satisfaction with Participation in Discretionary Social Activities

Social Health Status							
Satisfaction with Participation in Discretionary Social Activities							
Estimates of Fixed Effects							
Parameter	**Estimate**	**Std. Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Intercept [β_{00}]	50.79	2.28	192.32	22.23	< .05	46.28	55.30
Time [β_{10}]	7.29	2.07	356.07	3.53	< .05	3.23	11.36
Estimates of Covariance Parameters							
Parameter		**Estimate**	**Std. Error**	**Wald *Z***	**Sig.**	**95% CI**	
						Lower	**Upper**
Residual		250.12	20.93	11.95	< .10	212.28	294.69
Intercept + time	UN (1,1)	653.12	92.21	7.08	< .10	495.24	861.34
	UN (2,1)	-42.68	22.95	-1.86	< .10	-87.66	2.31
	UN (2,2)	20.98	9.43	2.23	< .10	8.70	50.63

Note. *df* = degrees of freedom; sig. = significance.
Highlighted area: The variance in slope when the statistical significance level was $p < .10$.
UN: Unstructured covariance matrix
(1,1): Variance estimate of random intercepts
(2,1): Variance estimate of covariance between slope and intercepts
(2,2): Variance estimate of random linear slope

Table 5-36: Unconditional Model – Patient Acceptance of Implantable Cardiac Device Therapy

Social Health Status							
Patient Acceptance of Implantable Cardiac Device Therapy							
Estimates of Fixed Effects							
Parameter	**Estimate**	**Standard Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Intercept [β_{00}]	68.18	1.76	148.36	38.68	< .05	64.70	71.66
Time [β_{10}]	2.28	.63	140.50	3.65	< .05	1.05	3.52
Estimates of Covariance Parameters							
Parameter		**Estimate**	**Standard Error**	**Wald *Z***	**Sig.**	**95% CI**	
						Lower	**Upper**
Residual		99.15	11.88	8.34	< .10	78.39	125.40
Intercept + time	UN (1,1)	226.83	60.46	3.75	< .10	134.54	382.45
	UN (2,1)	-4.01	19.89	-.20	.84	-43.00	34.98
	UN (2,2)	5.28	8.90	.59	.55	0.19	143.48

Note. *df* = degrees of freedom; sig. = significance.
Highlighted area: The variance in slope when the statistical significance level was $p < .10$.
UN: Unstructured covariance matrix
(1,1): Variance estimate of random intercepts
(2,1): Variance estimate of covariance between slope and intercepts
(2,2): Variance estimate of random linear slope

Table 5-37: Summary of the Unconditional Model Estimates of the Fixed Effects and Covariance Parameters (Social Health Status)

Social Health Status					
	FIXED EFFECTS		COVARIANCE PARAMETERS		
	Linear Growth (Time)	Quadratic Growth (QuadTime)	Variance in Intercept (1,1)	Variance in Covariance (2,1)	Variance in Slope (2,2)
SF-36v2 Role Physical (Diagonal Covariance Matrix)	X	X	✓	N/A	X
SF-36v2 Role Emotional	✓	X	✓	X	✓
SF-36v2 Social Functioning	✓	X	✓	X	✓
Satisfaction with Participation in Social Roles	✓	X	✓	X	✓
Satisfaction with Participation in Discretionary Social Activities	✓	X	✓	✓	✓
Patient Acceptance of Implantable Cardiac Device Therapy	✓	N/A	✓	X	X

Note. ✓ = statistically significant parameter (i.e., fixed effect is $p < .05$ and covariance parameter is $p < .10$). X = statistically non-significant parameter. N/A: Not applicable. *Note*.
Highlighted area: The variance in slope when the statistical significance level was $p < .10$.

5.6.6. Summary of the Unconditional Individual Growth Models

Using an unstructured covariance matrix for all of the models, except the SF-36v2 Role Physical model, which required a diagonal covariance matrix to achieve convergence, we found that there was statistically significant variability in the linear rates of change for SF-36v2 Physical Functioning, Sleep Disturbance (which was curvilinear), SF-36v2 Vitality, SF-36v2 Role Emotional, SF-36v2 Social Functioning, Satisfaction with Participation in Social Roles, and Satisfaction with Participation in Discretionary Social Activities. In examining the Level 2

residuals, we also noted that the initial status (baseline) and growth rates were correlated for SF-36v2 Physical Functioning, SF-36v2 Vitality, and Satisfaction with Participation in Discretionary Social Activities. Theses analyses allowed us to answer the second research question posed in our study, and to conclude that the change in PROs identified in the previous section was not the same for all the participants. A summary of the unconditional models is presented in Table 5-38. The identification of individual trajectories of change warranted further model development to explore the effects of adding theoretically-driven predictors, and to answer our final research questions about whether these individual differences could be explained.

Table 5-38: Summary of the Unconditional Model Estimates of the Fixed Effects and Covariance Parameters

	FIXED EFFECTS		COVARIANCE PARAMETERS		
	Linear Growth (Time)	Quadratic Growth (QuadTime)	Variance in Intercept (1,1)	Variance in Covariance (2,1)	Variance in Slope (2,2)
Physical Health Status					
SF-36v2 Physical Functioning	✓	X	✓	✓	✓
SF-36v2 Bodily Pain	X	X	✓	X	X
Sleep Disturbance	✓	✓	✓	X	✓
Mental Health Status					
SF-36v2 Mental Health	✓	X	✓	X	X
SF-36v2 Vitality	✓	X	✓	✓	✓
Shock Anxiety	✓	N/A	✓	X	X
Social Health Status					
SF-36v2 Role Physical	X	X	✓	N/A	X
SF-36v2 Role Emotional	✓	X	✓	X	✓
SF-36v2 Social Functioning	✓	X	✓	X	✓
Satisfaction with Participation in Social Roles	✓	X	✓	X	✓
Satisfaction with Participation in Discretionary Social Activities	✓	X	✓	✓	✓
Patient Acceptance of Implantable Cardiac Device Therapy	✓	N/A	✓	X	X

Note. ✓ = statistically significant parameter (i.e., fixed effect is $p < .05$ and covariance parameter is $p < .10$). X = statistically non-significant parameter. N/A: Not applicable.

5.7. Question 3: Predictors of Variation in Individual Change

The following section examines the fixed effects estimates of adding between-subjects predictors to the models of PROs shown to have significant unexplained variance in their slopes.

5.7.1. Bivariate Examination of Between-Subjects Predictors (Model 2)

In the conceptual framework underpinning this study, we identified nine predictor variables of theoretical or clinical interest that might serve to explain the variability in the temporal change of ICD recipients' PROs (if variability were to be found) (i.e., age, sex/gender, marital status, household size, employment status, distance to electrophysiology services, indication, urgency, and shock history). We present the analyses of the effects of these predictors on each of the seven PROs that had residual variability in their estimated slopes. Our aim was to identify statistically significant time and predictor interaction effects. We present the findings associated with the effects of each predictor on each PRO, in turn (see Tables 5-39 to 5-45).

The two physical health status PROs with unexplained variability in their trajectories were SF-36v2 Physical Functioning and Sleep Disturbance. The significant predictors related to the participants' scores on SF-36v2 Physical Functioning included Sex/Gender, Marital Status, Employment Status, and Indication for ICD, suggesting that women, single people, people working or caring for family (all coded 0 in the analyses) and those undergoing ICD implantation for secondary prevention had estimated intercepts (baseline scores) that were significantly lower than their counterparts (i.e., men, people within intimate relationships, retirees or those not working for health reasons, and those whose indication was primary prevention, respectively); they rated their physical functioning more poorly at baseline. For Sleep Disturbance, the statistically significant coefficients for Sex/Gender, Household Size, and

Employment Status suggest that women, people who did not live alone, and those with employment responsibilities had greater sleep disturbance at baseline.

The third research question focuses on identifying variables that might explain the variability in the rates of change of individuals. The time and sex/gender interaction was statistically significant for Physical Functioning and the time and sex/gender, time and employment status, and time and distance to electrophysiology services interactions were statistically significant for Sleep Disturbance. These coefficients reveal that women demonstrated a statistically significant faster rate of improvement in their SF-36v2 Physical Functioning and Sleep Disturbance values, over time, compared with men's temporal change in these PROs.

Table 5-39: Time-Predictor Interaction Model: SF-36v2 Physical Functioning

Physical Health Status							
SF-36v2 Physical Functioning							
Parameter	**Estimate**	**Standard Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
SF-36v2 Physical Functioning on Age							
Intercept	62.37	9.14	169.10	6.82	< .05	44.33	80.41
Time	6.86	3.17	148.50	2.16	< .05	0.59	13.13
Age	-.012	0.15	168.10	-0.82	.42	-0.41	0.17
Time*Age	-0.06	0.05	147.90	-1.14	.26	-0.16	0.04
SF-36v2 Physical Functioning on Sex/Gender							
Intercept	55.70	2.31	168.81	24.15	< .05	51.14	60.25
Time	2.62	0.79	147.29	3.32	< .05	1.06	4.19
Sex/Gender	-2.55	4.55	169.57	-0.56	**.08**	-11.54	6.43
Time*Sex/Gender	2.87	1.59	149.11	1.80	**.07**	-0.27	6.01
SF-36v2 Physical Functioning on Marital Status							
Intercept	65.49	4.62	170.00	14.19	< .05	56.38	74.60
Time	4.73	1.63	149.19	2.89	< .05	1.50	7.96
Marital Status	-9.50	3.81	170.89	-2.50	**< .05**	-17.02	-1.99
Time*Marital Status	-1.28	1.35	149.38	-0.94	.35	-3.96	1.40
SF-36v2 Physical Functioning on Household Size							
Intercept	51.67	3.66	168.60	14.11	< .05	44.44	58.90
Time	2.50	1.27	147.87	1.97	.05	-0.01	5.00
Household Size	3.18	2.90	169.41	1.10	.27	-2.54	8.90
Time*Household Size	0.81	1.02	149.10	0.79	.43	-1.20	2.81
SF-36v2 Physical Functioning on Employment Status							
Intercept	65.43	2.93	169.08	22.31	< .05	59.64	71.22
Time	2.87	1.08	147.30	2.66	< .05	0.74	5.00
Employment Status	-17.56	3.81	168.76	-4.60	**< .05**	-25.09	-10.03
Time*Employment Status	0.82	1.40	147.63	0.58	.56	-1.95	3.59
SF-36v2 Physical Functioning on Distance to Electrophysiology Services							
Intercept	54.21	2.48	168.52	21.89	< .05	49.33	59.10
Time	3.86	0.86	147.72	4.50	< .05	2.16	5.55
Distance to EP Services	2.41	4.15	169.29	0.58	.56	-5.78	10.61
Time*Distance EP Services	-1.49	1.44	147.71	-1.03	.30	-4.34	1.36

Physical Health Status							
SF-36v2 Physical Functioning							
Parameter	**Estimate**	**Standard Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
SF-36v2 Physical Functioning on Indication							
Intercept	52.38	2.43	169.56	21.51	< .05	47.58	57.19
Time	3.17	0.86	149.44	3.69	< .05	1.47	4.87
Indication	7.79	4.14	169.36	1.88	**.06**	-0.39	15.97
Time*Indication	0.43	1.44	147.36	0.30	.76	-2.42	3.28
SF-36v2 Physical Functioning on Urgency							
Intercept	55.93	2.61	167.63	21.44	< .05	50.78	61.08
Time	2.57	0.89	147.22	2.88	< .05	0.80	4.33
Urgency	-2.11	4.03	169.79	-0.52	.60	-10.07	5.85
Time*Urgency	1.90	1.40	148.08	1.36	.18	-0.87	4.68
SF-36v2 Physical Functioning on Shock History							
Intercept	55.02	2.25	147.09	24.40	< .05	50.56	59.47
Time	3.35	0.75	142.61	4.49	< .05	1.87	4.83
Shock History	4.32	6.67	146.40	0.65	.52	-8.85	17.50
Time * Shock History	-0.75	2.16	139.33	-0.35	.73	-5.01	3.51

Note. *df* = degrees of freedom; Sig. = significance; EP = Electrophysiology.
Highlighted area: Time/Predictor variable interaction effect when significance level was $p < .10$.

Table 5-40: Time-Predictor Interaction Model: Sleep Disturbance

Physical Health Status							
Sleep Disturbance							
Parameter	**Estimate**	**Std. Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Sleep Disturbance on Age							
Intercept	52.03	8.59	162.20	6.06	< .05	35.07	69.00
Time	-6.48	3.38	278.76	-1.92	.06	-13.14	0.17
QuadTime	1.84	0.59	255.42	3.11	< .05	0.67	3.00
Age	-0.03	0.14	160.16	-0.21	.83	-0.30	0.24
Time*Age	-0.02	0.04	142.13	-0.49	.62	-0.11	0.07
Sleep Disturbance on Sex/Gender							
Intercept	48.32	2.30	178.12	21.04	< .05	43.79	52.86
Time	-6.94	2.04	274.89	-3.39	< .05	-10.97	-2.92
QuadTime	1.83	0.59	257.49	3.11	< .05	0.67	2.99
Sex/Gender	7.55	4.21	161.17	1.79	**.07**	-0.76	15.87
Time*Sex/Gender	-3.51	1.37	141.00	-2.56	**< .05**	-6.23	-0.80
Sleep Disturbance on Marital Status							
Intercept	45.68	4.47	168.61	10.22	< .05	36.85	54.50
Time	-9.21	2.39	369.17	-3.85	< .05	-13.92	-4.51
QuadTime	1.83	0.59	256.01	3.09	< .05	0.67	3.00
Marital Status	4.17	3.62	162.56	1.15	.25	-2.97	11.32
Time*Marital Status	1.28	1.19	142.05	1.08	.28	-1.07	3.63
Sleep Disturbance on Household Size							
Intercept	56.45	3.50	170.59	16.14	< .05	49.55	63.36
Time	-8.61	2.22	341.91	-3.88	< .05	-12.98	-4.24
	1.85	0.59	256.86	3.14	< .05	0.69	3.02
Household Size	-5.82	2.68	161.37	-2.17	**< .05**	-11.12	-0.52
Time*Household Size	0.70	0.89	142.05	0.78	.44	-1.07	2.47
Sleep Disturbance on Employment Status							
Intercept	44.13	2.96	172.61	14.92	< .05	38.29	49.97
Time	-5.87	2.13	318.18	-2.76	< .05	-10.06	-1.69
QuadTime	1.84	0.59	257.87	3.13	< .05	0.68	3.00
Employment Status	10.38	3.70	160.89	2.81	**< .05**	3.08	17.68
Time*Employment Status	-3.33	1.21	140.86	-2.76	**< .05**	-5.71	-0.94

Physical Health Status							
Sleep Disturbance							
Parameter	**Estimate**	**Std. Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Sleep Disturbance on Distance to Electrophysiology Services							
Intercept	50.90	2.47	174.95	20.57	< .05	46.02	55.79
Time	-7.05	2.06	279.05	-3.41	< .05	-11.11	-2.98
QuadTime	1.85	0.59	255.63	3.12	< .05	0.68	3.01
Distance to EP Services	-1.81	3.89	160.34	-0.46	.64	-9.49	5.88
Time*Distance	-2.31	1.26	142.16	-1.84	**.07**	-4.79	0.17
Sleep Disturbance on Indication							
Intercept	49.93	2.45	175.65	20.38	< .05	45.09	54.76
Time	-7.85	2.06	280.21	-3.81	< .05	-11.91	-3.80
QuadTime	1.84	0.59	255.77	3.11	< .05	0.68	3.01
Indication	0.97	3.92	160.63	0.25	.80	-6.76	8.70
Time*Indication	0.05	1.27	141.23	0.04	.97	-2.45	2.55
Sleep Disturbance on Urgency							
Intercept	48.81	2.58	174.67	18.92	< .05	43.72	53.91
Time	-7.41	2.07	285.48	-3.57	< .05	-11.49	-3.33
QuadTime	1.83	0.59	255.86	3.10	< .05	0.67	3.00
Urgency	3.45	3.77	161.29	0.91	.36	-3.99	10.89
Time*Urgency	-0.99	1.23	141.89	-0.80	.42	-3.43	1.45

Note. *df* = degrees of freedom; Sig. = significance; EP = Electrophysiology.
Highlighted area: Time/Predictor variable interaction effect when significance level was $p < .10$.

The only mental health status PRO that exhibited variability in the rate of change was SF-36v2 Vitality. Both Sex/Gender and Employment Status were statistically significant predictors of SF-36v2 Vitality, with women and the participants with employment responsibilities having an estimated baseline status that was significantly lower than their counterparts (i.e., men and participants without work commitments, respectively). Over the course of the 6-month follow-up, the rate of improvement in SF-36v2 Vitality was statistically significantly faster for women compared with the men's rate of change in this PRO.

Table 5-41: Time-Predictor Interaction Model: SF-36v2 Vitality

Mental Health Status							
SF-36v2 Vitality							
Parameter	**Estimate**	**Standard Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
SF-36v2 Vitality on Age							
Intercept	35.49	7.75	165.29	4.58	< .05	20.20	50.79
Time	3.30	2.48	143.88	1.33	.19	-1.61	8.21
Age	0.16	0.12	164.43	1.27	.20	-0.09	0.40
Time*Age	-0.01	0.04	143.28	-0.36	.72	-0.09	0.06
SF-36v2 Vitality on Sex/Gender							
Intercept	47.55	1.92	164.21	24.72	< .05	43.75	51.35
Time	1.24	0.59	141.57	2.11	< .05	0.08	2.41
Sex/Gender	-9.49	3.80	164.87	-2.50	**< .05**	-16.99	-1.99
Time*Sex/Gender	4.74	1.19	143.15	3.98	**< .05**	2.39	7.09
SF-36v2 Vitality on Marital Status							
Intercept	49.90	3.97	165.85	12.57	.00	42.06	57.75
Time	3.75	1.27	143.93	2.95	.00	1.24	6.26
Marital Status	-4.38	3.28	166.53	-1.34	.18	-10.85	2.09
Time*Marital Status	-1.20	1.05	144.13	-1.13	.26	-3.28	.89
SF-36v2 Vitality on Household Size							
Intercept	42.79	3.11	164.57	13.76	< .05	36.65	48.93
Time	3.20	0.99	142.67	3.23	< .05	1.24	5.16
Household Size	2.16	2.46	165.21	0.88	.38	-2.70	7.02
Time*Household Size	-0.72	0.80	143.90	-0.90	.37	-2.29	0.86
SF-36v2 Vitality on Employment Status							
Intercept	50.93	2.58	164.56	19.78	< .05	45.85	56.02
Time	1.97	0.84	142.22	2.34	< .05	0.30	3.64
Employment Status	-9.92	3.35	164.34	-2.96	**< .05**	-16.53	-3.31
Time*Employment Status	0.83	1.10	142.56	0.75	.45	-1.35	3.00
SF-36v2 Vitality on Distance to Electrophysiology Services							
Intercept	44.98	2.11	164.62	21.37	< .05	40.82	49.14
Time	2.69	0.67	143.25	4.02	< .05	1.37	4.02
Distance to EP Services	0.35	3.53	165.22	0.10	.92	-6.62	7.31
Time*Distance to EP Services	-0.71	1.13	143.28	-0.63	.53	-2.95	1.52

Mental Health Status

SF-36v2 Vitality

Parameter	Estimate	Standard Error	*df*	*t*	Sig.	95% CI	
						Lower	Upper
SF-36v2 Vitality on Indication							
Intercept	44.21	2.09	165.04	21.20	< .05	40.09	48.33
Time	2.44	0.67	144.43	3.62	< .05	1.11	3.77
Indication	2.58	3.55	164.87	0.73	.47	-4.43	9.59
Time*Indication	0.01	1.13	142.35	0.01	.99	-2.22	2.24
SF-36v2 Vitality on Urgency							
Intercept	45.25	2.22	163.69	20.43	< .05	40.87	49.62
Time	2.26	0.70	142.46	3.23	< .05	0.88	3.64
Urgency	-0.34	3.43	165.45	-0.10	.92	-7.11	6.43
Time*Urgency	0.45	1.10	143.46	0.41	.68	-1.72	2.63
SF-36v2 Vitality on Shock History							
Intercept	45.35	1.86	144.76	24.42	< .05	41.68	49.02
Time	2.41	0.58	140.52	4.16	< .05	1.27	3.56
Shock History	5.23	5.49	144.22	0.95	.34	-5.62	16.09
Time*Shock History	-0.66	1.67	137.25	-0.39	.69	-3.96	2.65

Note. *df* = degrees of freedom; Sig. = significance; EP = Electrophysiology.
Highlighted area: Time/Predictor variable interaction effect when significance level was $p < .10$.

The social health status PROs that underwent further analyses to explore the demonstrated variability in their trajectories included SF-36v2 Role Emotional, SF-36v2 Social Functioning, Satisfaction with Participation in Social Roles, and Satisfaction with Participation in Discretionary Social Activities. Employment Status was a statistically significant predictor in the four models: people with work and/or caregiver commitments demonstrated lower scores at baseline for these four PROs compared with people who were retired or stated that their current main activity was recovering from illness. Age was found to be a statistically significant predictor of SF-36v2 Social Functioning, Satisfaction with Participation in Social Roles, and Satisfaction with Participation in Discretionary Social Activities, with older people demonstrating higher scores at the baseline assessment of these PROs. Sex/Gender was statistically significant in the models for SF-36v2 Social Functioning and Satisfaction with Participation in Discretionary Social Responsibilities, with women scoring lower than men on both PROs at baseline. Lastly, elective out-patients had statistically significantly lower initial scores in their Satisfaction with Participation in Social Roles than patients who were in-patients in acute care hospitals at the time of their surgery.

In exploring the variability in the rates of change of the participants, the *time*sex/gender* interaction was found to be statistically significant in the models for SF-36v2 Social Functioning, Satisfaction with Participation in Social Roles, and Satisfaction with Participation in Discretionary Social Activities with women experiencing faster rates of improvement, over time, compared with men's temporal changes. In addition, although Urgency was not a significant predictor of baseline status, the time and urgency interaction was statistically significant in the SF-36v2 Social Functioning model.

Table 5-42: Time-Predictor Interaction Model: SF-36v2 Role Emotional

Social Health Status							
SF-36v2 Role Emotional							
Parameter	**Estimate**	**Std. Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
SF-36v2 Role Emotional on Age							
Intercept	66.64	10.48	166.93	6.36	< .05	45.95	87.34
Time	5.72	3.51	145.29	1.63	.11	-1.22	12.67
Age	-0.05	0.17	165.98	-0.30	.77	-0.38	0.28
Time*Age	-0.05	0.06	144.58	-0.91	.37	-0.16	0.06
SF-36v2 Role Emotional on Sex/Gender							
Intercept	64.23	2.64	166.56	24.33	< .05	59.02	69.44
Time	1.94	0.87	144.17	2.22	< .05	0.21	3.66
Sex/Gender	-2.49	5.21	167.32	-0.48	.63	-12.77	7.80
Time*Sex/Gender	2.71	1.76	145.87	1.54	.13	-0.77	6.18
SF-36v2 Role Emotional on Marital Status							
Intercept	68.91	5.37	167.85	12.84	< .05	58.32	79.51
Time	6.06	1.77	145.34	3.42	< .05	2.56	9.57
Marital Status	-4.86	4.43	168.64	-1.10	.27	-13.60	3.87
Time*Marital Status	-3.21	1.47	145.70	-2.18	**.03**	-6.11	-0.30
SF-36v2 Role Emotional on Household Size							
Intercept	54.63	4.13	166.26	13.24	< .05	46.49	62.78
Time	2.96	1.41	143.98	2.10	< .05	0.18	5.74
Household Size	8.42	3.26	167.06	2.58	**< .05**	1.98	14.86
Time*Household Size	-0.31	1.13	145.26	-0.27	.78	-2.54	1.92
SF-36v2 Role Emotional on Employment Status							
Intercept	73.62	3.42	167.00	21.54	< .05	66.87	80.37
Time	2.58	1.19	145.40	2.16	< .05	0.22	4.93
Employment Status	-16.96	4.45	166.75	-3.82	< .05	-25.74	-8.19
Time*Employment Status	0.05	1.55	145.67	0.04	.97	-3.01	3.12
SF-36v2 Role Emotional on Distance to Electrophysiology Services							
Intercept	63.53	2.84	166.53	22.38	< .05	57.92	69.13
Time	2.73	0.95	144.63	2.88	< .05	0.85	4.61
Distance to EP Services	0.16	4.76	167.24	0.03	.97	-9.23	9.56
Time*Distance to EP Services	-0.36	1.60	144.75	-0.22	.82	-3.52	2.80

Social Health Status

SF-36v2 Role Emotional

Parameter	Estimate	Std. Error	*df*	*t*	Sig.	95% CI	
						Lower	Upper
SF-36v2 Role Emotional on Indication							
Intercept	62.94	2.81	167.11	22.36	< .05	57.39	68.50
Time	2.45	0.95	145.90	2.58	< .05	0.57	4.34
Indication	1.88	4.79	166.91	0.39	.70	-7.58	11.34
Time*Indication	0.41	1.60	143.96	0.26	.80	-2.74	3.56
SF-36v2 Role Emotional on Urgency							
Intercept	64.40	2.99	165.57	21.57	< .05	58.51	70.30
Time	2.71	0.99	143.84	2.73	< .05	0.75	4.67
Urgency	-1.95	4.62	167.64	-0.42	.67	-11.07	7.16
Time*Urgency	-0.27	1.56	145.07	-0.17	.86	-3.35	2.80
SF-36v2 Role Emotional on Shock History							
Intercept	64.58	2.52	146.93	25.62	< .05	59.60	69.56
Time	2.63	0.82	140.85	3.20	< .05	1.01	4.25
Shock History	-4.65	7.45	146.28	-0.62	.53	-19.39	10.08
Time*Shock History	-0.74	2.37	137.64	-0.31	.75	-5.43	3.94

Note. *df* = degrees of freedom; Sig. = significance; EP = Electrophysiology.
Highlighted area: Time/Predictor variable interaction effect when significance level was $p < .10$.

Table 5-43: Time-Predictor Interaction Model: SF-36v2 Social Functioning

Social Health Status							
SF-36v2 Social Functioning							
Parameter	**Estimate**	**Std. Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
SF-36v2 Social Functioning on Age							
Intercept	39.79	9.62	167.43	4.14	< .05	20.80	58.79
Time	6.03	3.47	146.73	1.74	.08	-0.82	12.88
Age	0.35	0.15	166.31	2.25	**< .05**	0.04	0.65
Time*Age	-0.02	0.05	145.94	-0.40	.69	-0.13	0.09
SF-36v2 Social Functioning on Sex/Gender							
Intercept	63.46	2.43	166.88	26.10	< .05	58.66	68.26
Time	3.73	0.85	145.53	4.37	< .05	2.04	5.42
Sex/Gender	-9.79	4.80	167.64	-2.04	< .05	-19.26	-0.32
Time*Sex/Gender	3.91	1.72	147.37	2.28	**.02**	0.52	7.31
SF-36v2 Social Functioning on Marital Status							
Intercept	66.76	4.99	168.29	13.39	< .05	56.92	76.61
Time	5.97	1.78	147.59	3.36	< .05	2.46	9.48
Marital Status	-5.32	4.11	169.14	-1.29	.20	-13.44	2.80
Time*Marital Status	-1.13	1.47	148.00	-0.77	.44	-4.04	1.78
SF-36v2 Social Functioning on Household Size							
Intercept	58.87	3.91	166.99	15.05	< .05	51.15	66.60
Time	5.17	1.38	146.25	3.74	< .05	2.43	7.90
Household Size	1.93	3.09	167.74	0.62	.53	-4.18	8.04
Time*Household Size	-0.42	1.11	147.62	-0.38	.71	-2.61	1.77
SF-36v2 Social Functioning on Employment Status							
Intercept	66.56	3.27	167.26	20.36	< .05	60.11	73.01
Time	4.38	1.17	146.25	3.73	< .05	2.06	6.70
Employment Status	-9.53	4.25	166.99	-2.24	**< .05**	-17.92	-1.13
Time*Employment Status	0.58	1.53	146.48	0.38	.70	-2.44	3.60
SF-36v2 Social Functioning to Electrophysiology Services							
Intercept	60.26	2.64	166.89	22.81	< .05	55.04	65.47
Time	4.49	0.93	146.66	4.81	< .05	2.65	6.34
Distance to EP Services	1.90	4.43	167.62	.43	.67	-6.84	10.65
Time*Distance to EP Services	0.66	1.57	146.89	0.42	.67	-2.45	3.77

Social Health Status

SF-36v2 Social Functioning

Parameter	Estimate	Std. Error	*df*	*t*	Sig.	95% CI	
						Lower	Upper
SF-36v2 Social Functioning on Indication							
Intercept	61.09	2.62	167.36	23.30	< .05	55.91	66.27
Time	3.91	.93	147.91	4.21	< .05	2.08	5.75
Indication	-0.37	4.46	167.20	-0.08	.93	-9.18	8.45
Time*Indication	2.22	1.56	145.90	1.42	.16	-0.86	5.29
SF-36v2 Social Functioning on Urgency							
Intercept	63.46	2.77	166.23	22.93	< .05	58.00	68.92
Time	3.59	0.97	146.01	3.71	< .05	1.68	5.50
Urgency	-6.03	4.28	168.33	-1.41	.16	-14.48	2.42
Time*Urgency	2.76	1.52	147.44	1.81	**.07**	-0.25	5.76
SF-36v2 Social Functioning on Shock History							
Intercept	62.70	2.36	146.72	26.59	< .05	58.03	67.36
Time	4.61	0.81	141.28	5.68	< .05	3.01	6.22
Shock History	-7.22	6.97	146.12	-1.04	.30	-21.01	6.56
Time*Shock History	-0.46	2.34	137.85	-0.19	.85	-5.09	4.18

Note. *df* = degrees of freedom; Sig. = significance; EP = Electrophysiology.
Highlighted area: Time/Predictor variable interaction effect when significance level was $p < .10$.
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Table 5-44: Time-Predictor Interaction Model: Satisfaction with Participation in Social Roles

Social Health Status							
Satisfaction with Participation in Social Roles							
Parameter	**Estimate**	**Standard Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Satisfaction with Participation in Social Roles on Age							
Intercept	31.18	9.71	165.54	3.21	< .05	12.01	50.34
Time	5.83	3.12	145.55	1.87	.06	-0.34	11.99
Age	0.30	0.15	164.75	1.95	.05	0.00	0.61
Time*Age	-0.01	0.05	145.02	-0.25	.81	-0.11	0.09
Satisfaction with Participation in Social Roles on Sex/Gender							
Intercept	51.52	2.45	164.16	21.00	< .05	46.68	56.37
Time	4.33	0.77	143.76	5.62	< .05	2.80	5.85
Sex/Gender	-7.27	4.84	164.71	-1.50	.14	-16.83	2.29
Time*Sex/Gender	3.07	1.55	145.33	1.98	**.05**	0.00	6.14
Satisfaction with Participation in Social Roles on Marital Status							
Intercept	52.33	5.02	164.96	10.42	< .05	42.42	62.25
Time	6.23	1.60	144.96	3.89	< .05	3.06	9.41
Marital Status	-2.44	4.14	165.51	-0.59	.56	-10.62	5.74
Time*Marital Status	-1.04	1.33	145.14	-0.78	.44	-3.67	1.59
Satisfaction with Participation in Social Roles on Household Size							
Intercept	48.56	3.93	164.32	12.36	< .05	40.80	56.32
Time	4.88	1.25	144.41	3.91	< .05	2.41	7.34
Household Size	1.03	3.11	164.86	0.33	.74	-5.11	7.17
Time*Household Size	0.22	1.00	145.55	0.22	.83	-1.76	2.20
Satisfaction with Participation in Social Roles on Employment Status							
Intercept	58.34	3.20	163.40	18.22	< .05	52.02	64.67
Time	4.01	1.06	142.78	3.80	< .05	1.92	6.10
Employment Status	-14.71	4.17	163.24	-3.53	< .05	-22.94	-6.49
Time*Employment Status	1.85	1.37	143.11	1.35	.18	-0.86	4.57
Satisfaction with Participation in Social Roles on Access to Electrophysiology Services							
Intercept	48.49	2.65	164.28	18.31	< .05	43.27	53.72
Time	5.41	0.84	144.58	6.43	< .05	3.75	7.08
Distance to EP Services	3.27	4.44	164.79	0.74	.46	-5.49	12.04
Time*Distance to EP Services	-0.89	1.42	144.58	-.63	.53	-3.69	1.92

Social Health Status

Satisfaction with Participation in Social Roles

Parameter	Estimate	Standard Error	*df*	*t*	Sig.	95% CI	
						Lower	Upper
Satisfaction with Participation in Social Roles on Indication							
Intercept	49.17	2.63	164.61	18.70	< .05	43.98	54.36
Time	5.20	0.85	145.84	6.15	< .05	3.53	6.87
Indication	1.40	4.48	164.46	0.31	.75	-7.43	10.24
Time*Indication	-0.28	1.42	143.88	-0.20	.84	-3.09	2.52
Satisfaction with Participation in Social Roles on Urgency							
Intercept	52.82	2.77	164.00	19.07	< .05	47.35	58.29
Time	4.62	0.88	144.40	5.27	< .05	2.89	6.36
Urgency	-7.55	4.29	165.58	-1.76	.08	-16.01	0.91
Time*Urgency	1.14	1.38	145.25	0.83	.41	-1.59	3.86
Satisfaction with Participation in Social Roles on Shock History							
Intercept	50.08	2.35	143.85	21.32	< .05	45.43	54.72
Time	5.09	0.73	141.94	6.99	< .05	3.65	6.53
Shock History	4.69	6.95	143.41	0.67	.50	-9.04	18.42
Time*Shock History	-0.97	2.10	138.84	-0.46	.65	-5.12	3.18

Note. *df* = degrees of freedom; Sig. = significance; EP = Electrophysiology.
Highlighted area: Time/Predictor variable interaction effect when significance level was $p < .10$.

Table 5-45: Time-Predictor Interaction Model: Satisfaction with Participation in Discretionary Social Activities

Social Health Status							
Satisfaction with Participation in Discretionary Social Activities							
Parameter	**Estimate**	**Standard Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Satisfaction with Participation in Discretionary Social Activities on Age							
Intercept	32.36	10.15	168.15	3.19	< .05	12.32	52.39
Time	3.20	3.17	148.84	1.01	.32	-3.07	9.47
Age	.32	.16	167.30	2.01	**.05**	0.01	0.64
Time*Age	.01	.05	148.16	0.11	.92	-0.09	0.10
Satisfaction with Participation in Discretionary Social Activities on Sex/Gender							
Intercept	55.02	2.55	167.01	21.55	< .05	49.98	60.06
Time	2.52	.78	146.23	3.24	< .05	0.98	4.06
Sex/Gender	-10.74	5.04	167.63	-2.13	**< .05**	-20.69	-0.79
Time*Sex/Gender	4.08	1.57	147.96	2.60	**< .05**	0.98	7.17
Satisfaction with Participation in Discretionary Social Activities on Marital Status							
Intercept	57.79	5.24	167.82	11.02	< .05	47.44	68.14
Time	3.35	1.64	148.34	2.05	< .05	0.11	6.59
Marital Status	-5.08	4.33	168.43	-1.17	.24	-13.62	3.46
Time*Marital Status	.19	1.36	148.60	0.14	.89	-2.49	2.88
Satisfaction with Participation in Discretionary Social Activities on Household Size							
Intercept	52.80	4.12	167.22	12.83	< .05	44.67	60.93
Time	3.53	1.27	147.41	2.78	< .05	1.02	6.04
Household Size	-.53	3.26	167.84	-0.16	.87	-6.96	5.89
Time*Household Size	.03	1.02	148.69	0.03	.98	-1.99	2.04
Satisfaction with Participation in Discretionary Social Activities on Employment Status							
Intercept	58.58	3.43	167.63	17.09	< .05	51.82	65.35
Time	2.55	1.08	146.86	2.37	< .05	0.43	4.67
Employment Status	-10.79	4.46	167.40	-2.42	**< .05**	-19.58	-1.99
Time*Employment Status	1.73	1.40	147.18	1.24	.22	-1.03	4.49
Satisfaction with Participation in Discretionary Social Activities on Distance to Electrophysiology Services							
Intercept	50.52	2.77	167.13	18.24	< .05	45.05	55.98
Time	3.73	.86	147.72	4.34	< .05	2.03	5.42
Distance to EP Services	4.85	4.64	167.73	1.04	.30	-4.31	14.01
Time*Distance to	-.48	1.44	147.80	-0.33	.74	-3.33	2.38

Social Health Status

Satisfaction with Participation in Discretionary Social Activities

Parameter	Estimate	Standard Error	*df*	*t*	Sig.	95% CI	
						Lower	Upper
EP Services							
Satisfaction with Participation in Discretionary Social Activities on Indication							
Intercept	51.21	2.75	167.52	18.61	< .05	45.78	56.65
Time	3.52	.86	149.05	4.10	< .05	1.82	5.22
Indication	2.95	4.69	167.38	0.63	.53	-6.30	12.20
Time*Indication	.10	1.44	146.97	0.07	.95	-2.75	2.95
Satisfaction with Participation in Discretionary Social Activities on Urgency							
Intercept	52.67	2.92	166.22	18.01	< .05	46.90	58.45
Time	2.98	.89	147.03	3.34	< .05	1.22	4.74
Urgency	-1.00	4.52	167.93	-0.22	.82	-9.93	7.93
Time*Urgency	1.42	1.40	148.17	1.01	.31	-1.35	4.19
Satisfaction with Participation in Discretionary Social Activities on Shock History							
Intercept	52.32	2.51	146.14	20.83	< .05	47.36	57.29
Time	3.46	.75	142.82	4.64	< .05	1.99	4.93
Shock History	.96	7.43	145.63	0.13	.90	-13.72	15.65
Time*Shock History	.60	2.15	139.37	0.28	.78	-3.65	4.85

Note. *df* = degrees of freedom; Sig. = significance; EP = Electrophysiology.
Highlighted area: Time/Predictor variable interaction effect when significance level was $p < .10$.

5.7.2. Summary of the Time-Predictor Interaction Effects

The examination of the variation in individual change revealed that, regardless of the variance of the intercepts, men and women differed significantly in their rates of change and did not experience parallel trajectories for six of the seven PROs identified in the unconditional model (Model 1) development. The Sleep Disturbance model included two additional statistically significant predictors, Employment Status and Distance to Electrophysiology Services, while Urgency emerged as a statistically significant predictor in the SF-36v2 Social Functioning model.

Although Employment Status emerged as a significant predictor in seven PROs at baseline (i.e., SF-36v2 Physical Functioning, Sleep Disturbance, 36v2 Vitality, 36v2 Role Emotional, 36v2 Social Functioning, Satisfaction with Participation in Social Roles, and Satisfaction with Participation in Discretionary Social Activities), Age in three PROs (i.e., 36v2 Social Functioning, Satisfaction with Participation in Social Roles, and Satisfaction with Participation in Discretionary Social Activities), and Household Size in two PROs (Sleep Disturbance and SF-36v2 Role Emotional), these factors failed to play a significant role in the individual rate of change. A summary of the time-predictor interaction effects on change over time is presented in Table 5-46.

Table 5-46: Summary of the Time-Predictor Interaction Effects on the Temporal Change in Patient-Reported Outcomes

	Predictor Variables				
	Characteristics of the Individual			Characteristics of the Environment	Biological Function
Patient-Reported Outcome	Sex/Gender	Marital Status	Employment Status	Distance to EP Services	Urgency
SF-36v2 Physical Functioning	✓				
Sleep Disturbance	✓		✓	✓	
SF-36v2 Vitality	✓				
SF-36v2 Role Emotional		✓			
SF-36v2 Social Functioning	✓				✓
Satisfaction with Participation in Social Roles	✓				
Satisfaction with Participation in Discretionary Social Activities	✓				

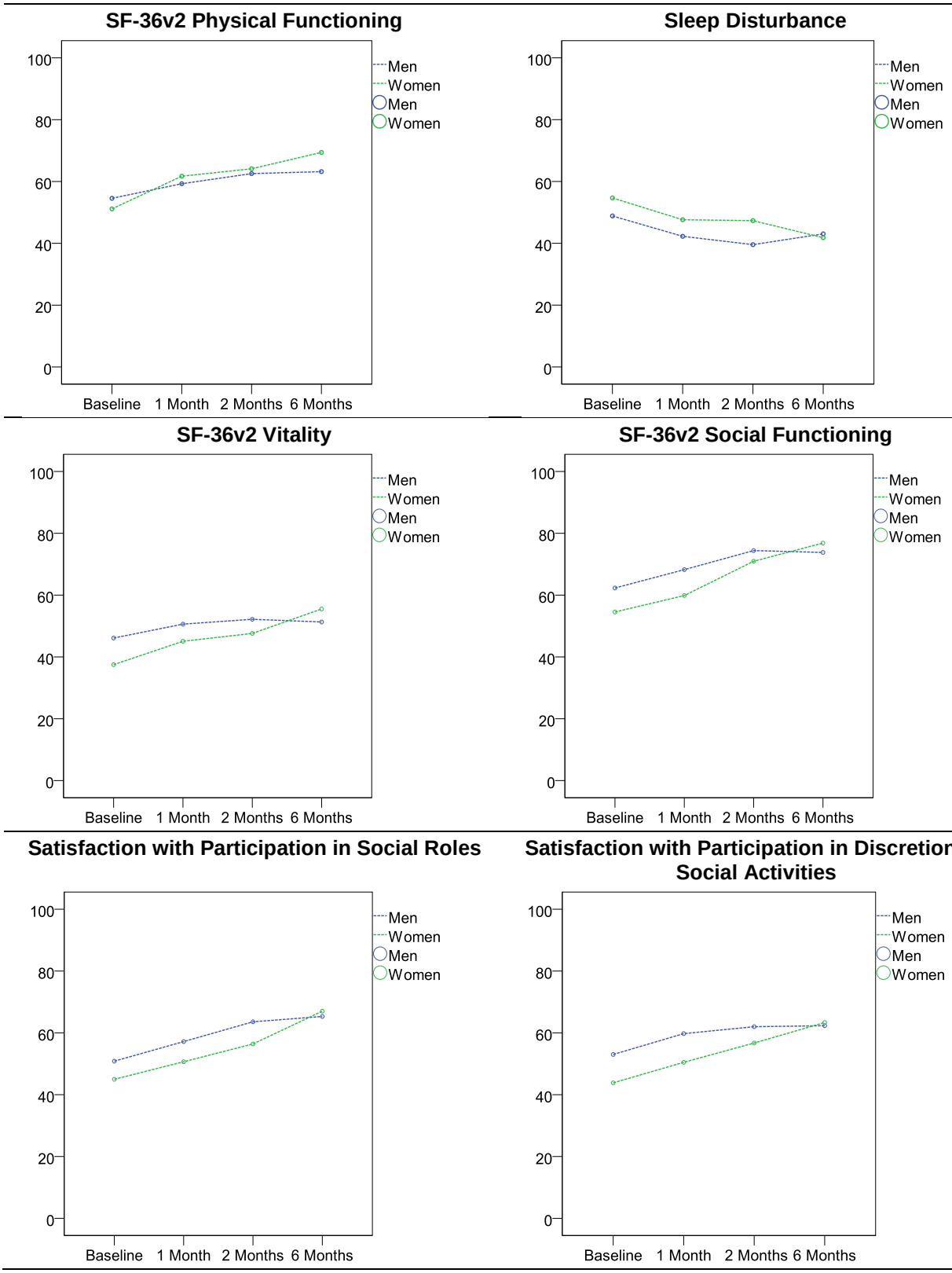
Note. EP = Electrophysiology; ✓ = statistically significant time and predictor interaction (i.e., the subgroup change trajectories were not parallel).

5.7.3. Change Trajectories by Statistically Significant Subgroups

Sex/Gender-Based Trajectories of Change

Model 2 demonstrated that men and women experienced different trajectories of change in two physical health status, one mental health status, and three social health status PROs. The trajectories are graphically depicted in Figure 5-9, and show a similar pattern of change with women exhibiting worse PROs at baseline, and a faster rate of change or improvement over the six months of follow-up. In three of the six PROs, women crossed over and achieved better scores compared with the men's, and in the other three PROs, they started out more poorly but achieved the men's levels at the last measurement occasion.

Figure 5-9: Sex/Gender-Based Trajectories of Temporal Change in Patient-Reported Outcomes



The disparity in the absolute mean differences between the scores at baseline and at the 6-month follow-up ranged between 3.4 and 11.6 points for men, and 16.9 and 23.9 points for women. Although men's mean scores exceeded women's mean scores on all PROs at baseline (range of absolute mean difference: 2.5 to 11.6 points), the rate of change of women resulted in a reversal in standing at six months after implantation, with the mean score of women exceeding the men's by 5.5 to 27.0 points. These findings are presented in Table 5-47 and Figure 5-10.

Table 5-47: Absolute and Relative Mean Differences in PROs of Men and Women between Baseline and 6-Month Follow-Up

	Difference between Baseline and 6 Months Scores for Men		Difference between Baseline and 6 Months Scores for Women		Difference between Men and Women at Baseline[c]		Difference between Men and Women at 6 Months[d]	
	Absolute Mean Difference[c] (points)	Relative Mean Difference[d]	Absolute Mean Difference[c] (points)	Relative Mean Difference[d]	Absolute Mean Difference[c] (points)	Relative Mean Difference[e]	Absolute Mean Difference[b] (points)	Relative Mean Difference[f] (%)
SF-36v2 Physical Functioning	8.0	14.5%	16.9	32.1%	2.5	4.5%	-6.4	-10.1%
Sleep Disturbance	3.4	7.2%	18.2	31.1%	11.6	24.7%	-3.2	-7.4%
SF-36v2 Vitality	3.9	8.3%	19.8	54.1%	10.6	22.5%	-5.3	-10.4%
SF-36v2 Social Functioning	10.2	16.1%	21.3	37.8%	7.0	11.0%	-4.1	-5.6%
Satisfaction with Participation in Social Roles	11.6	21.8%	23.9	53.8%	8.9	16.7%	-3.4	-5.2%
Satisfaction with Participation in Discretionary Social Activities	8.1	15.1%	20.5	46.4%	9.6	17.8%	-2.8	-4.5%

[a] Absolute mean difference in means between men and women at baseline is defined as the difference in means between men and women at baseline (i.e. $mean_{(men\ at\ baseline)} - mean_{(women\ at\ baseline)}$)

[b] Absolute mean difference in means between men and women at 6 months is defined as the difference in means between men and women at six months (i.e. $mean_{(men\ at\ 6\ months)} - mean_{(women\ at\ 6\ months)}$)

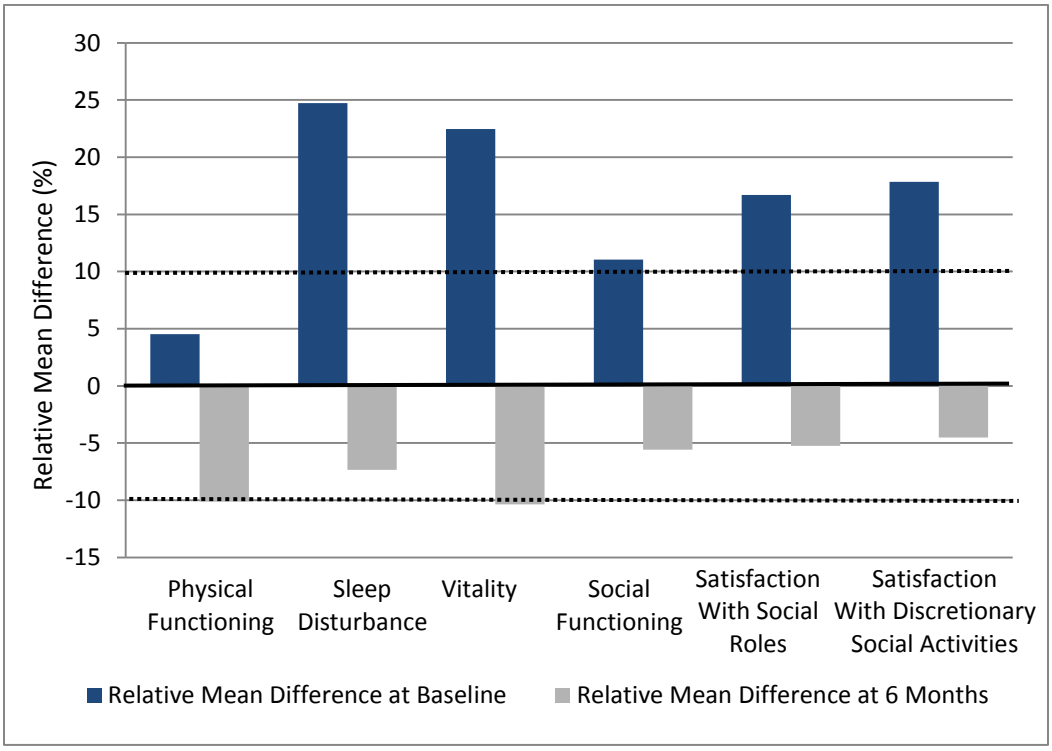
[c] Absolute mean difference between baseline and 6 months scores for men or women is defined as the difference in means between the six-month follow-up measure and baseline (i.e., $mean_{(6\ months)} - mean_{(baseline)}$).

[d] Relative mean difference between baseline and 6 months scores for men or women as a percentage is defined as the difference in means between the six-month follow-up measure and baseline, relative to the baseline, presented as a percentage (i.e., $mean_{(6\ months)} - mean_{(baseline)} / mean_{(baseline)} * 100$).

[e] Relative mean difference between men and women at baseline as a percentage is defined as the difference in means between men and women at baseline, relative to men's scores, presented as a percentage (i.e., $mean_{(men\ at\ baseline)} - mean_{(women\ at\ baseline)} / mean_{(men\ at\ baseline)} * 100$).

[f] Relative mean difference between men and women at 6 months as a percentage is defined as the difference in means between men and women at six months, relative to men's scores, presented as a percentage (i.e., $mean_{(men\ at\ 6\ months)} - mean_{(women\ at\ 6\ months)} / mean_{(men\ at\ 6\ months)} * 100$)

Figure 5-10: Relative Mean Differences in PROs of Men Compared to Women at Baseline and at 6-Month Follow-Up



Note: A difference greater than ± 10% (**----------**) is defined as a minimal important difference (Copay et al., 2007; Gerlinger & Schmelter, 2011; Hopman et al., 2006; Osoba, 2007).
Physical Functioning: SF-36v2 Physical Functioning subscale; Sleep Disturbance: PROMIS Sleep Disturbance short form; Vitality: SF-36v2 Vitality subscale; Social Functioning: SF-36v2 Social Functioning subscale; Satisfaction with Social Roles: PROMIS Satisfaction with Social Roles short form; Satisfaction with Discretionary Social Activities: PROMIS Satisfaction with Discretionary Social Activities short form.
Relative mean difference between men and women at baseline as a percentage is defined as the difference in means between men and women at baseline, relative to men's scores, presented as a percentage (i.e., $mean_{(men\ at\ baseline)}$ - $mean_{(women\ at\ baseline)}$ / $mean_{(men\ at\ baseline)}$ * 100).
Relative mean difference between men and women at 6 months as a percentage is defined as the difference in means between men and women at six months, relative to men's scores, presented as a percentage (i.e., $mean_{(men\ at\ 6\ months)}$ - $mean_{(women\ at\ 6\ months)}$ / $mean_{(men\ at\ 6\ months)}$ * 100).

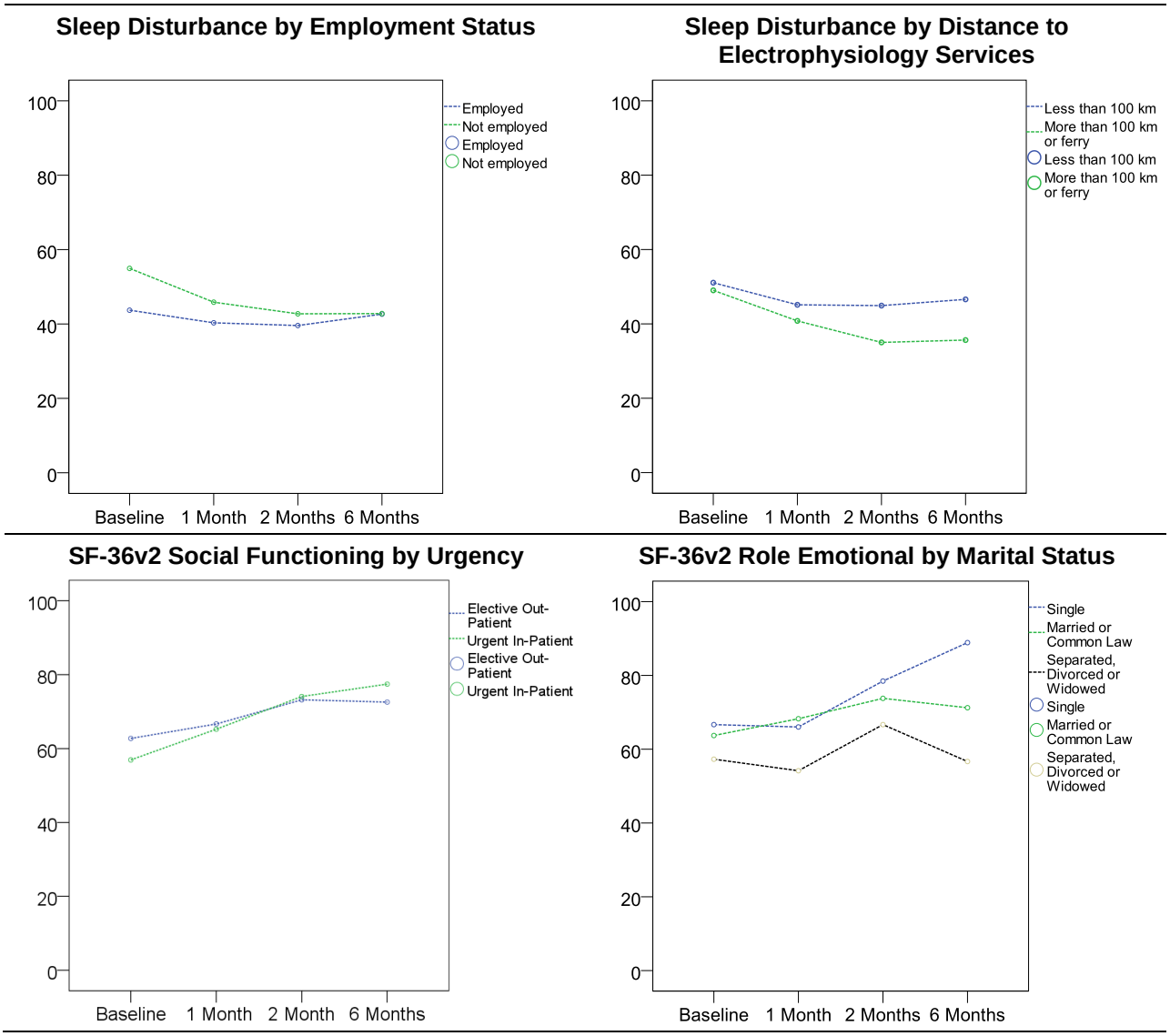
Other Subgroups' Trajectories of Change

In addition to the identification of the sex/gender-based differences in the participants' temporal changes in their PROs, we found some other salient subgroup trajectories of change. In particular, Sleep Disturbance appears to be associated with several predictors, including Employment Status. People who did not have a work commitment initially experienced greater

sleep disturbance but attained the same level as the employed participants over the course of the follow-up. People who lived in close proximity to specialised medical services failed to improve their sleep scores as much as did the participants who lived in more remote locations.

The participants that were urgent in-patients had lower scores of the SF-36v2 Social Functioning subscale at baseline, but improved more rapidly and crossed over to reporting better scores compared with the relatively more medically stable elective out-patients. Marital status differentiated the change trajectories associated with SF-36v2 Role Emotional; the separated, divorced or widowed participants exhibited the lowest scores during the entire course of follow-up, and the single participants achieved the greatest gains in their scores, over time. The trajectories of change for these subgroups are graphically presented in Figure 5-11.

Figure 5-11: Other Subgroup Trajectories of Change



5.7.4. Multivariable Models of Individual Growth

Both Sleep Disturbance and SF-36v2 Social Functioning were associated with more than one statistically significant time-predictor interaction. To explore the multivariable effects of these factors, we constructed two multivariable models of individual change to ascertain whether these predictors were independently associated with the PROs.

Sleep Disturbance

The average rate of change in sleep disturbance was -3.9 points over each measurement interval, indicating that, on average, the participants' scores improved significantly. The time-predictor interaction effects, described above, remained statistically significant when the three variables, (sex/gender, employment status, and distance to electrophysiology services) were entered into the model; they each influenced the participants' trajectories of sleep disturbance. The multivariable individual growth model for Sleep Disturbance is presented in Table 5-48.

Table 5-48: Multivariable Individual Growth Model of Sleep Disturbance

Physical Health Status							
Sleep Disturbance							
Estimates of Fixed Effects							
Parameter	**Estimate**	**Standard Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Intercept	41.83	3.55	169.21	11.79	< .05	34.83	48.84
Gender	8.73	4.13	160.52	2.12	< .05	0.58	16.88
Employment	11.00	3.69	160.18	2.98	< .05	3.72	18.28
Distance to EP	-0.85	3.77	160.72	-.23	.82	-8.29	6.59
Time	-3.86	2.18	352.80	-1.77	.08	-8.16	0.44
Time*Gender	-3.69	1.32	142.45	-2.80	< .05	-6.30	-1.09
Time*Employment Status	-3.70	1.16	141.59	-3.19	< .05	-5.99	-1.41
Time* Distance to EP Services	-2.47	1.19	141.78	-2.07	< .05	-4.83	-0.11
Quadtime	1.84	0.58	270.15	3.16	< .05	0.69	2.98

Estimates of Covariance Parameters

Parameter		**Estimate**	**Standard Error**	**Wald *Z***	**Sig.**	**95% CI**	
						Lower	**Upper**
Repeated	[Time=0]	356.38	54.49	6.54	< .05	264.11	480.90
	[Time=1]	204.30	31.42	6.50	< .05	151.14	276.17
	[Time=2]	152.75	27.62	5.53	< .05	107.17	217.73
	[Time=3]	125.33	34.79	3.60	< .05	72.74	215.94
Intercept + time	UN (1,1)	337.63	63.21	5.34	< .05	233.93	487.31
	UN (2,1)	34.31	16.83	2.04	< .05	1.31	67.30
	UN (2,2)	3.49	8.31	0.42	.67	.03	373.15

Note. EP = Electrophysiology; *df* = degrees of freedom; Sig. = significance.
Highlighted area: Time/Predictor interaction effect when the statistical significance level was $p < .05$.

SF-36v2 Social Functioning

The average rate of change for SF-36v2 Social Functioning was 2.9 units on the 100-point scale per measurement occasion. When included in a multivariable individual growth model, the Time-Urgency interaction effect became non-significant; whereas the Time-Sex/Gender interaction term remained statistically significant. This is consistent with the results provided in Table 5-3 that indicate that women were more likely than men to be in-patient urgent cases. The multivariable individual growth model for SF-36v2 Social Functioning is presented in Table 5-49.

Table 5-49: Multivariable Individual Growth Model of SF-36v2 Social Functioning

Physical Health Status							
SF-36v2 Social Functioning							
Estimates of Fixed Effects							
Parameter	**Estimate**	**Std. Error**	***df***	***t***	**Sig.**	**95% CI**	
						Lower	**Upper**
Intercept	65.37	2.93	164.58	22.33	< .05	59.59	71.15
Time	2.87	1.02	143.94	2.83	< .05	0.86	4.88
Gender	-9.08	4.84	167.35	-1.88	.06	-18.62	0.47
Urgency	-5.02	4.28	167.49	-1.17	.24	-13.47	3.44
Time*Gender	3.55	1.73	146.81	2.05	< .05	0.13	6.97
Time*Urgency	2.31	1.52	145.99	1.52	.13	-0.69	5.32
Estimates of Covariance Parameters							
Parameter		**Estimate**	**Std. Error**	**Wald *Z***	**Sig.**	**95% CI**	
						Lower	**Upper**
Repeated	[Time=0]	377.04	68.18	5.53	< .05	264.52	537.43
	[Time=1]	281.09	44.87	6.26	< .05	205.58	384.35
	[Time=2]	293.76	46.86	6.27	< .05	214.88	401.59
	[Time=3]	295.25	64.47	4.58	< .05	192.45	452.97
Intercept + time	UN (1,1)	493.69	88.20	5.60	< .05	347.84	700.68
	UN (2,1)	-20.22	27.07	-.75	.46	-73.28	32.84
	UN (2,2)	13.90	12.86	1.08	.28	2.27	85.26

Note. *df* = degrees of freedom; Sig. = significance.
Highlighted area: Time/Predictor interaction effect when the statistical significance level was $p < .05$.

5.8. Summary of Findings

The first research question of our study focused on exploring whether patients undergoing ICD implantation experienced changes in their PRO status in the first six months of living with the device. Using group statistics and graphical representations of change over time, we showed that overall, the participants demonstrated improvement in their self-reported physical, mental, and social health status in the early recovery phase.

We employed individual growth modelling to answer the second research question about whether the change in PROs was the same for all participants. In a series of unconditional individual growth models (Model 1), we identified statistically significant estimates of fixed effects and covariance parameters for seven of the 12 PROs (i.e., SF-36v2 Physical Functioning, Sleep Disturbance, SF-36v2 Vitality, SF-36v2 Role Emotional, SF-36v2 Social Functioning, Satisfaction with Participation in Social Roles, and Satisfaction with Participation in Discretionary Social Activities), and we demonstrated that the participants' baseline status was not sufficient to explain their individual trajectories of change. This difference in the rates of change between groups of people warranted further model development.

The final research question centred on whether these individual differences could be explained by testing a set of nine theoretically-driven predictor variables on the seven models identified through the development of Model 1. We conducted a series of individual growth models to test the time-predictor interaction effects (Model 2). We found that men and women experienced statistically significantly different trajectories for six of the seven examined PROs, with the gap between the two groups' relative mean difference in scores ranging from 17.6% to 45.8% over the course of follow-up. We also found some additional, but more inconsistent, interaction effects in four other PRO models, including Sleep Disturbance and employment

status, Sleep Disturbance and distance to electrophysiology services, SF-36v2 Role Emotional and marital status, and Satisfaction with Participation in Social Roles and urgency.

For two of the seven Model 2 PROs, Sleep Disturbance and SF-36v2 Social Functioning, for which at least two variables emerged as statistically significant predictors of individual change (i.e., sex/gender, employment status, and distance to electrophysiology services for Sleep Disturbance, and sex/gender and marital status for SF-36v2 Social Functioning), we conducted a multivariable individual growth model. Although other factors failed to further explain the variability in the individual trajectories, sex/gender remained a statistically significant factor in differentiating the participants' rate of change over time. We demonstrated that sex/gender was a statistically significant predictor of change in most PROs following ICD implantation, and found evidence that, although women presented with worse PROs than men immediately prior to surgery, they improved at a faster rate of change, meeting or exceeding men's scores after six months.

6. Discussion

The results of this study have several implications pertaining to the clinical care of people to support their recovery from ICD implantation and their adaptation to living with the device, especially in the early adaptation period. We first discuss the principal findings in relation to the research questions posed. We outline the strengths and weaknesses of our study, and discuss how these compare with other studies. We explore the meaning of the study, and propose some tentative recommendations. Finally, we discuss some questions that remain unanswered, and which warrant further research.

6.1. Principal Findings

The research questions focused on the temporal change in PROs in the first six months after ICD implantation. We demonstrated that the participants had differing physical, mental, and social health status at baseline, but on average, improved over time. The relative improvement in mean scores between the baseline and the 6-month follow-up assessments ranged between 6.9% and 35.3%, and exceeded the specified 10% threshold, representative of a minimal important difference, in 10 of the 12 PROs. This improvement was also characterised in changes ranging between 0.16 and 0.58 standard deviations for each measure, which exceeded the specified distribution-based threshold of 0.30 in 8 of the 12 PROs. When compared with established patient-assessed criteria, the magnitude of change seen in the SF-36v2 subscale scores was qualitatively categorised as moderate to large in six of the seven subscales.

The study participants demonstrated worse clinical and social health status on most of the SF-36v2 subscales, at nearly all measurement occasions, compared with the established norms of urban-dwelling Canadians aged 25 years or older. At the 6-month follow-up, the participants'

scores remained 11.6 to 21.5 points lower than the normative Canadian scores on five of the seven SF-36v2 subscales.

In addition to this general trend, we found that the participants' baseline status was not sufficient to explain the direction or rate of their individual change, for most of the studied PROs, and that there was significant variability in the trajectories that could be explained by other factors. We were particularly interested in the variability noted in the participants' social health status; there was significant variability in four of the six relevant PROs. Most significant, we found that women, compared with men, generally reported poorer PROs initially, with a relative mean difference ranging between 4.5% and 24.7% for six of the measured PROs, including three indicators of social health status. This difference exceeded the 10% benchmark for a minimal importance difference in five of the six PROs. Yet, the women's rates of improvement were significantly faster than those of men. Indeed, the women equalled or exceeded the men's PRO status at the completion of the follow-up period, by a relative mean difference ranging between 4.5% and 10.4%. None of the other explored predictors, including indication for implantation, explained the residual variability in the PRO trajectories with the compelling consistency found when we compared the men's and women's scores and trajectories.

The established conceptual framework underpinning this study was helpful in guiding the selection of PROs and predictor variables to begin to understand the relationships between the multidimensional factors that affect the quality of life of people with heart disease and an excessive risk of sudden cardiac arrest. The use of individual growth modelling allowed us to answer the questions that are at the core of the study of change in people: (a) how does the

outcome change over time and (b) can we predict differences in these changes (Singer & Willett, 2003).

6.2. Strengths and Weaknesses

6.2.1. Strengths of the Study

A strength of the study was the use of a prospective longitudinal design with four measurement occasions. Multiple cross-sectional studies have described patients' experiences of living with an ICD at various points in time, but few have focused on prospective changes, starting at the pre-implantation phase. We obtained an 81% completion rate of the 171 enrolled participants through diligent contact with participants, regular study reminders, and the distribution of tokens of appreciation for each measurement occasion completion.

The inclusion of four measurement occasions, over a 6-month period, was a purposeful attempt to focus on the early recovery phase. In most published studies, the measurement occasions were timed at baseline, and three and six months after implantation. Our study design was aimed at obtaining as many data points as pragmatically and operationally possible to allow us to study temporal variance, to contribute evidence about PROs in the relatively unstudied period in the first two months after surgery, and to compare our findings to other studies that have spanned six months of follow-up. Our confidence in drawing conclusions about the shape and direction of change was increased with four measurements in a time series design, modelled at the individual level.

The study participants represented a "real life" cross-section of patients who require an ICD in British Columbia. Our collaboration with the highest volume device implanting centre in the province, and the affiliated group of electrophysiologists responsible for identifying and providing specialised medical care for this group of patients at excessive risk for sudden cardiac

arrest, enabled us to access and enroll over 50% of the patients referred for ICD over the course of 15 months. The inclusion of patients with both primary and secondary prevention indications for ICD implantation reflected the practices of provincial follow-up clinics that do not offer indication-specific programs or services. These clinical programs contrast with most existing research, which has conventionally reported PROs for either primary or secondary prevention patients, but not both.

Another strength was the study's grounding in a theoretical framework that guided the conceptualisation of PROs, and the selection of theoretically-driven predictor variables. Although we stopped short of fully testing the revised Wilson and Cleary (1995) model, and did not explore all of the relationships between functional status, health perceptions, and overall quality of life of people with ICDs, we made a beginning attempt to understand how characteristics of these individuals, and their environments, biological functions, and symptoms affect their self-reported health status. Importantly, we ensured that the selection of outcome variables was congruent with Wilson and Cleary's (1995) theoretical framework, and supported by the PROMIS domain framework of self-reported health, a major clinical and scientific driver of the implementation and evaluation of PROs in current clinical practice (Patient-Reported Outcomes Measurement Information System, 2009). Furthermore, the study was informed by the clinical practice of the author, who held an advanced practice position with the arrhythmia program at the study centre. In leading the only provincial, clinician-led patient education and support group, the author had many opportunities to hear patients' descriptions of their health status, anecdotal issues related to the day-to-day implications of living with an ICD, and concerns related to their physical, mental and social health status.

Most important, our approach to the study of change contrasts with the more conventional use of difference scores, and permitted an analysis of selected correlates of the rate of change for each patient separately, and for groups of patients collectively (e.g., we addressed whether the rate of improvement in the PRO was related to the patient's sex/gender). Individual growth modelling, an approach to multilevel modelling, was ideally suited to answer the research questions. The use of individual growth modelling allowed us to investigate change within individuals to identify the presence, pattern, and predictors of change, and to explore between-individual change to understand whether all the participants changed in the same direction and at the same rate, or whether different groups followed different trajectories. Both the within- and between-individual change analyses provided important information about the nature of the temporal change in ICD recipients' PROs.

Lastly, the study was strengthened by the relative absence of missing data, with data at the scale-item level absent in 0.6% to 1.6% of the values collected at each measurement occasion. The use of the single imputation procedure at the item-level, which ensured total scale scores for individuals who provided some but not all relevant responses, reflected the recommended best practice to address the challenge of missing data (Tabachnick & Fidell, 2007).

6.2.2. Limitations of the Study

The study sample was limited to 171 participants, the available continuous patient population who consented to participate. The ability to detect an effect in individual growth modelling is related to both the sample size and the number of groups, which affect the number of parameters in the model. The intercepts depend on the mean of a variable within a group, but the slope estimates depend both on the levels of an outcome and a particular covariate (i.e.,

time), as well as the variability of their covariance among individuals within each group (Heck et al., 2010). Individual growth models are most robust with both a large sample size and the number of repeated measures (Singer & Willett, 2003). The moderate sample size and number of measurement occasions affected the generalisability of our study; thus, the reader is cautioned to interpret the analyses within the context of this significant limitation. It was, in part, for this reason that we chose a statistical significance level of .10 to identify the remaining residual variance.

Three hundred and eight people were approached to participate in the study, of which 137 (44.5%) were either missed, did not meet the inclusion criteria, or refused to participate. Twenty-four (7.8%) patients could not participate because they did not speak English. This exclusion limited the validity and generalisability of our findings in the linguistic, cultural, and ethnic diversity of the British Columbia health care environment. Although most patients were medically stable at the time of their ICD implantation, 16 (5.2%) patients were unable to participate because of the brain injury and cognitive impairment they sustained as a result of a cardiac arrest, or were critically ill at the time of surgery. Although our sample included 72 (42.1%) patients who were in-patients in acute care settings, the findings of our study have limited value in describing the outcomes of patients who present with catastrophic medical events in addition to their requirement for an ICD. In addition, 60 (19.5%) people refused to participate, and 32 of the 171 enrolled participants (18.7%) were subsequently lost to follow-up. Given the complexity of the course of heart disease and treatment, and the potential deterioration in physical, mental, and social health status, we recognise the potential for self-selection bias. It is possible that the people who were unable or refused to participate, and those who withdrew from the study, may have been more inclined to deteriorate over time because of their underlying

health condition. We lacked the clinical data to determine whether the 32 (18.7%) participants who withdrew had different health outcomes from those who completed the study. For example, we do not know whether there was an attrition bias related to the experience of shock or need for additional medical interventions, such as surgery. If present, these differences in patients' outcomes were not accounted for in the study, and present a source of bias and a limitation to the generalisability of the findings.

Although the study was strengthened by employing a theoretical framework, the analysis did not test the complete framework because of the nature of the research questions posed, the scope of the study, and logistical constraints. Supported by the PROMIS domain framework, we conceptualised Wilson and Cleary's "Functional Status" as encompassing physical, mental, and social health status. Although we accepted Wilson and Cleary's theoretical assumption that functional status is related to health perception and overall quality of life, we did not further articulate the relationships among these domains.

The study would have been strengthened by having data that could have determined the temporal change trajectories beyond the six months studied. The selection of the early recovery period reflected a clinical interest to guide practice and processes of care at the healthcare centre, but was likely insufficient to understand the full trajectory of the PROs in the context of a permanently implanted device with lifetime implications related to surveillance, replacement requirements, and management of shock therapy. We cannot comment on the direction and trajectories of change identified in this study beyond the six months of follow-up.

As discussed previously, individual self-report is the data source for PROs. We asked participants to recall activities, events, emotions, behaviours, interactions, and patterns of their daily lives in the past four weeks (for the SF-36v2) or seven days (for the PROMIS short forms).

It was methodologically important to retain the recall periods validated for the selected instruments. It is feasible that the dual time recall time periods may have been a source of confusion or inaccuracy in the participants' responses. Furthermore, the exercise of recalling wide-ranging behaviours and emotions over the course of potentially medically unstable periods, and the challenges associated with the request to summarise their status in the prescribed period of time, on a numeric scale, may be a source of inaccuracy. We discuss the implications of recall bias and response shift further in this chapter.

The self-report of information used to construct the multivariable models (i.e., the predictors of variability in the change trajectories) must be considered with caution. In particular, the self-report of ICD shock, used as an indicator of "Symptoms", relied solely on information provided by the patient. The shock history was not verified with electronic device interrogation, and thus, not confirmed. In addition, the lack of awareness of what a shock might feel like, led five participants to state, "I don't know" in the margins of the paper-based questionnaires for the question related to the experience of ICD shocks.

Although we attempted to reliably capture the complexity of PROs by selecting validated instruments that measured wide-ranging outcomes, informed by the literature review and theoretical framework, it is feasible that we failed to assess domains salient to people's experience of adjusting to ICD therapy. Our study included a series of exploratory open-ended questions to investigate elements of people's experiences that may not have been captured with the selected instruments. We inquired about recent life events that may have influenced the participants' responses, their most important concerns, changes caused by receiving an ICD, information they wished they had received prior to the implantation, and questions that remained unanswered. A cursory review of the participants' answers confirmed that the domains measured

in the study seemed to capture the essence of people's responses, although a rigorous thematic analysis was not conducted.

6.3. Discussion of the Study Findings in Relation to Other Evidence

In Chapter 2, we discussed the breadth of PRO research, and the necessity to capture domains that conceptually encompass the physical, mental, and social components of self-reported health status in order to reflect and appropriately measure the complexity and intersectionality of people's experiences of health and illness. Although multiple findings emerged in our study, we are particularly interested in the sex/gender-based trajectories that were identified, and the failure of age, the indication for implantation (i.e., primary or secondary), and shock history to emerge as statistically significant predictors of temporal change. We also discuss the use of individual growth modelling as a means of studying change in PROs, especially in relation to previous research findings. The impetus for this study was to facilitate knowledge translation of the findings into the current practice at British Columbia's specialised electrophysiology centres. The focus on sex/gender, age, indication, and shock history, and analytical approaches is particularly pertinent to addressing the gaps in current research and clinical practice, and to supporting clinical programs such as the implementation of PRO assessment in arrhythmia management practice.

6.3.1. Sex/Gender Differences in the PRO Change Trajectories

One of the most important findings of our study was the significantly different trajectories of change in men's and women's physical, mental, and social health status following ICD implantation. These findings echo previous research, which has raised concerns about sex/gender disparities in PROs in people with ICDs, with women reporting significantly poorer physical functioning and vitality (Habibovic et al., 2011), higher anxiety, shock-related distress,

depressive symptoms (Piotrowicz et al., 2007; Whang et al., 2005), and difficulties in assuming social roles and responsibilities (Spindler et al., 2009; Tagney et al., 2003). To compare the strengths and weaknesses of our study to the existing research, we address, in turn, the conceptualisation and operationalisation of sex and gender applied in current research, the sample sizes of previous studies, the domains and measures selected, the timing of measurement occasions, the analytical methods used to describe potential differences between men and women, and the findings and implications drawn.

The definitions of the terms, "sex" and "gender," in the published literature, are generally not outlined. We cautiously used the term "sex/gender" in recognition of the potential effects of multiple processes (i.e., physiological differences in arrhythmogenic responses, the cultural contexts of body image, or the social influences in the resumption of social roles following an acute event). Future research is urgently needed to parse better these differences between men and women; they are pivotal to understanding the mechanisms that differentiate the experiences of men and women. This knowledge would undoubtedly aid the development of appropriately timed and targeted clinical and supportive interventions.

In the literature review, we discussed how the sample sizes of most studies that have examined the PROs of people with ICDs, and sex/gender disparities in particular, have ranged widely. In our study, 43 (25.1%) of the 171 participants were women. This percentage is in keeping with that reported in a recent systematic review of gender disparities in psychological distress and quality of life in ICD recipients, which identified 18 studies, published between 2003 and 2010, with sample sizes greater than 100, and included primary and secondary prevention patient populations (Brouwers et al., 2011). The review was limited by the methodological heterogeneity in study design, the timing of the measurement occasions, and the

variety of instruments used to measure PROs. The mean percentage of women (mean age = 62 years) included in the samples was 21% (range: 14% to 33%). It is unclear whether this represented the proportion of women in the population, or difficulty in recruiting women. Although our sample was moderately sized, the proportion of the sample being female was similar to that achieved in other studies.

The impact of sex/gender on ICD-related PROs is equivocal and is currently being debated in the scientific literature. Our study contributes new evidence that men and women differ in their rates of change in multiple PRO domains in the early recovery period. In studies in which the impact of sex/gender was statistically evaluated, there were statistically significant differences found in men's and women's social functional status (Dunbar et al., 2009; Smith et al., 2006), physical and social functioning, mental health (Spindler et al., 2009), and anxiety (Vazquez et al., 2008). Both Spindler et al. (2009) and Vazquez et al. (2008) studied consecutive patients at follow-up clinics who differed in the length of time elapsed since their initial device implantation. In contrast, in the previously cited review of gender disparities in psychological distress and quality of life irrespective of indication for implantation, the researchers found that gender did not significantly affect PROs in 26 of the 32 (80%) studies examined, leading to the conclusion that: "there is insufficient evidence to conclude that gender *per se* is a major autonomous predictor for disparities" (p. 798), a call for caution about the clinical implications, and a call for further research sufficiently powered to reach more definitive conclusions (Brouwers et al., 2011).

There is insufficient evidence to understand the reasons for these equivocal findings, which may be related to the timing of measurement occasions, the selection of instruments, or some of the factors further discussed in this study, including response shift or differential item

functioning. It may be interesting to explore whether there are sex/gender differences in "catastrophising tendencies", a phenomenon reported in the pain and psychological literature about a general catastrophic thinking style about medical events or somatic experiences that may predispose people to worse outcomes (Drahovzal, Stewart, & Sullivan, 2006). Pain catastrophising, the tendency to focus on the experience and somatic sensations of pain and negatively anticipate and evaluate one's ability to deal with pain, has been identified as a strong psychosocial predictor of negative outcomes (Sullivan et al., 2001). Although this discussion is speculative, it may shed light on how men and women evaluate their health status at the time of ICD implantation, and could inform patient teaching interventions. Another factor related to the equivocal findings of differences between men and women may be the inconsistent measure of social support. Conventionally, demographic information captures self-reported marital status, but has limited value in quantifying a person's access to social resources. In our study, we attempted to gain a better understanding of the social environment by recording the participants' household size. This was likely insufficient to appropriately measure whether there were significant differences between men and women's access to social support. In a recent study of gender differences in the influence of social support on one-year changes in functional status in older patients with heart failure, Berard, Vandenkerkhof, Harrison, and Tranmer (2012) found that women reported significantly lower social support and physical functioning at baseline, but the differences in clinically meaningful functional decline abated over the course of the first year of their treatment for heart failure. This led the researchers to conclude that sex/gender-directed strategies aimed at optimising function may be of benefit in this population. Although these factors may illuminate the discussion, more research is needed to better identify the reasons for the substantial differences in men's and women's PROs found in this study.

In addition, the finding that these sex/gender differences abate over time, with men and women reporting similar outcomes at six months, raises the question about the shape and direction of change in the longer-term recovery period and adaptation to living with an ICD. After the initial six months of living with an ICD, we do not know whether women continue to improve at a faster rate than men, whether men and women retain similar rates of change, or whether men significantly worsen in the longer term. In particular, it may be worrisome to note the shape of the men's PRO trajectories, and to speculate that they experience a slower and possibly decelerating pattern of long-term change. There is currently no research that has sufficiently addressed this question.

6.3.2. Study Design and Analytical Approach

The PROs of interest and the measures employed in previous studies were somewhat different from the theoretically-driven selection we made. Some prominent researchers in the field of ICD-related PROs are psychologists, and have focused on the study of mental health and psychological functioning, with a particular interest in anxiety, device-related anxiety, and depression. These studies have been theoretically driven by a psychological framework, and have aimed to identify, predict, and treat psychological distress. This focus on psychology, psychological function and dysfunction, and intervention aimed at improving mental function, explain the measurement instruments researchers have employed to measure PROs of interest. Examples of the various measures employed include the State-Trait Anxiety Inventory (Pedersen, Theuns, Jordaens, & Kupper, 2010; van den Broek, Denollet, Nyklicek, & van der Voort, 2006), the Hospital Anxiety and Depression Scale (Kapa et al., 2010; Spindler et al., 2009), the Florida Shock Anxiety Scale (Sears et al., 2007; Vazquez et al., 2008) (also used herein), the Center for Epidemiological Studies Depression scale (Whang et al., 2005), the Beck

Depression Inventory (Dunbar et al., 2009), personality traits (Pedersen et al., 2004), and coping mechanisms (Dunbar et al., 1999). Our study was grounded in the Wilson and Cleary (1995) theoretical framework, which differs from a psychological approach, in that it situates PROs within the evaluation of overall quality of life. Our particular focus was on functional status as conceptualised as physical, mental and social health PROs. We were particularly interested in exploring the social dimensions of PROs, including how people resumed their social roles and activities, attended to work and family commitments, and functioned in their everyday lives to attend to obligations and enjoy opportunities. Of the 12 PRO indicators selected, six were conceptualised as measuring social health status. Thus, the measurements selected were broader than are those employed in the previously cited studies.

The timing of the assessments differed from that of most existing longitudinal research. Smith et al. (2006) measured PROs before and immediately after ICD implantation, whereas Spindler et al. (2009) and Vazquez et al. (2008) conducted cross-sectional studies with their participants with the time elapsed since implantation varying between mere weeks to years. Similar to our study, Smith et al.'s (2006) found that women had worse PROs than men in the early implantation period, but did not follow the participants over time. In our study, three of the four measurement occasions (baseline, first and second follow-up) were approximately within 10 weeks of the participants' surgery, a period of early recovery and adaptation to living with an ICD poorly described to date. Previous research has suggested that men and women differ in their patterns of cardiac post-operative recovery, with women experiencing more depressive symptoms following coronary artery bypass grafting (Con, Linden, Thompson, & Ignaszewski, 1999; Mitchell et al., 2005), and an overall slower recovery (Vaccarino et al., 2003). Thus, this

study's focus on the weeks immediately following surgery contributes to better understanding the differences between men and women in the potentially vulnerable recovery phase.

To answer the research questions posed in this study, we employed individual growth modelling, a relatively novel approach to the study of temporal change in health status. The analysis method distinguished our study from most existing research. To date, most studies have used descriptive and repeated univariate or multivariate analyses of variance or covariance, chi-square tests, or (repeated) *t*-tests to determine differences in scores between groups, or between two repeated observations.[41] One exception was Pedersen, Theuns, Jordaens, and Kupper's (2010) study of the course of anxiety and device-related concerns in ICD patients in the first year following implantation; they used hierarchical, latent class regression models to examine change over time and to identify latent classes (i.e., group-based anxiety trajectories), and multinomial regression analysis to examine predictors of the different trajectories (i.e., personality type, social support, clinical indication for ICD, experience of ICD shocks, and comorbidities). They found that their patients' course of general anxiety in the first year post implantation was stable, while there was more variation in device acceptance. Personality type and social support, and not gender differences, were determinants of both outcomes, whereas ICD shock was associated with worse device-related concerns. We further discuss the use of various analytical methods in the study of group and individual change in PROs, later in the chapter.

6.3.3. The Influence of Age, Clinical Indication, and Shock History on the PRO Change Trajectories

Based on the findings of the literature review, we selected, among other theoretically-derived variables, age, clinical indication for implantation, and shock history as potential

[41] As Ragosa (1995) pointed out, two repeated measures are insufficient to study change. One can obtain a determination of the *amount* of change, but two observations contribute nothing to an understanding of the functional form of development or growth.

predictors of PROs and their trajectories of change. These predictors did not emerge as statistically significant in our analyses, except for age, which was associated with participants' change only on Social Functioning, Satisfaction with Participation in Social Roles, and Satisfaction with Participation in Discretionary Social Activities. These non-significant findings contrasted with the existing research related to these variables, which we discuss in turn.

Age

The age at which people require an ICD varies widely, as illustrated by the age range of our participants (i.e., between 18 and 81 years), and may reflect the nature, events, and progression of their underlying heart disease. Understanding the effects of age for this patient population is of vital importance to the planning of clinical services and interventions, given the current clinical debate about the appropriateness of group education and interventions for people who are at different chronological and developmental stages (Snoek, 2012; Trento & Porta, 2012).

Older age at the time of ICD implantation has been associated with diminished physical functioning and greater anxiety over the course of the first year of having an ICD (Hamilton & Carroll, 2004), and relatively poorer device acceptance within the first three months (Carroll et al., 2012). Researchers have highlighted the exclusion of the elderly from most of the randomised controlled studies that established the indications for ICD, and the current absence of evidence related to the value and impact of ICD therapy in this potentially more vulnerable patient population (Yarnoz & Curtis, 2006).

Similarly, limited longitudinal evidence exists about the PROs of younger patients who require lifelong ICD therapy, of the impact of the device at various developmental stages, and of the effects of repeated device replacements and other technological issues, which may occur over

decades of a recipient's life. Studies of children with ICDs (≤ 18 years) have suggested that, similar to children with other chronic diseases, younger patients, especially girls, report poorer quality of life and more social avoidance behaviour (Sears et al., 2011), but that the age (e.g., early childhood, early adolescence, adolescence) at which children receive their devices does not significantly affect their PROs (Koopman et al., 2012). Because younger patients are expected to experience more ICD shocks over the course of their lives, researchers have suggested that additional research and clinical attention are required to better understand the PROs in younger people with ICDs (Sears, St Amant, & Zeigler, 2009).

Although our study included 93 (54.4%) participants 65 years and younger, and 78 (45.6%) older patients, it is possible that our study lacked the statistical power necessary to identify the effects of age on PRO trajectories. Because we treated age as a continuous variable, the model assumed that age was linearly related, which may not have been the case.

Clinical Indication for ICD Implantation

In our study, we utilised the medical history and the referral form completed by an electrophysiologist to confirm that 99 (57.9%) of the enrolled patients received their ICD for primary prevention, whereas 72 (42.1%) patients had survived a previous ventricular arrhythmia and received the ICD for secondary prevention. As illustrated in Chapters 1 and 2, the patient who requires an ICD for primary prevention usually presents differently from the patient who requires ventricular arrhythmia prophylaxis for secondary prevention. We hypothesised that the antecedent arrhythmic events and the underlying heart disease processes were contributing factors, conceptualised as reflecting "Biological Function", of differences in the temporal change of PROs. We were especially concerned about the practice of excluding either primary or secondary prevention patients from randomised clinical trials and other prospective studies,

which limits the ability to compare these clinical populations. Clinical indication did not emerge as a statistically significant factor in the patients' trajectories of change, which echoed the conclusion of a review of five studies (seven articles) published between 2002 and 2009 concerning the impact of clinical indication on PROs, in samples ranging from 91 to 426 participants who were followed for 2 to 12 months. These studied measured various endpoints, including anxiety, depression, quality of life, and ICD-specific quality of life, and not one reported an association between clinical indication and PROs (Pedersen, Sears, Burg, & Van Den Broek, 2009). In our study, cardiovascular or biological function might have been better measured with the patients' left ventricular ejection fractions (i.e., the percentage of blood ejected into the arterial circulation with each cardiac contraction cycle), rather than the less specific indicator, clinical indication, but we lacked complete data for this variable.

Self-Reported Shock History

Our study was limited by our sole reliance on the participants' self-reported histories of shocks. We argued that the self-report of shocks was in keeping with our interest in capturing the patient's direct perspective. This potential predictor was not found to be statistically significant in the individual growth modelling analyses.

It is possible that participants perceived having sustained a shock when they felt strong palpitations or a rapid pacing event.[42] Some patients lose consciousness prior to an ICD shock,[43] and may not recall a shock. Because of this approach, our findings cannot be easily compared to studies that have used electronic device interrogation to record the experience of shock.

[42] One of the features of the ICD therapy algorithm is antitachycardia pacing (ATP) or overdrive pacing programming, which can terminate ventricular tachycardia through pacing therapy rather than a shock. Patients may experience palpitations prior to ATP.

[43] When the heart beats very fast or very erratically, there is no time for the ventricles to fill appropriately, and not enough force to eject blood flow. This leads to decreased stroke volume, the amount of blood ejected with each cardiac cycle. This may lead to decreased brain perfusion and rapid loss of consciousness as a consequence of the ventricular arrhythmia.

Inconsistent methodological approaches to the measurement of shocks have been identified as one of the current limitations in our understanding of the mixed evidence of an association between ICD shocks and PROs (Pedersen et al., 2010). In addition, the small number of shocks reported by the participants in this study limited our capacity to evaluate the effect of people's shock histories on their PROs. It is possible that the attrition of 18.7% of study participants in our study may be related to the experience of shock, and the subsequent decision to withdraw from the study. We lack the information to speculate further, but cannot discount this potential explanation.

In Chapter 2, we discussed the association between ICD shocks and relatively poor PROs, including anxiety, psychological distress, and QOL. As summarised by Pedersen et al. (2010), researchers have reached some of the following conclusions: "Most research has pointed to ICD shock as the primary culprit if reductions in QOL [quality of life] occur" (Burns et al., al., 2005, p. 384), "ICD patients potentially face significant psychological distress because of ... the occurrence of ICD shock" (Passman et al., 2007, p. 999), and "Those individuals who experience an ICD shock relate greater levels of psychological distress, anxiety, anger, and depression than [do] those who do not" (Poole et al., 2008, p. 1017) . Yet, a review of the strength of the evidence from primary and secondary prevention randomised controlled trials showed that three of the seven pivotal trials found no relationship between shocks and PROs (Irvine et al., 2002; Namerow et al., 1999; Strickberger et al., 2003), three provided mixed or inconclusive findings (Mark et al., 2008; Passman et al., 2007; Piotrowicz et al., 2007), and one showed that the experience of five or more shocks was a significant predictor of worse PROs (Schron et al., 2002).

These inconsistent findings may be related to differences in study design and the method of assessment of patients' histories of shocks (e.g., self-reports vs. objective device interrogation) and quantification of those shocks (e.g., dichotomous measurements of shocks/no shocks vs. actual number of shocks) (Pedersen & van den Broek, 2008). With current changes in technology and device programming resulting in patients sustaining fewer shocks (Gasparini & Nisam, 2012), the impact of shocks may be less significant than was suggested by earlier research; further research should be conducted to better understand the mechanisms at play. More definitive findings could inform the identification of patients at higher risk for adverse reactions and the development of interventions to improve their PROs following ICD shocks.

It is also important to note that we used the total scores of both of the ICD-specific PRO instruments, the Florida Shock Anxiety Scale and the Florida Patient Acceptance Survey. We did not conduct confirmatory factor analyses to support our measurement approach. This is a limitation of our study. These instruments did not produce scores that demonstrated unique trajectories of change in their respective unconditional individual growth models (Model 1) and thus were eliminated from the subsequent model building. Among several possible explanations for these findings, it is possible that the instruments lack sufficient sensitivity to detect such changes because of poor construct validity. If this is indeed the case, the use of total scores may not be advisable. Further psychometric analysis of the two instruments is needed.

6.3.4. Analytical Approaches

In the preceding chapters, we discussed the diversity of patients who require an ICD in terms of, for example, their age, sex/gender, underlying cardiac condition, the clinical course of their disease, their comorbid burden, and their challenges in adjusting to a complex technological device. The prevailing analytical approaches that limit the detection of differences to change

scores fail to consider this heterogeneity and these pivotal individual differences. Researchers have called for longitudinal studies to examine individual change by using statistical methods capable of describing between- and within-individual change over time (Shek & Ma, 2011).

The use of individual growth modelling is a relatively new statistical approach to study change over time. As discussed previously, we selected this method because it was well suited to identify the presence and direction of change in PROs, account for differences in individual rates of change, and predict membership in the different trajectories. We argued that confining analyses to comparisons at the group level failed to account for potential differences in patients' baseline status, and in their pattern and rate of change over time, and that the clinical utility of this current study rested on providing evidence to develop timed and targeted interventions for individuals at higher risk of experiencing poorer outcomes. Our analytical plan contrasted with the conventional between-group approaches used in most of the existing research. We believe that this unique analytical approach, which enabled us to identify different trajectories of change, represented a novel contribution to the study of PROs and ICDs.

After highlighting some salient differences in the strengths and weaknesses of our study compared with existing research, we turn our attention to exploring some possible explanations of the results of our study, especially the clinical applicability of the findings.

6.4. Possible Explanations of the Study Results

The primary purpose of this research project was to inform the clinical practice of cardiac centres charged with treating people at high risk for sudden cardiac arrest due to an underlying cardiac disease, in the planning and provision of health services to: (a) assist people when making a decision about whether to undergo ICD implantation, (b) support ICD recipients in their transition in the early recovery phase, and (c) implement interventions for groups of

individuals who share common risk factors associated with relatively poor outcomes. We explore the clinical significance of the general improvement in PROs we found over the course of the follow-up, in discussing the potential mechanisms at play that may affect the direction and shape of this change, and reflecting on the sex/gender-based trajectories identified. We include some tentative recommendations for clinical practice before concluding with a discussion of some questions that remain unanswered and which warrant further research.

6.4.1. Clinical Importance

We aimed to understand the direction and shape of temporal change in ICD recipients' PROs to explore the early recovery phase and to inform clinical practice. The goal of the ICD is not to cure heart disease, improve physiological function, or decrease symptoms, but rather to provide a rapid and effective resuscitation intervention in the event of sudden cardiac arrest. Thus, the consideration of the minimal important difference (MID) in people with a relatively new ICD does not indicate a response to treatment in the sense of taking a new medication to improve cardiac function or percutaneous coronary intervention to improve coronary perfusion, but rather, is indicative of people's adjustment to their new adjunctive safety device. The absence of existing evidence of the MID for ICD patients caused us to investigate the meaning of group and individual change in our study with caution, as we aimed to better understand the potential mechanisms at play. The assessment of minimal important difference in PROs in cardiovascular care has not been routinely employed to date. As we discussed in Chapter 4, we adopted a 10% change in scale score (all scales were standardised to range from 0 to 100) and a difference of 0.30 SDs as benchmarks for change that is likely to be important to ICD patients.

Against these benchmarks, our findings are clinically important. In 10 of the 12 PROs, the change in PROs exceeded 10%, and in eight PROs, the change in SD was greater than 0.30.

We cautiously concluded that the participants demonstrated an important improvement in PROs, over time and to varying degrees. In addition to the sample size and other limitations of our study, the science of the MID of PROs in heart disease in general, and in people with ICDs in particular, is likely too immature to draw strong conclusions about temporal change from the data. Nevertheless, this exploratory assessment may be a helpful contribution to a beginning understanding of the average magnitude of change experienced by ICD patients, over time. Before we further examine some potential reasons for the change over time later in this chapter, we discuss some of the clinical implications of the findings.

For clinicians responsible for pre-operative patient education and follow-up programs, our findings are of interest. The processes of care in place to support patients undergoing ICD implantation do not conventionally assume that there is a change in health status over time. The structure and content of the early follow-up visits focus on skin healing, device programming and response, medical issues, and other arising health issues. Our findings highlight that the implantation of an ICD to improve physical health safety is not a benign intervention, in spite of the limited effect on the course and treatment of heart disease, aside from the termination of potentially malignant arrhythmias. The change identified in this study challenges the perspective that providing an ICD to patients affords them greater safety without otherwise intervening in the course of their disease or treatment. From a patient's perspective, the implantation of an ICD is a significant health event associated with relatively poor PROs at the time of surgery, and an improvement in self-reported health status during the first six months. In particular, we highlighted the changes in the social domains of PROs related to people's roles, responsibilities, leisure, and overall social function. This is important new evidence that can help inform clinical care. The current evidence-based focus on shock anxiety and psychological functioning may

benefit from the inclusion of indicators of social health status. The impaired social functioning identified in this study highlights behaviours that restrict people's capacity to work to their full capacity, attend to their caregiver responsibilities, participate in leisure activities, or foster friendships. This may be related to psychological processes, such as a state of heightened vigilance, shock-related anxiety, or depressive symptoms, and may contribute to a cycle of worsening PROs. Interventions aimed at improving social functioning may offer new opportunities to interrupt this cycle, and contribute to improving PROs, including mental health functioning. This finding is pertinent to nursing practice, in particular, because of nurses' expertise in assessing social functioning and in implementing interventions to support social health.

The significance of the findings is reinforced when comparing the participants' change over time to the benchmarks established for patients' perceptions of the magnitude of change in the subscales scores of the SF-36. We found that the participants experienced moderate or large changes in all the PROs except for the SF-36v2 Bodily Pain subscale, although the changes did not meet the much higher thresholds established by expert physicians. As expected, once past the immediate post-operative recovery period and the experience of surgical pain, the participants' returned to their baseline pain status, likely related to other chronic conditions. The expectation usually set at the time of discharge that patients may resume normal activities within two to four weeks may not reflect the significant impairment in health status reported at baseline, and the time required to experience an improvement in daily functioning, especially in the social realm.

The finding that the participants reported poorer PROs than that of the CaMOS normative population is difficult to explain, but it is conceivable that the underlying disease processes and the multiple adaptation issues related to living with an ICD play a role in producing these

relatively large differences. Of interest, the small difference in the mental health scores may further suggest that the current focus on psychological functioning, expressed in the ICD PRO literature, might not be the area of primary concern for these patients, or the area of intervention that might yield readjustment to Canadian normative levels, something attainable for many of these patients, especially those with secondary indication. We lack the longitudinal follow-up to assess whether people's longer term trajectory brings their PROs closer to that of the CaMOS normative population. We can speculate that even for potentially asymptomatic patients, such as people who have received an ICD in the relative absence of concomitant health problems, there may be a tendency to exhibit characteristics of the "worried well", the behaviours associated with health-related anxiety in the absence of active disease or threat (Handy, 2006; Nakayachi, 2012; Pidgeon, Kasperson, & Slovic, 2003). The ICD is protective against a "dormant" threat, the potential risk of a ventricular arrhythmia causing a cardiac arrest. The device is visible, palpable, and requires monitoring; thus, it is not "invisible' from people's lives, and may remind them of their vulnerability to an unpredictable life-threatening event. Before the decision to implant a device is made, most people must undergo multiple diagnostic testing, and consult with many medical specialists. In addition to managing their underlying disease(s), this intense scrutiny and the ensuing conversations about the risk of sudden cardiac arrest may seriously influence people's thinking about their overall health, and cause them to appraise their health status as "under threat".

In this discussion of the minimal important difference in PROs, and the interpretation of the SF-36v2 findings of our study, we established that the participants reported poorer PROs than the average, urban-dwelling Canadian, although there appeared to be 'real' important

improvements in their PROs, over the follow-up period. In the following section, we discuss some potential mechanisms to explain why the participants reported improved PROs.

6.4.2. Possible Explanations for the Observed Improvements in the Patient-Reported Outcomes

Although our study had limitations, we established that there was overall improvement in the sample's mean scores, over time and for all the outcomes assessed. This finding warrants some discussion of the factors that may have influenced the patients' reported experiences after their ICD implantation. In particular, we discuss the need for measurement invariance (equivalence) and the effect of the ICD as a safety device.

Lack of Measurement Invariance

The potential effects of response shift and differential item functioning as factors related to a lack of measurement invariance merit some attention to frame the discussion of some possible explanations of the study findings. We discuss these two phenomena in turn.

Response Shift

The medical recommendation and the decision to undergo ICD implantation mark a significant milestone in people's treatment of their heart disease (Clark et al., 2011). The patient education provided by nurses, and the discussions between a patient and an electrophysiologist at the time of referral and during the consenting process, centre on the patient's high risk for death due to sudden cardiac arrest, and the risks and benefits of the device. Before these conversations occur, the patient might have survived a primary event that required rapid resuscitation and critical care, and for which there would be a sense of feeling "extremely lucky" to have survived. Although this catastrophic event may have significant adverse effects on many aspects of the affected person's daily life, including some residual neuro-cognitive changes, a need for

extensive convalescence, and the possible requirement for change in occupation, the individual may view the ICD implantation as a mere "inconvenience" or adjunct therapy that pales in implication when compared with their survival from a cardiac arrest. This perspective may be the context for current quality of life assessments. In another scenario, a patient with a long history of severe coronary artery disease and heart failure may decide to undergo ICD implantation in response to an electrophysiologist's recommendation that the device would provide some measure of 'safety' and would likely lead to a longer life. The patient may conclude that having an ICD is similar to buying life insurance, affording a new lease on a longer life, and allowing daily life to be managed with greater ease and satisfaction. This greater sense of personal safety may reframe the patient's quality of life assessments, and may influence the answers given to health status questions. Yet another patient may hear an electrophysiologist explain how the heart is "stretched out, boggy, and not pumping well" and is causing the conduction in the cells "to short-circuit and cause a heart rhythm that could make the heart stop." In spite of the assurance that the ICD will recognise and treat a ventricular arrhythmia should one occur, the patient reveals that it feels like "being on death row", with a "ticking time bomb" under the shoulder blades.[44]

The varying perspectives of ICD patients and the device's placement in the continuum of their medical histories and daily lives raise the issue of whether patients "reset their clocks" or shift in how they report their health status before and after surgery. It is likely that people revise their health status standards or their priorities after significant medical events (Galenkamp, Huisman, Braam, & Deeg, 2012). This phenomenon, known as response shift, is a challenge in the interpretation of PRO research findings.

[44] All anecdotes are based on conversations held with ICD patients.

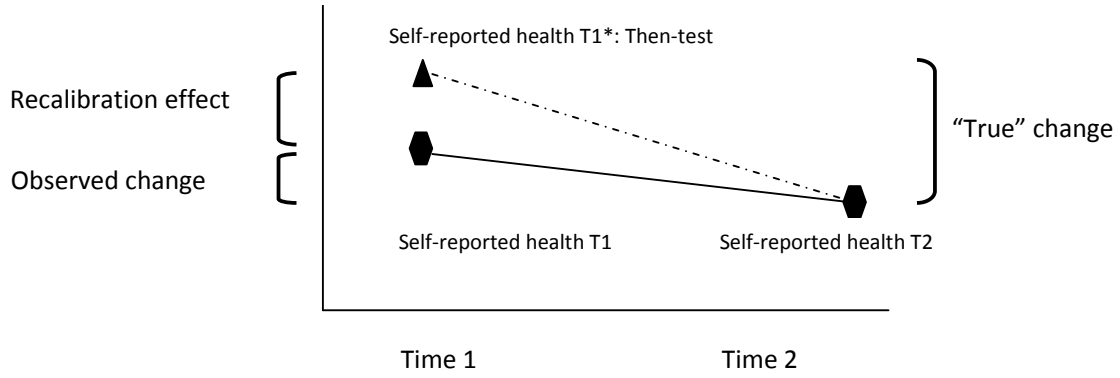
In their theoretical model, which attempts to explain when response shift might occur, including its antecedents and mechanisms, and which supports the integration of response shift in health-related quality of life research, Sprangers and Schwartz (1999) defined the process as a change in the meaning of an individual's PRO. Response shift includes three components: (a) recalibration (i.e., a change in a person's personal standard of measurement), (b) reprioritisation (i.e., a change in the value or importance of a domain of PROs), and (c) reconceptualisation (i.e., a change of the target construct) (Kvam, Wisloff, & Fayers, 2010; Sprangers & Schwartz, 1999). This adaptive process, studied in cancer patients mostly (Andrykowski, Donovan, & Jacobsen, 2009; Sharpe, Butow, Smith, McConnell, & Clarke, 2005), poses a significant challenge in the interpretation of PRO findings (Kvam et al., 2010). The study of response shift originated in education studies, and is in its infancy in health research (Razmjou, Schwartz, Yee, & Finkelstein, 2009; Schwartz et al., 2006). A meta-analysis by Schwartz et al. (2006) suggested that response shift may play a significant role in PRO research, and that the direction (i.e., positive vs. negative perception) of the shift varied across studies. The authors concluded, however, that the magnitude and importance of the phenomenon remains unresolved in current PRO research. To date, there have been few studies completed that inform the discussion about the measurement, evaluation, and implications of response shift, and its discerning features, including how it differs from recall bias (McPhail & Haines, 2010).

Although response shift may be beneficial to patients and may reflect a positive adaptive process, it has the potential to produce inaccurate assessments of change in PROs (McPhail & Haines, 2010). To assess response shift, various methodological approaches have been suggested, including individualised, preference-based, and successive comparison methods, and research design and statistical methods (Schwartz & Sprangers, 1999). A detailed discussion of

the merits of these approaches is beyond the scope of this work, but the use of the "then-test" warrants some discussion because of the uptake in current research and its potential implications for future research in the area of interest.

The then-test refers to the psychometrically-driven selection and administration of entire measures or scale items where response shift would be expected to occur (e.g., most subjective outcomes) to minimise the patient's burden while ensuring the selection of the items potentially most sensitive to response shift. Participants are asked to retrospectively re-evaluate their baseline or earlier health status during a follow-up measurement occasion (Schwartz & Sprangers, 1999). In a simple two wave study design, the score difference obtained between Time 1 and Time 2 (observed change) is compared with the difference between the when-test for Time 1 and the Time 2 score. The spread between Time 2 and the then-test represents the response shift effect (Galenkamp et al., 2012; Kvam et al., 2010). The graphic representation of response shift by Galenkamp et al. (2012), conceptualised as a recalibration effect, is a helpful illustration of the process at play (see Figure 6-1).

Figure 6-1: An Example of Change in Self-Reported Health Status and the Effect of Response Shift due to Recalibration



Note. T1 = Time 1; T2 = Time 2; T1* = the then-test at Time 1. From Galenkamp et al., (2012).

In our study, we did not include a then-test or another method to measure response shift. Our findings of overall improvement in group PROs and the existence of different trajectories for men and women must be interpreted within the context of this limitation. As we outlined in the introduction to this section, the antecedent medical events that frame people's PROs at the time of surgery represent a potentially significant variable that may reset their internal standards, values, and conceptualisations, and shift their responses in subsequent measurement occasions. Patients have reported becoming used to the sight and feeling of an ICD under their skin as their incisional scar heals, and lessening their vigilant attention to potential shocks as time goes by (Palacios-Cena et al., 2011). In addition to decreasing device-related anxiety and increasing device acceptance, it is possible that the process of getting used to the feeling of the implanted device, trust, and new knowledge in its functioning, or habituation, may further affect people's retrospective perceptions of their physical, mental and social health status at the time of initial implantation. For the 72 (42.1%) participants who were urgent in-patients at the time of their ICD implantation, it is conceivable that they retrospectively evaluated their baseline status as far worse or far better than they perceived at the time of their baseline assessment, after better

understanding the implications of their admission diagnosis. Similarly, the retrospective evaluation of health status could shift over the course of a six-month follow-up.

The nature of comparisons over time and the question of whether response shift was operational in this study remains unanswered, which is the prevailing challenge in most longitudinal PRO research (McPhail & Haines, 2010). Those who have argued that response shift is of concern believe that people use a former state as a referent when they are asked to make an assessment of their current status. This might not always be the case. For example, Kelly and Ratner (2005) concluded that people use different referents; some make comparisons with other people (a few, an ideal person, or many) rather than with their former self. The clinical importance of response shift remains under debate; for example, it is possible that response shift may affect men and women differently. Further research is required to understand the mechanisms and implications in this patient population, and to identify appropriate remedies.

Differential Item Functioning

A person's response to an item of a PRO instrument can be influenced by both the person's health status and confounded by another construct-irrelevant factor, such as sex/gender, age, or ethnicity. An item functions differently if two people with the same health status do not share the same probability of endorsing an item related to that health status in a similar way, meaning that the scoring or metric of the item will not be comparable for groups of people. This phenomenon is known as differential item functioning (DIF), and can threaten the validity of a measure (Perkins, Stump, Monahan, & McHorney, 2006; Sawatzky, Ratner, Kopec, & Zumbo, 2012). Instruments that contain DIF items may invalidate the findings of between-group comparisons because the scores may unequally reflect attributes other than the construct that is intended to be measured, and thus exaggerate or diminish "true" differences between the groups

(Collins, Raju, & Edwards, 2000; Perkins et al., 2006). Various statistical techniques have been advocated to examine DIF, including confirmatory factor analysis of parameter invariance, logistic regression approaches, and item response theory DIF analysis techniques (Sawatzky et al., 2012).

The sample size, unequal representation of men and women, a focus on total scores, and other limitations constrain our ability to comment definitively on the possibility of DIF in our study; however, we can look to existing research to ascertain whether men and women respond differently to the questions we employed in our PRO assessments.

In spite of the extensive use of the SF-36 instrument in clinical trials and other studies, and the examination of its psychometric properties, discussed in Chapter 4, the assessment of potential DIF in the 36 items is lacking in the literature, especially DIF related to sex/gender (Perkins et al., 2006). The current heightened interest in item response theory and computer adaptive testing will likely yield helpful directions in the future, but we presently can only gain limited insight into the impact of DIF on the SF-36 and other instruments. In a study of demographic comparisons and DIF in the SF-36 using U.S. national data sets with different population characteristics, Perkins et al. (2006) found that age comparisons could be compromised by DIF, with older and younger people answering 12 of the 36 questions significantly differently regardless of health status, whereas no items were identified for sex/gender-based DIF. Overall, the effects of DIF did not transfer to the scale level (Perkins et al., 2006). In a study of DIF in a Danish translation of the SF-36, Bjorner, Kreiner, Ware, Damsgaard, and Bech (1998) found that 12 of the 35 items exhibited cross-language DIF (i.e., English-language vs. Danish-language versions), which had little impact at the scale level. Although raising a cautionary warning about the potential bias of using single items, they

concluded that DIF was not an invalidating threat to the use of the SF-36 in cross-national comparisons.

The evaluation of DIF among key demographic and clinical groups in the Patient-Reported Outcomes Measurement Information System (PROMIS) is an important component of the psychometric evaluation and calibration of the item banks, and focuses on the generation of DIF hypotheses through qualitative analyses, and the evaluation of presence, magnitude, and impact of DIF using item-response theory-based and other methods (Reeve et al., 2007). In a study of measurement invariance in the PROs of people with disabilities that used six PROMIS short form measures, including the Satisfaction with Participation in Social Roles and the Sleep Disturbance short forms used in this study, Cook, Bamer, Amtmann, Molton, and Jensen (2012) found negligible age- or diagnosis-related DIF (in almost 2,500 people with spinal cord injuries, muscular dystrophy, postpolio syndrome, or multiple sclerosis). They concluded that the use of the PROMIS short forms was valid in the measurement of PROs across age groups and different diagnoses. These findings failed to include cardiovascular patients, and did not apply a sex/gender lens, but nevertheless suggest that DIF may not play a significant role in the validity of the PROMIS short forms. The absence of research related to DIF in the Florida Shock Anxiety Scale and Florida Patient Acceptance Survey prevents us from commenting on the role of DIF in these measures, and is an area in need of further research.

Improved Personal Safety

In Chapter 3, we conceptualised the ICD as a safety device, adjunctive to the biological function component of the Wilson and Cleary (1995) framework that underpins this study. As discussed, the ICD does not treat the underlying heart disease that increases people's risk for a sudden cardiac arrest, but provides prophylactic safety should the patient develop a potentially

fatal ventricular arrhythmia. This discerning characteristic of the ICD, in addition to the nature of the electric shock therapy it administers, is a unique feature of the treatment modality. The improvement in scores seen in all PROs in our study cannot be explained by the mechanisms of conventional cardiac interventions, such as improved cardiac output due to a new medication, bypass graft surgery, valve replacement, or pacemaker. The ICD, *per se*, does not physiologically improve biological function, symptoms, or physical functioning. Yet, we saw convincingly strong evidence of improved physical, mental, and social health outcomes in most participants' early recovery after ICD implantation. We believe that the added safety afforded by the ICD may explain this phenomenon, at least in part.

The study of change in perceived personal safety has not been a major focus of PRO research in people with ICDs. A cursory exploratory assessment of the data we collected from the open-ended questions about people's experiences of living with an ICD suggested that many participants had a similar appraisal of the effects of the device on their sense of personal safety. In a preliminary exploration of the responses received to the question, "In what ways has your defibrillator changed your life?" we noted multiple and repeated comments related to feelings of increased personal safety, including those provided in Figure 6-2.

Figure 6-2: Statements Made by the Participants about the Increased Personal Safety Afforded by their ICD

In what ways has your defibrillator changed your life?	Measurement occasion
"I feel more confident about my heart health since I got the defibrillator".	1 Month
"Giving me more confidence day to day".	1 Month
"None, except feeling safer".	1 Month
"I feel safer from the knowledge that I will be able to care for my husband here at home knowing that I have the ICD".	1 Month
"I have peace of mind".	1 Month
"Feeling a lot calmer regarding heart problems".	1 Month
"I feel safer and more protected".	1 Month
"I don't worry about dropping dead of a heart attack".	1 Month
"Less worries".	2 Months
"I feel assured that if I have any problems that the ICD would work and I can get medical help".	2 Months
"I feel more secure. I feel that it has improved my health and life".	2 Months
"More confidence I won't drop dead. It fills me with hope of a normal life".	2 Months
"It has given some hope that I will remain alive after damage caused by the cardiac arrest".	6 Months
"I know it's just there – but I am feeling better just all of a sudden".	6 Months
"I'm just not as worried about my heart".	6 Months
"It took a very long time to get used to even the idea of the ICD, but with my condition, I feel much safer having the ICD, than not having it, and I know I am a lot safer now, and I take comfort in that".	6 Months
"It will save my life and I have the peace of mind that it will continue to do so".	6 Months

The two device-specific instruments selected to capture the ICD-related PROs identified in the literature review were the Florida Shock Anxiety Scale (Kuhl et al., 2006) and the Florida Patient Acceptance Survey (Burns et al., 2005). The Florida Shock Anxiety Scale focuses on the fears people with ICDs may experience related to physical activities, thoughts and emotions, and social behaviours (e.g., fear of exercise, of being alone, of anger, of touching, of creating a scene, of unwanted thoughts), and the Florida Patient Acceptance Survey provides an inventory of items related to the impact of the ICD on the return to daily functioning, device-related distress, self-appraisal of the device, and body image concerns. Although both instruments encompass

items that describe the multidimensional aspects of physical, mental and social personal safety, the only item which directly refers to "safety" is "I am safer from harm because of my device" in the Florida Patient Acceptance Survey. Other terms such as "I am confident", "I am careful", and "I am concerned" may be interpreted in a similar fashion, but fail to fully capture people's appraisals of the ICD as a safety device.

To date, clinicians and researchers have stressed the importance of measuring people's responses to shocks, and managing the negative consequences of ICD-related anxiety and impaired device acceptance. The presence of improved outcomes in the absence of cardiovascular physiological changes found in this study highlights an opportunity to further explore whether people's heightened sense of personal safety may improve their PROs following ICD implantation. This evidence could significantly inform patient teaching initiatives in device clinics, which currently emphasise the management of ICD-related anxiety, the implementation of a shock plan, and teaching about daily activities. Interventions to support patients to frame the device as providing a higher degree of personal safety, regardless of the administration of shocks, driving and other activity restrictions, and other issues such as risk for manufacturers' advisories and implications for body image, might contribute to improving PROs for this population. To this end, it is necessary to better measure the construct of the ICD as a personal safety device, study whether people's appraisals of their safety are associated with their health outcomes, and design and evaluate interventions to maximise the pre-operative, recovery and longer-term experience of the safety benefits of the ICD. Further research is required to investigate the value of this hypothesis; the potential for informing clinical practice represents an exciting opportunity.

6.4.3. Men's and Women's Trajectories of Change in Health Status

We found compelling evidence that men and women differ in their trajectories of change, both in terms of their starting points (i.e., baseline scores) and their rates of change. For 6 of the 12 examined PROs, women consistently had lower scores at baseline, compared with the men's, and improved at a faster rate, such that they either matched or exceeded the men's average scores at the 6-month measurement occasion. Although this finding echoes the evidence in the literature that men and women experience different outcomes following ICD implantation, we believe that this is the first study to demonstrate differences in the trajectories (i.e., the rates of change) between the two groups. The unique consistency of this finding – encompassing one physical, two mental, and three social health status PROs – was not anticipated, as we hypothesised that other theoretically-driven predictors such as age, indication, and urgency would also contribute to differences in change. Given the limitations of the study, the discussion about the potential reasons for this marked difference is solely speculative, but may nevertheless inform future research and clinical practice. In particular, we explore our findings within the context of existing evidence related to the differences in the recovery patterns and rates of men and women. That is, the observed differences may have arisen for methodological reasons (sex/gender-based differences in measurement), which would have implications for future research, or for substantive reasons, which would have implications for clinical programming.

Lacking evidence that DIF likely explained why the men and women of this study differed in their baseline PROs and their trajectories of change, we hypothesise that the two groups might have had truly different levels of health status before their ICD implantation and rates of change in the early recovery period. To date, the limited research available on sex/gender differences has highlighted that although sudden cardiac death is less prevalent in women, at all ages, and occurs, on average, 10 years later in women than in men (Ghani et al., 2011), women

with ICDs generally experience more anxiety and poorer quality of life than do men, although many of these studies have been inconclusive about the effects of sex/gender (Brouwers et al., 2011). Our study adds to this evidence by suggesting that not only do men and women differ in their PROs, but that the rate of any change that they experience, over time, is different.

This finding is congruent with research of other health conditions, which describes women's faster rates of recovery. For example, after standard knee arthroplasty, and in spite of greater functional limitations at the time of surgery, women were found to recover faster, gained better joint function, and experienced less pain in the early recovery period, compared with men (Liebs, Herzberg, Roth-Kroeger, Ruther, & Hassenpflug, 2011). Similarly, cerebrovascular stroke is known to have a greater effect on women than men because women experience worse strokes, and have lower baseline functional status at the time of their event, likely due to their advanced age. Yet, being female has not been found to be an independent factor for negative outcomes. Indeed, Caso et al. (2010) reported that women tended to recover as well or better than men in spite of having worse stroke pathologies. The reasons for this paradox remain unknown. Similarly, in a study of sex differences in the rate of fatigue development and recovery following musculoskeletal injury in the workplace, Albert, Wrigley, McLean, and Sleivert (2006) found that men experienced a greater relative loss of muscle strength, a higher rate of fatigue development, and a reduced capacity to maintain fatiguing contractions in their lower limbs, compared with women, thus decreasing their physical capacity and slowing their recovery. Overall, the women were found to be more fatigue resistant and demonstrated an enhanced ability to maintain their musculoskeletal force levels.

The reasons for these differences are currently not known, and more research is required to understand the mechanisms underpinning the different trajectories. Of interest, there is a

current debate about the comparative health vulnerabilities between men and women. In a provocative editorial in *Gender Medicine,* Legato (2007) asked "How much do we really care about men?" She remarked that men have been "socialized to minimize anxiety, to press ahead, to focus on the job at hand and not their physical wellbeing" although "men are as anxious about frailty, aging, and death as women are" (p. 285). At every age, and in almost all countries, women have a lower risk of mortality compared with men. This gap is widening (Kraemer, 2000). Men die from coronary artery disease and cancer in disproportionately higher rates than women (Solomon, Noll, & Guttman, 2008).

There are likely multiple complex reasons for this difference. For example, geneticists have remarked that women's duplicate X chromosome may afford some degree of biological protection in the expression of diseases, whereas XY males may be more vulnerable to some genetic mutations (Migeon, 2007). Zoologists have argued that there is a "cost" associated with testosterone, that results in high energy use costs, reduced fat stores, increased injury and mortality, and suppression of immunity (Wingfield, Lynn, & Soma, 2001). In addition, social and cultural attitudes, values and beliefs may add "social insult to biological injury" (Kraemer, 2000, p. 1609). Compared with girls, boys experience more developmental disorders, exhibit more misjudgement of risk, have less emotional vocabulary to express emotions, experiences, and need for help, and are more likely to avoid contact with people when they feel stressed. Later in life, men are less likely to recognise symptoms or other indicators of illness, and less likely to talk to others about their health concerns or to seek medical attention (Kraemer, 2000).

Further discussion or speculation about the mechanisms at play is beyond the scope of this project. Nevertheless, we recognise the complexity of the multiple factors that may influence sex/gender differences in the early recovery phase after ICD implantation. From a clinical

perspective, it is important to further study why women report poorer health status, and develop interventions to support them, at the time of implantation, to optimise their surgical outcomes and their transition home. It is equally important for clinicians to better understand if the slower rate of improvement identified in men reflects a worrisome pattern of poor longer term PROs that may benefit from interventions timed during this potentially more challenging adaptation phase. To answer these questions, sex/gender-focused research, designed and powered to identify the predictors of men's and women's trajectories of change, over a longer follow-up phase, is needed to better understand the potential reasons for and patterns of change in PROs after ICD implantation.

6.5. Clinical Implications and Future Research

The inter-professional healthcare team involved in ICD-related patient and family education, decision support, consent, discharging planning and support, and follow-up will be interested in our findings that the implantation of an ICD is a significant event marked by relatively poor PROs at the time of surgery that improve during the recovery period. In addition, people with ICDs report significantly poorer health status compared with the average, adult, urban-dwelling Canadian, although they generally achieve substantial improvements, over time, in all of the domains of health status studied here, and for each measurement occasion. This finding should inform clinicians' communication with patients who require an ICD to prepare them for the anticipated trajectory of change; that is, that substantial improvement is experienced by most patients. It may inform patient education and support interventions to facilitate the recovery phase, especially in terms of social functioning.

Research questions that could be asked in the future relate to fully testing the Wilson and Cleary (1995) conceptual framework in the ICD population, refining the identification of salient

predictors of change in health status after ICD implantation, the sex/gender-based trajectories of change, the effect of response shift, and patients' experiences of the ICD as a means of achieving greater personal safety. We discuss these in turn.

The Wilson and Cleary (1995) framework provided a helpful anchor for the selection of the PROs and the testing of theoretically-driven predictors, and the conceptualisation of PROs in the continuum of biological function, symptoms, functional status, general health perceptions and overall quality of life. We captured the principal elements that drive patients' overall outcomes, but future research, which takes these variables into account, will need to be undertaken to establish the conceptual relationships proposed by Wilson and Cleary.

In our study, only sex/gender emerged as a consistent predictor of the PRO trajectories. As we discussed, other theoretically-driven predictors failed to explain people's patterns of change after receiving an ICD. It is possible that we committed a Type II error due to our sample size and other study limitations. As discussed previously, we identified very diverse individual trajectories. Because of the exploratory nature of our study, we selected a statistical significance level of $< .10$ for the main effects to lower the risk of a Type II error. It may have been defensible to have reduced the risk of Type II further by accepting an even higher than conventional risk for Type I error (e.g., a statistical significance level of $< .25$ for the residual variances). Statistical simulation studies may be warranted to explore this issue further.

However, more research on this topic is required before the association between the theoretically-derived predictor variables proposed in this study and PROs in the ICD population is more clearly understood. In future investigations, it might be possible to include stronger markers of biological function, including left ventricular ejection fraction, and to further explore

the predictive value of the experience of ICD shocks and clinical indication. These are important issues for future research.

In our study, we failed to focus on the participants who did not improve. The sample of linear individual growth trajectories graph of 30 randomly-selected participants (see Figure 5-3) showed that some people retained poor scores, or had worsening PROs over the course of the study. We were limited by our sample size and our analytical approach to capture this pattern of change (the residual variance that persisted represented these ill fitted cases). Future research is recommended to focus on the individual growth modelling of people who experience poor PROs after ICD implantation, and to identify predictors of membership in this pattern of change.

To further understand how men and women differ in their trajectories of change, it would be informative to conduct a more detailed exploration of the findings at the item level, rather than rely on scale scores. The findings suggested that the dimension of social health status might be the prevailing area of difference. The examination of the greatest differences in the scale items might lead to the emergence of evidence of other domains in which men and women differ in their experiences. In addition, research about longer-term outcomes would inform the shape of the change trajectories and allow us to answer the question about whether women simply 'catch up' to men in their PROs, or continue to improve, and whether the slower rate of improvement for men signals negative longer-term outcomes. It is feasible that there might be differences between the early recovery phase, studied in this project, and the longer-term adaptation related to living with a permanent device. Further work is required to establish this.

We currently lack an understanding of the effects of response shift in the trajectories of change after ICD. Research is needed to understand the potential mechanisms of people's re-evaluation of their PROs, and whether there is a "re-setting of the clock" or shift in how people

perceive their health status once they begin to live with an ICD. This is pivotal information for clinicians who need evidence to anchor their assessments and on-going monitoring, and to guide the timing and evaluation of interventions. To this end, researchers will need to select the optimal method to evaluate response shift, including those proposed by Schwartz (1999). For example, the use of the then-test might offer a simple way to explore whether response shift is present, and the direction (i.e., better or worse PROs) in which it influences people's perceptions of their health status.

Further research should be conducted to investigate the potential contribution of measuring people's perceptions of the personal safety afforded by the ICD, and whether this factor plays a role in their PROs. This research could complement the current use of the ICD-specific PRO measures of device acceptance and shock anxiety, and might help to further elucidate the individual trajectories of change identified in this study. These findings could inform the development and delivery of patient education, and interventions aimed at framing people's perceptions and their responses to the ICD as a safety device.

6.6. Conclusions

The ICD offers effective protection from the devastating effects of sudden cardiac arrest in people with various heart conditions, without offering additional treatment benefits, such as increased physiological cardiac function. It is a unique and permanent treatment modality that may deliver unpredictable electric shocks to restore normal electrical conduction in the heart, or can remain "dormant" for the duration of a person's life. The device's visible and palpable presence under the skin, the requirements for on-going monitoring, and the regular lifetime need for device component replacement, contribute to people's experiences of on-going 'interaction" with their ICD. This is unlike other cardiovascular interventions such as coronary

revascularisation or valve replacement. Thus, it is pivotal to directly measure patients' experiences to assess how they report their health status as they learn to live with the device. The measurement of PROs can support clinicians' assessment, and support the development of timed and targeted interventions to support groups of patients who may be at higher risk for experiencing poor outcomes.

The purpose of our research was to identify the presence and direction of change in PROs after ICD, and to explore the existence and predictors of individual trajectories of change. We found that the implantation of an ICD was not a "benign" intervention, and resulted in important differences in patients' PROs during the initial 6-month recovery period, with most people improving over time. Most strikingly, we identified significantly different individual trajectories of change for men and women for 6 of the 12 measured PROs, Overall, women presented with poorer health status, compared with men, before surgery, but improved at a faster rate, meeting or exceeding men's scores in six months' time. We cautiously conclude that researchers and clinicians cannot assume that men and women experience the same trajectories of change when their condition warrants an ICD, especially in terms of their social health. We failed to identify a consistent relationship between other theoretically-derived variables and the PRO trajectories, including the patients' age, social support, employment status, access to specialised medical services, their health history indication for implantation, or their self-reported history of ICD shocks.

We recommended that further research be conducted to address the limitations of our study, and the questions raised by our findings. In particular, we stress the importance of further investigation of the social dimensions of PROs, as these emerged as important indicators of self-reported health and have not been the focus of research to date. More research must be

undertaken on the differences between men's and women's trajectories of change before the association between sex/gender and PROs in people with ICDs is more clearly understood.

The findings of this study are pertinent to clinicians who provide care to patients with heart disease who are at high risk of dying after sudden cardiac arrest. We demonstrated that the inclusion of PRO findings adds new evidence to the evaluation of outcomes following ICD. Clinicians can potentially anticipate that most of their patients will experience impaired PROs at the time of implantation, and will gradually improve over time albeit not at the level of health status reported by most urban-dwelling Canadian adults. They may also expect men and women to present differently at the time of surgery, and to change at different rates. This new knowledge may offer opportunities to support decision making and informed consent, to improve patient and family teaching, and to test interventions aimed at supporting patients as they adapt to living with an ICD for the duration of their lives.

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Appendices

Appendix A: Literature Search Strategies

Search date: August 3, 2012
Databases searched: PUBMED. EMBASE, CINAHL, PsychINFO

Ovid MEDLINE
Filters:
Publication dates: January 1, 1997 to August 3, 2012
Species: Humans
Language: English

	Concept	Keywords or MeSH Term	Citations
1	Quality of life	"Quality of life" OR "QOL"	107,283
2	Health-related quality of life	"Health related quality of life" OR "HRQOL" OR "HRQL"	14,969
3	Patient-reported outcome	"Patient-reported outcome" OR "Patient-reported outcomes"	1,819
4 (1-3)	Quality of life, health-related quality of life, or patient-reported outcome	"Quality of life" OR "QOL" OR "Health related quality of life" OR "HRQOL" OR "HRQL" OR "Patient-reported outcome" OR "Patient-reported outcomes"	108,116
5	Implantable cardioverter-defibrillator	"Defibrillators, implantable" OR "implantable cardioverter-defibrillator"	8.075
6 (4-5)	Quality of life, health-related quality of life, or patient-reported outcome AND Implantable cardioverter-defibrillator	("Quality of life" OR "QOL" OR "Health related quality of life" OR "HRQOL" OR "HRQL" OR "Patient-reported outcome" OR "Patient-reported outcomes") AND ("Defibrillators, implantable" OR "implantable cardioverter-defibrillator")	680

Appendix B: Consent Form

HEART CENTRE
PROVIDENCE HEALTH CARE

UBC

Consent Form

Heart and Health Experiences of Living with a Defibrillator
Heart-HELD Study

Principal investigator: Pamela A. Ratner, PhD, RN, FCAHS
Professor – UBC School of Nursing

Co-investigators: Sandra Lauck, MSN, RN
Doctoral student – UBC School of Nursing – Dissertation research project
Clinical Nurse Specialist – The Heart Centre

Karin Humphries, PhD
Associate Professor – UBC Faculty of Medicine

Joy L. Johnson, PhD, RN, FCAHS
Professor – UBC School of Nursing

Richard G. Sawatzky, PhD, RN
Associate Professor – Trinity Western University

Purpose of study:

- You are being invited to participate in this study to help us understand people's experiences living with a cardiac defibrillator.
- Your doctor has recommended that you receive an implantable cardioverter-defibrillator (ICD or defibrillator) because of your heart disease.
- Our goals are to:
    - Understand people's experiences in the first 12 months after receiving an ICD
    - Predict who needs additional support to cope with an ICD
    - Determine when support is best provided.
- The results of the study will help us implement supportive programs to strengthen people's capacity to have the best possible life with an ICD.
- This research project is part of Sandra Lauck's doctoral program at the University Of British Columbia School Of Nursing.

Study procedure:

- The study involves filling out questionnaires before your surgery, and after the ICD is implanted, at 1, 2, 6 and 12 months. It will take about 30 minutes of your time to complete the questionnaire, each time.
- If you agree to participate in the study, you will choose between completing the questionnaires using a secure website or a paper copy. You will receive the study envelope with instructions to access the website or the paper questionnaire from a member of the study team, either in person if you are at St. Paul's Hospital or by mail if you are home.
- You will either submit the survey electronically or return the questionnaire in a stamped self-addressed sealed envelope or to the nurse taking care of you.
- We will collect information from your hospital chart, including information about yourself and your medical history, and complete a questionnaire about your type of device, your medical history, your age, gender and city where you live. We will ask you additional questions about your education and employment.
- We plan on asking approximately 200 people to participate in this study.

Confidentiality:

Your confidentiality will be respected. Information that discloses your identity will not be released without your consent unless required by law or regulation. However, research records and medical records identifying you may be inspected in the presence of the investigator her designate, by representatives of the UBC-PHC Research Ethics Board for the purposes of monitoring the research. No records that identify you by name or initials will be allowed to leave the investigator's office.

Potential risks and benefits:

There is a potential risk that some questions might be emotionally upsetting. As your participation in the study is voluntary and there is no obligation to complete the study, you can choose at any point to not answer some or all of the questions. In addition, you can contact us if you wish to speak to a healthcare professional about any distress you might experience. There is no payment or reward for participating in this study.

You will not directly benefit from participating in this study.

Contact for information about the study:

If you have any questions or wish to receive more information about this study, you can contact Sandra Lauck at 604-682-2344 ext. 63749 or via pager at 604-252-4720.

Concerns about the rights of research participants:

If you have any concerns about your rights as a research subject and/or your experiences while participating in this study, contact the 'Research Subject Information Line in the University of British Columbia Office of Research Services' at 604-822-8598" or the Chair of the UBC-PHC Research Ethics Board at 604-682-2344 ext 63496.

Voluntary participation:
Your participation is entirely voluntary. You have the right to refuse to participate in this study. If you decide to participate, your decision is not binding and you may choose to withdraw from the study at any time without any negative consequences to the medical care, education, or other services you may receive from this clinic or this hospital.

CONSENT:

Your signature indicates that you consent to participate in this study. You will receive a copy of the signed and dated consent form for your records.

PARTICIPANT:

Participant's signature	Date
Printed name of participant	Telephone number

WITNESS:

Name of witness	Witness signature

RESEARCHER:

Printed name of primary investigator/designate d representative	Telephone number
Signature of primary investigator/designated representative	

Appendix C: Study Recruitment Brochure

HEART CENTRE

Heart-HELD Study

Heart and Health Experiences of Living with a Defibrillator

- Your doctor has recommended that you receive a defibrillator because of your heart disease.
- We are inviting you to participate in a study led by the UBC School of Nursing about your experiences living with a defibrillator.
- The purpose of the study is to understand people's experiences in the first 12 months after receiving a defibrillator, to help predict who needs additional support to cope with a defibrillator, and to determine when support is best provided.
- The study involves completing a questionnaire before your surgery, and then 1, 2, 6 and 12 months after you receive your defibrillator.
- If you are willing to be contacted about this study, please return this card to your cardiologist's secretary.

☐ I am interested in hearing more about participating in the Heart-HELD Study

- Name: _____ Telephone number: _____

Heart-HELD Study Interest Card 17.01.10

Appendix D: Baseline Questionnaire

HEART CENTRE
PROVIDENCE HEALTH CARE

Heart HELD Study

Heart and Health Experiences of Living with a Defibrillator

Thank you for participating in the Heart HELD Study to help us to better understand the experiences of living with a defibrillator. This survey deals with various aspects of your health and well-being, and asks you about such things as physical activity, social relationships and health status. By health, we mean not only the absence of disease but also physical, mental and social well-being.

Completing the survey will take about 20 minutes of your time, and will help us to understand how you adapt to living with your defibrillator. For each question, please give the one answer that comes closest to the way you have been feeling.

Because we are interested in your personal experience, some of the questions are of a personal nature. The answers you give are strictly confidential and will not be shared in any way that people would recognize you.

*To answer the question, please put an **X** in the box next to the answer that you want to choose. If you need to change your answer, you can simply put a line through your first answer and put an **X** in the box next to your new answer.*

Thank you for helping us to understand the experiences of people who need a defibrillator. Please complete and return this survey **as soon as possible in the stamped return envelope.** If you have any difficulties filling out this survey or have any questions, please contact Sandra Lauck.

1. How would you like to complete the questionnaires after your surgery?

- ☐ Paper questionnaire sent to me with a stamped return envelope
- ☐ By e-mail with an automatic link to a web address

  My e-mail address is: _____

The following questions ask how you feel about your quality of life, health, or other areas of your life. Please choose the answer that appears most appropriate. If you are unsure about which response to give to a question, the first response you think of is often the best one. Please keep in mind your standards, hopes, pleasures and concerns. We ask that you think about your life in the last four weeks.

2. How would you rate your quality of life?

- ☐ Very poor
- ☐ Poor
- ☐ Neither poor nor good
- ☐ Good
- ☐ Very good
- ☐ No answer

3. How satisfied are you with your health?

- ☐ Very dissatisfied
- ☐ Dissatisfied
- ☐ Neither satisfied nor dissatisfied
- ☐ Satisfied
- ☐ Very satisfied
- ☐ No answer

4. How satisfied are you with your life in general?

- ☐ Very satisfied
- ☐ Satisfied
- ☐ Neither satisfied nor dissatisfied
- ☐ Dissatisfied
- ☐ Very dissatisfied
- ☐ No answer

5. In general, would you say your health is:

- ☐ Excellent
- ☐ Very good
- ☐ Good
- ☐ Fair
- ☐ Poor
- ☐ No answer

6. Compared to one year ago, how would you rate your health in general now?

- ☐ Much better now than a year ago
- ☐ Somewhat better now than a year ago
- ☐ About the same as one year ago
- ☐ Somewhat worse now than one year ago
- ☐ Much worse now than one year ago
- ☐ No answer

7. The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

	Yes, limited a lot	Yes, limited a little	No, not limited at all	No answer
1) Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports	☐	☐	☐	☐
2) Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	☐	☐	☐	☐
3) Lifting or carrying groceries	☐	☐	☐	☐
4) Climbing several flights of stairs	☐	☐	☐	☐
5) Climbing one flight of stairs	☐	☐	☐	☐
6) Bending, kneeling or stooping	☐	☐	☐	☐
7) Walking more than a mile	☐	☐	☐	☐
8) Walking several hundred yards	☐	☐	☐	☐
9) Walking one hundred yards	☐	☐	☐	☐
10) Bathing or dressing yourself	☐	☐	☐	☐

8. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

	All of the time	Most of the time	Some of the time	A little of the time	None of the time	No answer
1) Cut down the amount of time you spent on work or other activities?	☐	☐	☐	☐	☐	☐
2) Accomplished less than you would like?	☐	☐	☐	☐	☐	☐

	All of the time	Most of the time	Some of the time	A little of the time	None of the time	No answer
3) Were limited in the kind of work or other activities?	☐	☐	☐	☐	☐	☐
4) Had difficulty performing the work or other activities (for example, it took extra time)?	☐	☐	☐	☐	☐	☐

9. During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

	All of the time	Most of the time	Some of the time	A little of the time	None of the time	No answer
1) Cut down on the amount of time you spent on work or other activities	☐	☐	☐	☐	☐	☐
2) Accomplished less than you would like	☐	☐	☐	☐	☐	☐
3) Did work or activities less carefully than usual	☐	☐	☐	☐	☐	☐

10. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbours, or groups?

- ☐ Not at all
- ☐ Slightly
- ☐ Moderately
- ☐ Quite a bit
- ☐ Extremely
- ☐ No answer

11. How much bodily pain have you had during the past 4 weeks?

- ☐ None
- ☐ Very mild
- ☐ Mild
- ☐ Moderate
- ☐ Severe
- ☐ Very severe
- ☐ No answer

12. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

- ☐ Not at all
- ☐ Slightly
- ☐ Moderately
- ☐ Quite a bit
- ☐ Extremely
- ☐ No answer

13. These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks...

	All of the time	Most of the time	Some of the time	A little of the time	None of the time	No answer
1) Did you feel full of life?	☐	☐	☐	☐	☐	☐
2) Have you been very nervous?	☐	☐	☐	☐	☐	☐
3) Have you felt so down in the dumps that nothing could cheer you up?	☐	☐	☐	☐	☐	☐
4) Have you felt calm and peaceful?	☐	☐	☐	☐	☐	☐

	All of the time	Most of the time	Some of the time	A little of the time	None of the time	No answer
5) Did you have a lot of energy?	☐	☐	☐	☐	☐	☐
6) Have you felt downhearted and depressed?	☐	☐	☐	☐	☐	☐
7) Did you feel worn out?	☐	☐	☐	☐	☐	☐
8) Have you been happy?	☐	☐	☐	☐	☐	☐
9) Did you feel tired?	☐	☐	☐	☐	☐	☐

14. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc...)?

- ☐ All of the time
- ☐ Most of the time
- ☐ Some of the time
- ☐ A little of the time
- ☐ None of the time
- ☐ No answer

15. How TRUE or FALSE is each of the following statements for you?

	Definitely true	Mostly true	Don't know	Mostly false	Definitely false	No answer
1) I seem to get sick a little easier than other people	☐	☐	☐	☐	☐	☐
2) I am as healthy as anybody I know	☐	☐	☐	☐	☐	☐
3) I expect my health to get	☐	☐	☐	☐	☐	☐

	worse					
4)	My health is excellent	☐	☐	☐	☐	☐	☐

16. The questions below refer to how you have felt and behaved during the last week.

		Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of the time (3-4 days)	Most or all of the time (5-7 days)	No answer
1)	I was bothered by things that don't usually bother me	☐	☐	☐	☐	☐
2)	I did not feel like eating; my appetite was poor	☐	☐	☐	☐	☐
3)	I felt that I could not shake off the blues even with the help of my family or friends	☐	☐	☐	☐	☐
4)	I felt that I was just as good as other people	☐	☐	☐	☐	☐
5)	I had trouble keeping my mind on what I was doing	☐	☐	☐	☐	☐
6)	I felt depressed	☐	☐	☐	☐	☐
7)	I felt everything I did was an effort	☐	☐	☐	☐	☐
8)	I felt hopeful about the future	☐	☐	☐	☐	☐
9)	I thought my life had	☐	☐	☐	☐	☐

	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of the time (3-4 days)	Most or all of the time (5-7 days)	No answer
been a failure					
10) I felt fearful	☐	☐	☐	☐	☐
11) My sleep was restless	☐	☐	☐	☐	☐
12) I was happy	☐	☐	☐	☐	☐
13) I talked less than usual	☐	☐	☐	☐	☐
14) I felt lonely	☐	☐	☐	☐	☐
15) People were unfriendly	☐	☐	☐	☐	☐
16) I enjoyed life	☐	☐	☐	☐	☐
17) I had crying spells	☐	☐	☐	☐	☐
18) I felt sad	☐	☐	☐	☐	☐
19) I felt that people disliked me	☐	☐	☐	☐	☐
20) I could not get "going"	☐	☐	☐	☐	☐

17. In the past 7 days...

	Not at all	A little bit	Somew hat	Quite a bit	No answer
1) I am satisfied with my ability to do things for my family	☐	☐	☐	☐	☐
2) I am satisfied with my ability to meet the needs of those who depend on me	☐	☐	☐	☐	☐

	Not at all	A little bit	Somew hat	Quite a bit	No answer
3) I am satisfied with my ability to perform my daily routines	☐	☐	☐	☐	☐
4) I am satisfied with my ability to run errands	☐	☐	☐	☐	☐
5) I am satisfied with my ability to work (include work at home)	☐	☐	☐	☐	☐
6) I am satisfied with my ability to do household chores/tasks	☐	☐	☐	☐	☐
7) I am satisfied with how much work I can do (include work at home)	☐	☐	☐	☐	☐

16. In the past 7 days...

	Not at all	A little bit	Somew hat	Quite a bit	Very much	No answer
1) I am satisfied with my ability to do things for fun at home (like reading, listening to music, etc…)	☐	☐	☐	☐	☐	☐
2) I am satisfied with my ability to do things for my friends	☐	☐	☐	☐	☐	☐
3) I am satisfied with my ability to do leisure activities	☐	☐	☐	☐	☐	☐
4) I am satisfied with the amount of time I spend doing leisure activities	☐	☐	☐	☐	☐	☐
5) I am satisfied with my current level of activities with my friends	☐	☐	☐	☐	☐	☐
6) I am satisfied with my current level of social activity	☐	☐	☐	☐	☐	☐
7) I am satisfied with my ability to do things for fun outside my home	☐	☐	☐	☐	☐	☐

17. In the past 7 days...

	Not at all	A little bit	Somewhat	Quite a bit	Very much	No answer

1) My sleep was restless	☐	☐	☐	☐	☐	☐
2) I was satisfied with my sleep	☐	☐	☐	☐	☐	☐
3) My sleep was refreshing	☐	☐	☐	☐	☐	☐
4) I had difficulty falling asleep	☐	☐	☐	☐	☐	☐

18. In the past 7 days...

	Never	Rarely	Sometimes	Often	Always	No answer
1) I had trouble staying asleep	☐	☐	☐	☐	☐	☐
2) I had trouble sleeping	☐	☐	☐	☐	☐	☐
3) I got enough sleep	☐	☐	☐	☐	☐	☐

19. In the past 7 days, my sleep quality was…

☐ Very poor
☐ Poor
☐ Fair
☐ Good
☐ Very good
☐ No answer

20. In the past 4 weeks, how many times have you seen a doctor?

_____ Doctor visits

21. In the past 4 weeks, how many times have you gone to an emergency department or have you been admitted to a hospital?

_____Trips to emergency department or admissions to the hospital

22. Is there anything that has happened in your life recently that impacts the way you have answered any of the questions in this survey?

_____
_____
_____

23. Is there anything else you would like us to know about you?

_____
_____
_____

We find it very helpful to describe who has taken part in our research. These last questions are about who you are.

24. What is the highest level of education you have obtained?

- ☐ High school
- ☐ Some trade, technical, vocational school or business college
- ☐ Some community college, CEGEP or nursing school
- ☐ Some university
- ☐ Diploma or certificate from community college, CEGEP or nursing school
- ☐ Bachelor's or undergraduate degree or teacher's college
- ☐ Master's degree
- ☐ Doctorate
- ☐ Other

25. What do you consider to be your current main activity? (for example, working for pay, caring for family)

- ☐ Caring for family
- ☐ Working for pay or profit
- ☐ Caring for family AND working for pay or profit
- ☐ Recovering from illness or disability
- ☐ Looking for work
- ☐ Retired
- ☐ Other

26. How many people live in your household? _____People

27. Are you:

- ☐ Single
- ☐ Married
- ☐ Common law
- ☐ Divorced
- ☐ Separated
- ☐ Widowed
- ☐ Other

28. Please estimate your household's total annual income before taxes. Again, we want you to know that all of your answers are confidential and will not be used to recognize you.

- ☐ Less than $39,999 per year
- ☐ Between $40,000 and $69,999 per year
- ☐ Between $70,000 and $99,999 per year
- ☐ More than $100,000 per year
- ☐ No answer

29. Please feel free to comment about completing this survey

_____

_____

_____

Thank you for taking the time to complete this survey. To be able to understand changes in the first months after receiving a defibrillator, we will contact you again 1, 2 and 6 months after your surgery to ask for your help in completing this study.

If you have any questions about this study, please contact Sandra Lauck.

Appendix E: Correlation Coefficients and Inter-Item Coefficients

Scale	Baseline		1 Month		2 Months		6 Months	
	α	IIC	α	IIC	α	IIC	α	IIC
SF-36v2 (Number of items)								
Physical Functioning (10)	.92	.52	.88	.42	.92	.52	.93	.57
Bodily Pain (2)	.88	.79	.89	.80	.92	.85	.90	.84
Mental Health (5)	.87	.58	.85	.54	.89	.62	.87	.58
Vitality (4)	.87	.63	.85	.58	.88	.64	.86	.61
Role Physical (4)	.94	.79	.94	.81	.95	.82	.94	.80
Role Emotional (3)	.93	.82	.91	.77	.93	.81	.93	.82
Social Functioning (2)	.84	.73	.80	.66	.90	.82	.88	.80
PROMIS								
Sleep Disturbance (7)	.93	.64	.94	.67	.93	.64	.94	.68
Satisfaction with Social Roles (7)	.95	.72	.96	.77	.96	.79	.95	.74
Satisfaction with Discretionary Social Activities (8)	.95	.74	.95	.74	.96	.76	.95	.74
ICD-Specific								
Florida Shock Anxiety Scale (10) *original scale*	N/A	N/A	.90	.47	.91	.49	.91	.48
Florida Shock Anxiety Scale (9)	N/A	N/A	.90	.51	.91	.52	.91	.52
Florida Patient Acceptance Scale (18) *original scale*	N/A	N/A	.86	.26	.88	.30	.88	.31
Florida Patient Acceptance Scale (12)	N/A	N/A	.84	.32	.88	.39	.86	.36

Note:
α: Cronbach's alpha
IIC: Mean inter-item correlation
N/A: Not applicable (scale not completed)