"Back on your feet in no time": Measuring the mobility levels of older adults during acute medical hospital stay

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Abstract

Aim

The main aim of this study was to describe the mobility levels of older adults during acute medical hospitalisation at Wellington Regional Hospital, New Zealand. The secondary aims were to explore associations between mobility levels during acute hospital stay and patient specific characteristics that had been identified by previous studies.

Study Design

This was a prospective observational cohort study.

Participants

Eighty-two community residing older adults admitted to Wellington Hospital for acute medical care were included in the study.

Main Outcome Measures

Mobility levels were measured using an accelerometer (StepWatch Monitor); participants donned the monitor within 24 hours of admission and wore it until discharge. The monitor recorded steps per day and time spent active. Step gain from first to last complete hospital day was calculated. Low mobility was defined as performing less than 1500 steps per day. Premorbid community mobility was measured by Life space and mobility aid use. Mobility status on admission was assessed using the Elderly Mobility Scale. Length of stay, input from occupational therapy and physiotherapy during admission, and mortality six months following discharge was recorded.

Results

Participants performed a median (IQR) of 1006 (+/- 938) steps per day. Participants spent 95.6% of each hospital day inactive, that is to say not walking. Two thirds of the sample took more steps on their last day than their first with a median (IQR) gain of 234 (+/- 812) steps. No statistical significant difference was found between premorbid community mobility, mobility status on admission, occupational or physiotherapy input during admission, or mortality six months following discharge. Participants with shorter periods of hospitalisation recorded statistically higher levels of mobility than those who were in hospital for longer (x^2=13.98, p=.007).

Conclusions

Older adults performed physiologically deterimental low levels of mobility during acute medical hospitalisation. Only length of stay was found to influence mobililty levels. The findings of this study concurs with previously published research and demonstrates that low mobility levels during acute hosptialisation is an international issue. This study contributes to previous research suggesting that low mobility levels during acute hospitalisation may be a common pathway leading to adverse health decline associated with acute hospitalisation.

Table of Contents

Abstract i
List of Figures vi
List of Tables vii
Attestation of Authorship viii
Acknowledgements ix
Chapter 1: Introduction 1
1.1 Outline of Study 4
1.2 Hypotheses 4
1.3 Delimitations 5
1.4 Limitations 5
1.5 Operational Definitions 5
Chapter 2: Literature Review 7
2.1 Introduction 7
2.2 Health of the Older Adult in Acute Care 7
2.2.1 Older Adults and Acute Hospitalisation 7
2.2.2 Disability Following Hospitalisation 8
2.2.3 Frailty 9
2.2.4 Section Summary 12
2.3 Geriatric Syndromes 13
2.3.1 Geriatric Syndromes and Frailty 13
2.3.2 Urinary Incontinence 14
2.3.3 Falls 15
2.3.4 Pressure Injury 16
2.3.5 Delirium 17
2.3.6 Hospitalisation-Associated Functional Decline 18
2.3.7 Section Summary 20
2.4 Older Adult Health and Mobility Levels 21
2.4.1 Mobility Level as a Risk Factor for Geriatric Syndromes 21
2.4.2 Increasing Mobility Levels During Hospitalisation 22
2.4.3 Section Summary 23
2.5 Mobility Levels During Acute Medical Hospitalisation 24
2.5.1 Observational Studies 24
2.5.2 Retrospective Reporting Studies 25
2.5.3 Accelerometer Studies 27
2.5.4 Wireless Activity Monitor Studies 29
2.5.5 Summary of Relevant Research 29
2.5.6 Section Summary 32
2.6 Defining Mobility Levels 32

2.6.1 Community Mobility Levels 33
2.6.2 Short Term Reduced Activity 34
2.6.3 Section Summary 35
2.7 General Summary 36
Chapter 3: Method 38
3.1 Introduction 38
3.2 Study Setting and Design 38
3.3 Participants 39
3.3.1 Inclusion Criteria 39
3.3.2 Exclusion Criteria 39
3.4 Recruitment 40
3.5 Ethical and Cultural Considerations 41
3.6 Instrumentation and Measures 42
3.6.1 StepWatch Step Activity Monitor 42
3.6.2 Anthropometric Measures 43
3.6.3 Life Space 44
3.6.4 Braden Risk Assessment Tool 46
3.6.5 Identification of Seniors at Risk Screening Tool 46
3.6.6 Elderly Mobility Scale 47
3.6.7 Clinical Diagnosis 48
3.6.8 Other Measures Recorded 48
3.7 Procedure 49
3.7.1 Staff Education 49
3.7.2 Commencement of Data Collection 49
3.7.3 Monitoring 50
3.7.4 Cessation of Data Collection 50
3.8 Data Management 51
3.9 Data Analysis 51
Chapter 4: Results 54
4.1 Introduction 54
4.2 Recruitment and Retention 54
4.3 Basic Cohort Characteristics 56
4.4 Mobility Levels During Hospitalisation 57
4.4.1 Steps Per Day 57
4.4.2 Time Spent Inactive 59
4.4.3 Step Change First to Last Day 60
4.4.4 Time Spent Active Change First to Last Day 60
4.4.5 Mobility Levels and Primary Objective 61
4.5 Relationship of Mobility Levels to Characteristics 61
4.5.1 Demographic and Pre-Admission Function Characteristics 62
4.5.1.1 Steps per day 62

4.5.1.2 Step change from first to last complete hospital day 65
4.5.2 Characteristics at Recruitment 67
4.5.2.1 Steps per day 67
4.5.2.2 Step change from first to last complete hospital day 69
4.5.3 Characteristics at Discharge 70
4.5.3.1 Steps per day 70
4.5.3.2 Step change from first to last day 73
4.5.4 Characteristics at Six Months 74
4.5.4.1 Steps per day 74
4.5.4.2 Step change from first to last complete hospital day 76
4.5.5 Mobility Levels and Secondary Objectives 78
4.6 Summary 80
Chapter 5: Discussion 82
5.1 Introduction 82
5.2 Study Sample 83
5.3 Reliability of Instrumentation and Results 85
5.4 Mobility Levels During Acute Hospital Stay 86
5.4.1 Comparison With Previous Research 86
5.4.2 Clinical Implications of Low Mobility Levels 87
5.5 Characteristics Influencing Mobility Levels 90
5.5.1 Premorbid Community Mobility 90
5.5.2 Mobility Status on admission 91
5.5.3 Physiotherapy and Occupational Therapy 91
5.5.4 Length of Stay 92
5.5.5 Six Month Mortality 93
5.5.6 Clinical Implications of Participant Characteristics Influencing Mobility Levels . 94
5.6 Future Research 95
5.7 Conclusion 96
References 98
Appendix A: Patient Information Sheet 119
Appendix B: Consent Form 122
Appendix C: Ethics Approval 123
Appendix D: Staff SAM Information 124
Appendix E: Data Collection Sheet 125
Appendix F: Patient SAM Information 128

List of Figures

Figure 2.1. Vulnerability of frail older adult to acute illness. Adapted from Clegg et al. (2013). 10

Figure 2.2. Cycle of frailty. Adapted from Fried et al. (2005). 11

Figure 2.3. Interaction of frailty and geriatric syndromes. Adapted from Inouye et al. (2007). 14

Figure 4.1. Participant recruitment and retention. 55

Figure 4.2. Percentage of participants steps per day in incremental bands 58

Figure 4.3. Median steps per day by complete hospital days 59

Figure 4.4. Percentage of participants time spent inactive 60

List of Tables

Table 2.1. Hospital Mobility Scoring System Developed by Brown et al. (2004) 26
Table 4.1. Basic Characteristics of Cohort...56
Table 4.2. Summary of Mobility Level Data for Cohort 57
Table 4.3. Steps per Day by Sex, Falls History and Life Space Maximum Level..........63
Table 4.4. Steps per Day by Age, Living Situation, Indoor Aid, Outdoor Aid and Life Space Independent Level 64
Table 4.5. Step Change From First to Last Day by Sex, Falls History and Life Space Maximum Level...65
Table 4.6. Step Change From First to Last Day by Age, Living Situation, Indoor Aid, Outdoor Aid and Life Space Independent Level..66
Table 4.7. Steps Per Day by Braden and ISAR...68
Table 4.8. Steps Per Day by BMI and EMS 68
Table 4.9. Step Change from First to Last Day by Braden and ISAR 69
Table 4.10. Step Change by BMI and EMS..69
Table 4.11. Steps per Day and Physiotherapy and Occupational Therapy Input During Hospitalisation..70
Table 4.12. Steps per Day by Diagnosis and Length of Stay...71
Table 4.13. Significance Testing of Length of Stay and Steps per Day 72
Table 4.14. Steps per Day by Number of Complete Hospital Days 72
Table 4.15. Step Change and Physiotherapy and Occupational Therapy Input During Hospitalisation..73
Table 4.16. Step Change from First to Last Complete Hospital Day by Diagnosis and Length of Stay 74
Table 4.17. Steps per Day by Readmissions 75
Table 4.18. Steps per Day by Mortality 76
Table 4.19. Step Change from First to Last Day by Readmission.................................77
Table 4.20. Step Change from First to Last Day by Mortality 78
Table 4.21. Benjamini-Hochberg Correction..80

Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgement), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Signed:

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Chapter 1: Introduction

Over the past 25 years the proportion of the New Zealand population over 65 years has doubled; it is projected that by 2061, 30% of the population will be over 65 years (Bascand, 2012). Whilst mirroring international trends, the rate of growth in the older adult population in New Zealand is greater in comparison to other developed countries (Kowal, Towers, & Byles, 2014).

New Zealanders are also living for longer; over the first ten years of this century life expectancy increased by 3 years for males to 70.3 years and 1.9 years for females to 83.0 years (Bascand, 2012; Cornwall, 2004). With a steadily rising life expectancy and older population, statisticians have predicted that the over 85 years age bracket will be the fastest growing population group in New Zealand (Bascand, 2013).

Rising life expectancy is associated with increased health care costs. New Zealand researchers calculated the accumulated lifetime health costs for older adults based on age of dying (Blakely et al., 2014). Cumulative healthcare costs for an adult dying at 70 years was estimated to be $113,000, compared to $223,000 for an adult who dies at 90 years; furthermore these calculations do not include aged residential care costs. The difference in healthcare costs is attributed to the management of increasing chronic health problems and disability (Blakely et al., 2014).

Disability is a difficulty or restriction in ability to complete activities of daily living and is associated with increased mortality, greater use of formal and informal supports, and reduced quality of life (Fried, Ferrucci, Darer, Williamson, & Anderson, 2004; Gill, 2014; McPherson, 2014). As a consequence of the physiology of aging and the development of chronic disease and morbidity, disability is common in older adults (Chatterji, Byles, Cutler, Seeman, & Verdes, 2015; Gill, Allore, Hardy, & Guo, 2006; Gill, Allore, Holford, & Guo, 2004; McCusker et al., 1999; Verbrugge & Jette, 1994).

Information from Statistics New Zealand's Disability Survey indicates there has been a steady rise in disability rates in the over 65 age group since 1996 (McPherson, 2014). In 2013 59% of New Zealanders aged over 65 identified themselves as disabled, compared to 49% in 1996 (McPherson, 2014).

This then begs the question; as New Zealanders can expect longer lives, will they experience more years of good health? Research is currently equivocal as to the impact of longer life expectancy on rates of disability and dependence. Three potential theories have been proposed (Chatterji et al., 2015; Fries, Bruce, & Chakravarty, 2011; Graham, Blakely, Davis, Sporle, & Pearce, 2004).

- Compression of morbidity whereby the onset of chronic diseases that cause disability are postponed until later in life.
- Expansion of morbidity with improved mortality rates resulting in older adults living longer with disability.
- Dynamic equilibrium. This theory combines the theories of compression and expansion. It is postulated that whilst advancements in chronic health management minimise severe disability, there is a concurrent increase in mild to moderate disability.

Research has yet to identify which theory best describes the trajectory of aging in New Zealand though current studies allude to a state of dynamic equilibrium (Boyd et al., 2011; Graham et al., 2004). To achieve compression of morbidity there is a need to develop innovations to optimise recovery from illness and minimise disability rate (Kowal et al., 2014). In response to these issues the New Zealand Government has documented the need to provide a health system that improves and maintains the fitness, wellbeing and independence of older adults (Ministry of Business, Innovation & Employment, 2013).

Older adults constitute a large proportion of acute hospital inpatient population. In Australia and New Zealand adults over 65 years of age account for 40% of all acute hospital admissions (Croucher, 2010; Australian Institute of Health and Welfare, 2015). Narrowing this data to acute medicine, a New Zealand hospital reported older adults accounted for 62% of general medical admissions (Croucher, 2010). Indeed it is speculated that geriatric medicine is fast becoming the core business of hospital care (Croucher, 2010).

The immediate focus of acute hospitalisation is to resolve the medical situation that triggered admission. However the very act of hospital admission can precipitate secondary health and wellbeing issues. Hospitalised older adults are susceptible to declining physical health and new or worsening disability that cannot be attributed to their primary health problem (Covinsky et al., 2003; Covinsky, Pierluissi, & Johnston, 2011; Creditor, 1993; Gill, Allore, Gahbauer, & Murphy, 2010; Murphy, 2011). Indeed half of disability in older adults originates from a period of acute hospitalisation (Gill et al., 2004).

Low mobility levels during hospitalisation have been identified as a risk factor for developing secondary health issues and iatrogenic decline (Callen, Mahoney, Grieves, Wells, & Enloe, 2004; Covinsky et al., 2011; Fisher et al., 2011). Despite this, low levels of mobility during hospitalisation have been commonly reported. International research has shown that acutely hospitalised older adults are largely sedentary with the majority of their admission spent either in bed or in a chair (Brown, Redden, Flood, & Allman, 2009; Fisher et al., 2011; Fisher, Kuo, Graham, Ottenbacher, & Ostir, 2010; Pedersen et al., 2013).

1.1 Outline of Study

This purpose of this study was to describe the mobility levels of older adults during acute medical hospitalisation in Wellington Regional Hospital, New Zealand. Knowing how much hospitalised older adults mobilise within current local care practices may assist in providing local information to best direct future intervention studies. Prior to this study, there was no New Zealand based data on this topic. As such, the secondary purpose of this study was to explore for associations between mobility levels during acute hospital stay and patient specific characteristics that had been identified by previous studies.

1.2 Hypotheses

The primary research question was: "What are the mobility levels of older adults during acute hospital stay?" The secondary research question was: "Do the same characteristics identified by previous studies influence mobility levels during acute hospital stay in New Zealand?" To address these research questions the following general hypotheses were adopted for this study:

1. Participants will exhibit low levels of mobility during acute hospital stay taking less than 1500 steps per day.
2. All participants will exhibit low levels of mobility regardless of:
    a. Premorbid community mobility
    b. Mobility status on admission
    c. Physiotherapy and occupational therapy involvement during admission.
3. The mobility levels of participants during acute hospital stay will be associated with:

a. Length of stay. Those with shorter length of stays will record higher levels of mobility when compared to those with longer periods of hospitalisation.

b. Mortality within 6 months following discharge. Participants who die within six months following discharge will have recorded lower levels of mobility during hospitalisation than those who survive.

1.3 Delimitations

The following delimitations apply to this study:

1. Extrapolation of the results of this study was limited to older adults admitted to Wellington Regional Hospital, Wellington, New Zealand due to an acute medical issue and who were mobile around their own home two weeks prior to hospitalisation.
2. Medical diagnosis was recorded. Information concerning comorbidities or severity of illness was not considered.

1.4 Limitations

The following limitations apply to this study:

1. During the course of this study, some participants in this study were transferred within the hospital to different wards and therefore exposed to different environments.
2. Recruitment to the study and the StepWatch Activity Monitor may have motivated participants to increase mobility levels.

1.5 Operational Definitions

Mobility levels: amount of walking performed

Older Adult: an adult aged 65 years or over

Medical Services: hospital department specialising in Internal Medicine.

Hospitalisation: admission to hospital involving at least one overnight stay.

Acute Hospitalisation: admitted to hospital due to a medical condition that requires urgent and short-term secondary care.

Steps: one step is defined as two consecutive strides by one foot then the other. With respect to accelerometer data, steps per day totals were calculated by multiplying the daily stride count by two.

Disability: difficulty or restriction in ability to complete activities of daily living.

Chapter 2: Literature Review

2.1 Introduction

This purpose of this study was to describe the mobility levels of older adults during acute medical hospitalisation. This chapter provides context for the study by discussing health changes common to older adults after a period of acute hospitalisation. It introduces the concepts of frailty and geriatric syndromes, and the relationship of nosocomial impairments with mobility levels during acute hospital stay. This chapter presents evidence for increasing mobility levels as demonstrated by acute healthcare studies. This chapter collates similar international research and reviews the mobility levels of older adults during acute hospital stay and when living in the community. Finally this chapter provides an overview of physiological changes that can occur after a short period of reduced activity.

2.2 Health of the Older Adult in Acute Care

2.2.1 Older Adults and Acute Hospitalisation

The primary focus of acute admission to hospital is to diagnose and treat the primary illness. However it has long been recognised that for older adults, particularly for those with multiple comorbidities and chronic disease, acute illness and hospitalisation can prompt functional decline and disability (Covinsky et al., 2011; Hubbard, 2015; Tinetti et al., 2002). Independent of acute illness severity, hospital admission is a sentinel event for older adults and has been shown to have deleterious effects (Covinsky et al., 2011; Davis et al., 2002; Davis, Lay-Yee, Briant, & Scott, 2003). As such the focus of acute care for older adults needs to be wider than that of the immediate health problem (Tinetti et al., 2002).

2.2.2 Disability Following Hospitalisation

Older adults who experience health issues that lead to hospitalisation are at risk of developing disability (Boyd et al., 2008; Boyd et al., 2009; Gill et al., 2010). Hospitalised older adults experience significantly high rates of new or persistent disability following discharge (Gill et al., 2004). Approximately half of disability in older adults originates from a period of acute hospitalisation (Gill et al., 2004). Whilst some older adults will recover from disability associated with hospitalisation, a significant proportion will not (Covinsky et al., 2011; Davydow, Hough, Levine, Langa, & Iwashyna, 2013; Gill et al., 2010). For example at least one third of older adults leave acute hospital with new or additional disability (Boyd et al., 2008). From that number, only 30% will recover to their premorbid baseline 12 months after discharge (Boyd et al., 2008). Indeed longitudinally, health issues that lead to further hospitalisations are significantly associated with progression of the severity of disability (Gill, Gahbauer, Han, & Allore, 2011).

Hospitalisation for older adults is commonly associated with declining physical health, worsening disability and adverse outcome. When compared to younger in-patient groups, older adults experience increased length of stay, a higher re-admission rate and are more at risk of complications (Croucher, 2010; Hart, Birkas, Lachmann, & Saunders, 2002). Literature refers to these complications as the hazards of hospitalisation (Creditor, 1993; Wilkerson, Iwata, Wilkerson, & Heflin, 2014). Older adults can have less physiological reserve to cope with an acute health event, resulting in slow or sub optimal recovery (Clegg, Young, Iliffe, Rikkert, & Rockwood, 2013; Shamliyan, Talley, Ramakrishnan, & Kane, 2013). This vulnerability can be attributed to frailty (Clegg et al., 2013; Evans, Sayers, Mitnitski, & Rockwood, 2014; Fried et al., 2004; Hubbard, 2015; Walston et al., 2006).

2.2.3 Frailty

Frailty has been defined as a "vulnerability to stressors, with reduced ability to maintain or regain homeostasis after a destabilising event" (Walston et al., 2006, p. 922). Frailty is in essence diminished resilience to a health event ascribed to the decline of multiple physiological systems and lifestyle choices (Clegg et al., 2013; Strandberg, Pitkälä, & Tilvis, 2011; Walston et al., 2006). In a clinical context, for a hospitalised non-frail older adult who experiences a health event such as pneumonia it would be expected that they recover in a timely manner following appropriate medical intervention. For a hospitalised older adult who is frail, an infection such as pneumonia can prompt systemic deterioration, increased dependency and initiate a declining health journey. Furthermore hospitalisation can trigger frailty for older adults and each hospital admission increases this risk of deterioration by 33% (Gill et al., 2004). The development of frailty is independent from clinical disease, age, health status, socioeconomic group, premorbid disability and co-morbidities (Evans et al., 2014; Fried et al., 2001; Gill et al., 2004; Green et al., 2015; Rockwood et al., 2004). Figure 2.1 demonstrates this vulnerability.

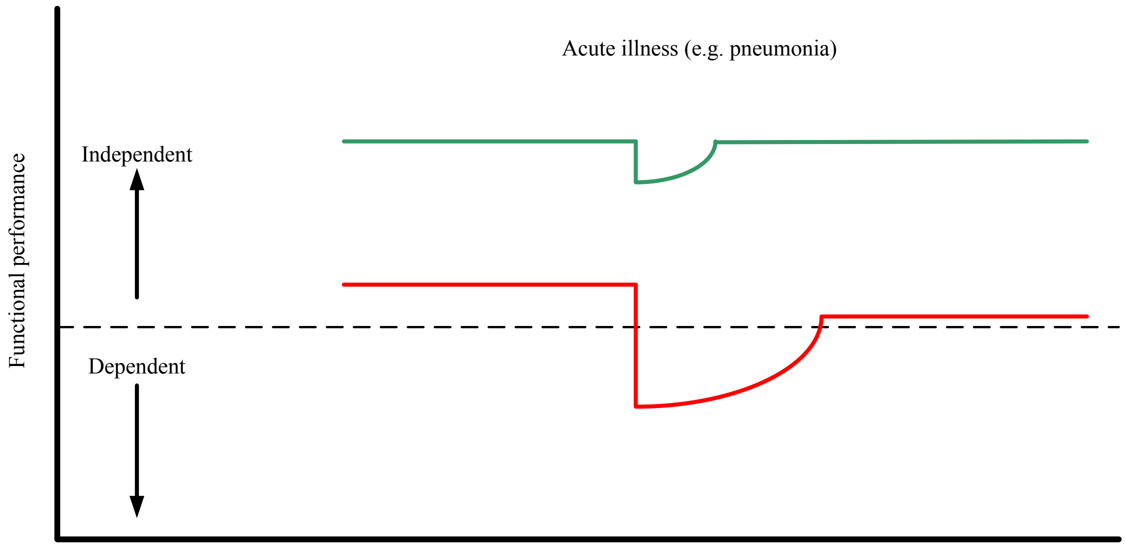

Figure 2.1. Vulnerability of frail older adult to acute illness. Adapted from Clegg et al. (2013). The dotted line represents the cut off between functional independence and dependence. The green line represents a non-frail older adult's response to acute illness and depicts a small change in function after illness with recovery to premorbid function. The red line represents a frail older adult's response who, after a similar illness, has a greater deterioration, which is in this case represented by functional dependency. This older adult takes longer to recover and does not return to premorbid function.

In essence frailty reduces an individual's ability to recover (Fried et al., 2009; Gill et al., 2004; Gill et al., 2011). Frailty is associated with negative health outcomes including falls, functional decline, institutionalisation, fractures and mortality (Fried et al., 2004; Heuberger, 2011; Lang, Michel, & Zekry, 2009; Marshall, Nazroo, Tampubolon, & Vanhoutte, 2015; Walston et al., 2006). Figure 2.2 presents a pictorial overview of the multiple and complex components of frailty and the cyclical nature of the phenotype.

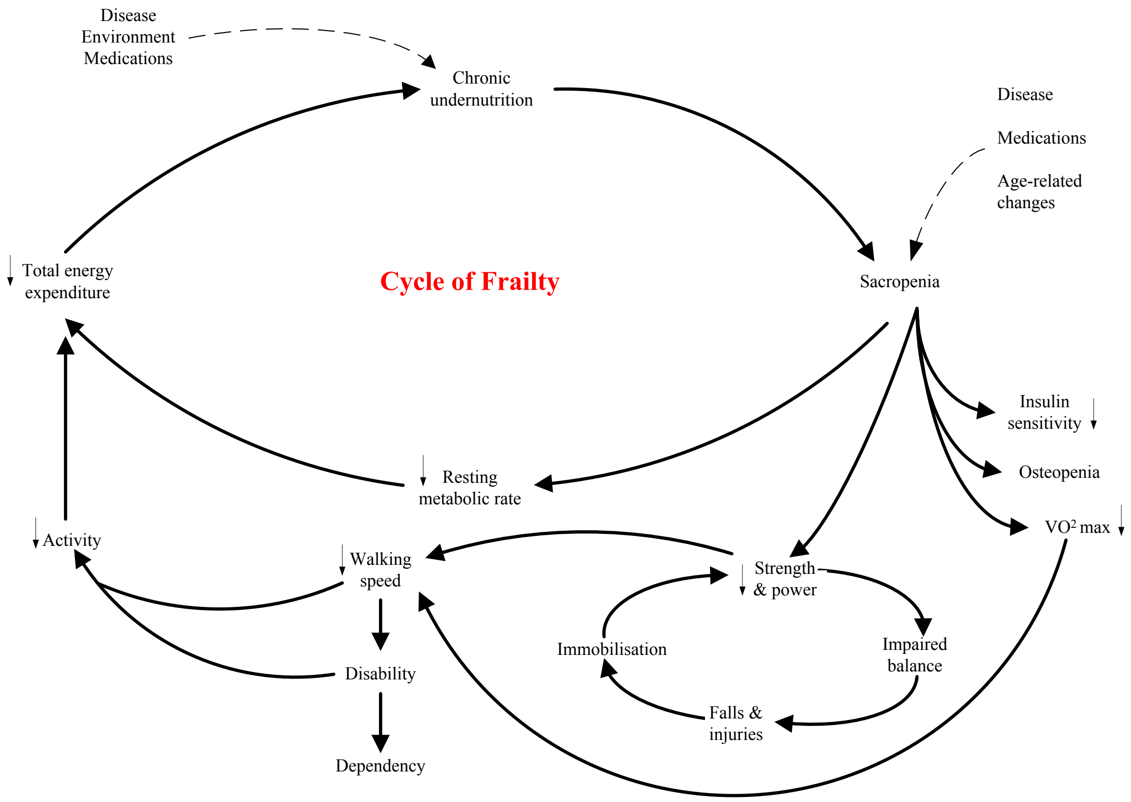

Figure 2.2. Cycle of frailty. Adapted from Fried et al. (2005).

Frailty is characterised by five key criteria: fatigue, weight loss, inactivity and reduced gait speed and grip strength (Strandberg et al., 2011). Frailty is a dynamic process defined by three transitional states; non-frail (no criteria met), pre-frail (one to two criteria met), and frail (three or more criteria met) (Fried et al., 2001; Op Het Veld et al., 2015). The extent of frailty is indicative of an older adult's capacity to live an independent life (Marshall et al., 2015).

Frail older adults are more susceptible to developing adverse outcomes following hospitalisation (Clegg et al., 2013; Ekerstad et al., 2011; Gill, 2014; Lang, Clark, Medina-Walpole, & McCann, 2008). As a result of hospitalisation older adults who are pre-frail or frail are more likely to experience sustained general decline, disability, institutionalisation and increased mortality (Fried et al., 2004; Gill et al., 2010; Gill, Gahbauer, Allore, & Han, 2006; Lang et al., 2009; Shamliyan et al., 2013; Walston et al., 2006). Frailty and pre-frailty also restricts functional recovery following discharge from hospital (Gill et al., 2004). Whilst non-frail older adults still experience disability following hospitalisation, pre-frail and frail older adults are less likely to recover from physical disability (Gill et al., 2004; Hardy & Gill, 2004).

Although it is more common for frailty to progress in severity, some older adults improve and progress to lesser states of frailty (Gill, 2014). Those most likely to recover from frailty include those who experienced only mild disability, are cognitively intact, and classified as non-frail premorbidly. However despite recovering from frailty, these older adults continue to be at high risk of developing recurrent disability (Boyd et al., 2008; Boyd et al., 2009; Gill, 2014). Targeting this declining health cycle is therefore key to minimising morbidity for acutely hospitalised older adults.

2.2.4 Section Summary

In summary a large proportion of acute hospital admissions involve older adults. For these individuals, the act of hospitalisation can be detrimental to their health and wellbeing. Acute hospitalisation can initiate and worsen frailty amongst older adults. This risk is independent from presenting condition and premorbid health and disability.

The clinical consequences of frailty are significant and can increase an individual's morbidity and disability. Maximising the recovery from frailty is important for the health of older adults. Recent research has suggested the incidence and severity of frailty in the United Kingdom is increasing (Marshall et al., 2015; Yang & Lee, 2010). This is indicative of an expansion of morbidity with improved mortality rates, health and social care resulting in older adults living longer with disability. Given the expected demographic changes, there is urgency to elucidate primary and secondary prevention modalities to minimise frailty in older adults.

The development of frailty involves a complex multisystem health decline that is due to heterogeneous factors. The focus of acute care must also involve prevention strategies and treatment modalities that target frailty (Mackey et al., 2014; Marshall et al., 2015; Strandberg et al., 2011; Tinetti et al., 2002; Yang & Lee, 2010). Exploring the nosocomial effects of hospitalisation is key to considering how to optimise the health of older adults during and recovery following hospital admission.

2.3 Geriatric Syndromes

Provoked by the ageing process and pre-existing chronic health conditions, geriatric syndromes are often triggered and aggravated by an acute health event such as hospitalisation (Ahmed, Mandel, & Fain, 2007; Anpalahan & Gibson, 2008; Chang, Tsai, Chen, & Liu, 2010; Inouye, Studenski, Tinetti, & Kuchel, 2007; Wald, 2012). Geriatric syndromes are common and complex health conditions particular to older adults that cannot be contributed to a single discreet disease process (Carlson, Merel, & Yukawa, 2015; Chang et al., 2010; Flacker, 2003; Inouye et al., 2007; Wald, 2012). By definition, geriatric syndromes are

> multifactorial, occur primarily in older persons, and result from an interaction between identifiable patient-specific impairments and identifiable situation-specific stressors (Flacker, 2003, p. 575)

The five core geriatric syndromes are delirium, incontinence, falls, functional decline, and pressure injuries (Inouye et al., 2007). These syndromes have been described as the core contributors to disability in older adults (Inouye et al., 2007). Acute hospitalisation can provoke the development of new geriatric syndromes and worsen syndromes that were apparent premorbidly (Lakhan et al., 2011).

2.3.1 Geriatric Syndromes and Frailty

Geriatric syndromes are associated with morbidity, increased length of hospitalisation, disability, admission to aged residential care, reduced quality of life and higher healthcare costs (Anpalahan & Gibson, 2008; Carlson et al., 2015; Chang et al., 2010; Inouye et al., 2007). In essence the development of geriatric syndromes can prompt the start of a declining health journey. As such geriatric syndromes are intrinsically linked to the overarching diagnosis of frailty. Figure 2.3 depicts the close relationship between frailty, geriatric syndromes, and declining health in older adults.

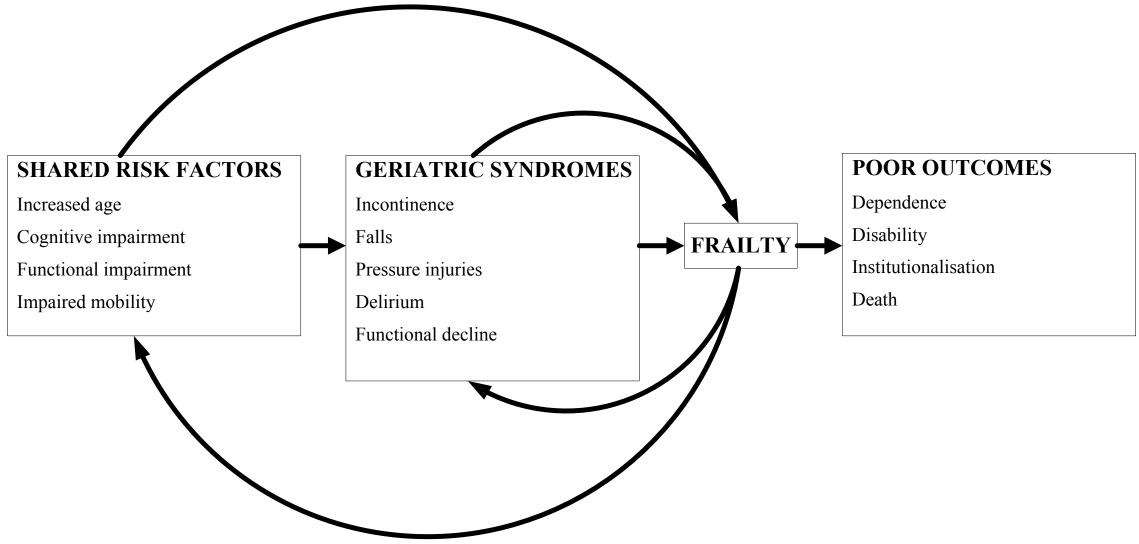

Figure 2.3. Interaction of frailty and geriatric syndromes. Adapted from Inouye et al. (2007).

2.3.2 Urinary Incontinence

Approximately 45% of older adults admitted to hospital have pre-existing urinary incontinence (Baztán, Arias, González, & de Prada, 2005; Zisberg, Gary, Gur-Yaish, Admi, & Shadmi, 2011). The development of new urinary incontinence during acute hospitalisation is common and affects 17% of older adults (Zisberg et al., 2011). Risk factors for developing urinary incontinence whilst in hospital includes impaired mobility and the use continence pads (Ostaszkiewicz, O'Connell, & Millar, 2008; Anna Zisberg et al., 2011).

Inappropriate use of continence products and urinary catheters is common in hospitalised older adults (Apisarnthanarak et al., 2007; Ostaszkiewicz et al., 2008; Tiwari, Charlton, Anderson, Hermsen, & Rupp, 2012). Ostaszkiewicz et al. (2008) found 41% of older adult inpatients wearing continence pads had no incidents of incontinence in the preceding 24 hours. Furthermore Apisarnthanarak et al. (2007) discovered that 34% of older adults admitted to acute medical services had a catheter inserted for inappropriate reasons.

New urinary incontinence and the use of continence products and urinary catheters can have deleterious effects on older adult's health and wellbeing. These continence factors are associated with increased length of stay, slower rate of functional recovery, more likely to develop a urinary tract infection and a higher risk of pressure injury (Apisarnthanarak et al., 2007; Baztán et al., 2005; Ostaszkiewicz et al., 2008; Tiwari et al., 2012; Zisberg et al., 2011).

Urinary incontinence and the use of continence products incurs increased healthcare costs in terms of both products and care needs, an extra AU$49 per 24 hours of hospital stay (Morris et al., 2005). Furthermore the development of new urinary incontinence during hospitalisation can incur more cost, an additional AU$19 per day in comparison with older adults who were admitted with incontinence or were continent on discharge (Green JP, 2003).

2.3.3 Falls

In-hospital falls, that is to say falls during hospitalisation, are a common occurrence. It is estimated that 2-15% of the hospital population will sustain a fall whilst an inpatient (Halfon, Eggli, Van Melle, & Vagnair, 2001). The majority of patients who experience an in-hospital fall are over 65 and receiving acute care in a medical unit (Bradley, Karani, McGinn, & Wisnivesky, 2010; Healey et al., 2008; Oliver, Healey, & Haines, 2010; Rochat, Monod, Seematter-Bagnoud, Lenoble-Hoskovec, & Büla, 2013).

Contributory factors to in-hospital falls include weakness, acute changes in mobility, cognitive impairment and pharmacology (Bradley et al., 2010; Hitcho et al., 2004; Rochat et al., 2013). It is estimated that almost 20% of older adults who fall once in hospital will fall again before discharge (Bradley et al., 2010; Halfon et al., 2001).

Approximately 40% of in-hospital falls result in injury (Dunne, Gaboury, & Ashe, 2014; Hitcho et al., 2004). Despite the majority of in-hospital falls being non-injurious they can punctuate the start of a deleterious cycle of fear of falling, self limiting activity leading to further weakness and increased risk of falls (Oliver et al., 2010). Regardless of severity of injury, adults who fall whilst an inpatient stay in hospital approximately two weeks longer than non-fallers (Baird, Maxson, Wrobleski, & Luna, 2010; Bradley et al., 2010; Dunne et al., 2014).

In a study based in post acute rehabilitation, patients who sustained multiple in-hospital falls were more likely to be admitted from a medical ward, have multiple co-morbidities, and experience poorer functional recovery (Rochat et al., 2013). Furthermore older adults who have an in-hospital fall are more likely to fall after they are discharged. Davenport et al. (2009) found that almost a third of patients who experienced an in-hospital fall, fell at home within the first two weeks following discharge.

2.3.4 Pressure Injury

Pressure injury is a serious health condition that is potentially preventable. For older adults pressure injury can have serious ramifications including pain, disability, and social isolation (Gorecki et al., 2009). The incidence and prevalence of hospital acquired pressure injuries in New Zealand hospitals is currently unknown (Tweed, 2014). International data has suggested hospital prevalence rates of up to 7%, three quarters of whom are over 65 years old (Lyder et al., 2012; VanGilder, Amlung, Harrison, & Meyer, 2009; Whittington, Patrick, & Roberts, 2000). Specifically addressing older adults admitted to medical wards, Baumgarten et al. (2006) found 6.2% of older adults acquired a pressure injury within the first two days of their hospital stay (*N*=3233). A national audit of pressure injuries in North American hospitals found that the most common site of injury was the sacrum (26%) and coccyx (31%) (*N*=17,560) (Whittington et al., 2000).

Pressure injury acquired during hospitalisation is an independent predictor of length of stay for older patients. Older adults with hospital acquired pressure injuries experience an extended length of stay of up to 4.31 days longer than those without (Graves, Birrell, & Whitby, 2005; Theisen, Drabik, & Stock, 2012). Furthermore those who develop pressure injury whilst in hospital experience reduced quality of life, higher risk of mortality during hospitalisation and higher readmission rates (Gorecki et al., 2009; Lyder et al., 2012).

Graves et al. (2005) explored the economic impact of pressure injury in Australian public hospitals. Their research predicted that pressure injuries sustained during hospital admission may potentially account for 398,432 beds days lost and cost the public health system AU$285,000,000.

2.3.5 Delirium

Delirium can occur following an acute health event such as major surgery or sepsis (Inouye, Westendorp, & Saczynski, 2014). It is a "syndrome characterized by the rapid onset of impaired attention that fluctuates, together with impaired cognition and/or altered consciousness, perceptual disturbances and behaviour" (Hubbard, 2015, p. 1).

The incidence of developing delirium in hospitalised adults has been reported to be as high as 56% (Inouye, 2006). In New Zealand, the prevalence of delirium amongst adults during acute hospital stay has been recorded as 23.4% (Holden, Jayathissa, & Young, 2008). The risk of developing delirium increases with age; hospitalised older adults over 80 years experience a prevalence rate of up to 35% (Ryan et al., 2013). Furthermore the prevalence of delirium superimposed on dementia in hospitalised older adults has been recorded as 32% (Fick, Steis, Waller, & Inouye, 2013).

Once an individual has developed delirium they are at greater risk of developing other geriatric syndromes and deleterious health problems. These include poor functional recovery (69%), permanent cognitive changes, pressure injury, longer hospitalisation, higher rate of hospital readmission and increased mortality (Dasgupta & Brymer, 2014; Eeles et al., 2010; Fick et al., 2013; S. K. Inouye et al., 2014). Mortality rates from delirium during hospitalization range from 22 to 76% (Inouye, 2006).

One New Zealand based study collected data for patients aged over 65 years admitted to an acute medical unit (Holden et al., 2008). Delirious older adults experienced a length of stay that was twice that of older adults without delirium. When they did leave hospital delirious patients required more support on discharge (52% compared with 19%), and had a higher rate of discharge to aged residential care (23% in comparison to 13%). This increase in care needs comes at a high cost. A North American study suggested the national health care costs attributed to the management of delirium to be US$152 billion (Leslie, Marcantonio, Zhang, Leo-Summers, & Inouye, 2008).

2.3.6 Hospitalisation-Associated Functional Decline

For many older adults acute hospitalisation is accompanied by a decline in their ability to perform basic activities of daily living (Kortebein, 2009). This translates as older adults requiring more assistance to complete rudimentary tasks such as walking within their home and personal cares following an acute health event. Functional decline commonly results in prolonged hospital admission, increased care needs on discharge, higher readmission rates, incomplete functional recovery and triggers transition to aged residential care (Boyd et al., 2008; Depalma et al., 2013).

Functional decline that occurs during an acute health event is complex (Covinsky et al., 2003; K. E. Covinsky et al., 2011; Lakhan et al., 2011). Researchers have commented on functional decline as a hospital acquired disability however the prevalence of functional decline solely exclusive to nosocomial factors is relatively low (4-12%) (Boyd et al., 2008; Boyd et al., 2009; Covinsky et al., 2003; K. E. Covinsky et al., 2011; Creditor, 1993; Lakhan et al., 2011). When compared to premorbid or normal baseline, there are four points on the acute hospitalisation continuum at which stability, recovery, and decline of function can occur: pre admission, admission, discharge and post discharge. For the majority of hospitalised older adults who experience new functional impairment, this decline occurs prior to admission at the onset of acute illness (Covinsky et al., 2011; Mudge, O'Rourke, & Denaro, 2010). In a clinical context an older adult who developed an infection such as community acquired pneumonia will likely have experienced a deterioration in function as the infection developed. The extent of decline in function and health at home commonly precedes acute hospitalisation. Thus, to measure function on admission is not reflective of an individual's true functional abilities. Hospitalisation-associated functional decline is therefore interpreted as a lack of physical recovery following acute illness (Hoogerduijn, Schuurmans, Duijnstee, de Rooij, & Grypdonck, 2007).

The prevalence of hospitalisation-associated functional decline in older adults has been recorded at between 34%-54% on discharge from acute medical care (Boyd et al., 2008; Boyd et al., 2009; Covinsky et al., 2003; Huang, Chang, Liu, Lin, & Chen, 2013; Lakhan et al., 2011; Mudge et al., 2010). Hospitalisation-associated functional decline can take a significant amount of time to recover from. In a large study by Boyd et al. (2009) impairment continued to be prominent for older adults discharged with functional decline at one month (53%), three months (40%), six months (32%) and twelve months (29%) following discharge (n=2279).

Risk factors for hospitalisation-associated functional decline include age, length of stay, the presence of other geriatric syndromes and comorbidities (Boyd et al., 2009; Huang et al., 2013; Mudge et al., 2010). Covinsky et al. (2003) found that 50% of participants aged 85 to 90 years and over developed hospitalisation-associated functional decline compared with 28% of those aged 70 to 75 years.

2.3.7 Section Summary

For older adults, the complications of acute hospitalisation are significant and detrimental to their health. Geriatric syndromes and the overarching concept of frailty reflect the core health problems that can affect the health and recovery of older adults following an acute illness. The prevention and management of these syndromes are pivotal to minimising the nosocomial consequences of hospitalisation and optimising quality care for older adults during and after acute care (Anpalahan & Gibson, 2008; Chang et al., 2010; Dasgupta & Brymer, 2014; Inouye et al., 2007; Theisen et al., 2012). Inouye et al. (2007) conducted a thorough review of pertinent literature and identified four shared risk factors for the aforementioned geriatric syndromes:

- Older age
- Cognitive impairment
- Functional impairment
- Impaired mobility

Targeting one or more of these risk factors could positively influence older adult health during acute care and after discharge. Intervention that maximises mobility during hospitalisation has been seen as pivotal to optimising older adult health (Callen et al., 2004; Inouye et al., 2007; Lahmann et al., 2015). Exercise and prompt mobilisation during times of ill health has been suggested as both a primary and secondary preventative strategy for disability and frailty (Strandberg et al., 2011; Wald, 2012; Walston et al., 2006). This study therefore sought to focus on describing the mobility levels of older adults during acute medical hospitalisation.

2.4 Older Adult Health and Mobility Levels

2.4.1 Mobility Level as a Risk Factor for Geriatric Syndromes

The mobility levels of older adults is directly linked to all five core geriatric syndromes. Each of these syndromes has been demonstrated to curtail recovery and compound disability following an illness or injury in acutely hospitalised older adults.

Reduced mobility during hospitalisation is a risk factor for bowel and bladder incontinence, inappropriate use of urinary catheters and pressure injury (Apisarnthanarak et al., 2007; Baumgarten et al., 2006; Coleman et al., 2013; Ostaszkiewicz et al., 2008; Reddy, Gill, & Rochon, 2006). Low mobility levels and acute hospital stay are linked to deterioration in gait and balance skills, hospital-associated functional decline and the prevalence of falls during admission and following discharge (Bradley et al., 2010; Brown, Friedkin, & Inouye, 2004; C. J. Brown et al., 2009; De Buyser et al., 2014; Hitcho et al., 2004; Murphy, 2011; Oliver et al., 2010; Zisberg et al., 2011).

The pathophysiology and optimal treatment for delirium is yet to be determined (Anand & MacLullich, 2013; Inouye et al., 2014). Although there is no proven link between delirium and physical activity, immobility is strongly associated with both the development and severity of delirium (Caplan & Harper, 2007; Eeles et al., 2010; Inouye et al., 1999; Voyer, McCusker, Cole, St-Jacques, & Khomenko, 2007). Moreover geriatric experts recommend regular mobilisation as both a preventative measure and management technique for delirium (Anand & MacLullich, 2013; S. K. Inouye et al., 1999; Inouye et al., 2014; Mattison et al., 2014).

2.4.2 Increasing Mobility Levels During Hospitalisation

The amount of walking performed by patients during acute hospitalisation has been shown to correlate with health gains. Research has been undertaken in various specialities within acute care.

The benefits of increasing mobility levels following surgical intervention are well documented. Early mobilisation, or early rehabilitation programmes that involve increasing mobility levels, significantly decrease postoperative complications including length of stay, pain, pneumonia and fatigue (Baird et al., 2010; Chair, Thompson, & Li, 2007; Kurabe, Ozawa, Watanabe, & Aiba, 2010; Marzen-Groller et al., 2008; Nicholson et al., 2014; Raue et al., 2004; Rezaei-Adaryani, Ahmadi, & Asghari-Jafarabadi, 2009). Improvements in pulmonary function, walking capacity, functional mobility, patient satisfaction and sub maximal exercise capacity on discharge are also documented (Hirschhorn, Richards, Mungovan, Morris, & Adams, 2008; Martínez-Velilla et al., 2015; Nguyen et al., 2015; Raue et al., 2004).

The impact of increased mobility levels for mechanically ventilated patients in intensive care has been well researched. A recent systematic review concluded that mobilisation improved outcomes for mechanically ventilated patients (Li, Peng, Zhu, Zhang, & Xi, 2013). Benefits included increased strength, improved independence, successful ventilation weaning and reduced length of stay in intensive care and hospital.

Early mobilisation after total joint replacement is one component of the New Zealand Ministry of Health's Enhanced Recovery After Surgery pathway, which has been adopted by 18 district health boards (Ministry of Health, n.d.). Increasing mobility levels following joint replacement has been shown to reduce the risk of developing deep vein thrombosis in adults, improve joint range of motion and the recovery of mobility (Chandrasekaran, Ariaretnam, Tsung, & Dickison, 2009; Nakao et al., 2010; Pua & Ong, 2014).

Increased mobility levels after arthroplasty and hip fracture surgery are associated with organisational benefits including reduced length of stay, accelerated functional recovery and lower healthcare costs (Larsen, Hansen, Thomsen, Christiansen, & Søballe, 2009; Oldmeadow et al., 2006; Pua & Ong, 2014; Raut, Mertes, Muniz-Terrera, & Khanduja, 2012). Conversely delaying mobilisation following hip fracture surgery is associated with increased rates of delirium, pneumonia, functional impairment and mortality (Kamel, Iqbal, Mogallapu, Maas, & Hoffmann, 2003; Siu et al., 2006).

Increasing mobility levels during acute medical hospitalisation mirror the outcomes of the aforementioned surgical studies. Adults recovering from an exacerbation of chronic obstructive pulmonary disease experienced a higher re-admission rate within 30 days if performed low levels of mobility during hospitalisation (Nguyen et al., 2015). In adults with community-acquired pneumonia, early and progressive mobilisation in hospital significantly reduced length of stay by 1.1 days (Mundy, Leet, Darst, Schnitzler, & Dunagan, 2003; Stolbrink et al., 2014).

By increasing walking opportunities, studies have demonstrated a decrease in delirium, trends towards lower risk of falls and pressure injury, improved recovery of function and shorter length of stay (Courtney, 2012; Killey & Watt, 2006; Mudge, Giebel, & Cutler, 2008; Mudge, McRae, & Cruickshank, 2015; Padula, Hughes, & Baumhover, 2009; Shadmi & Zisberg, 2011; Wood et al., 2014). Furthermore low mobility levels during acute medical admission have been associated with functional decline, institutionalisation and higher mortality rates (Brown et al., 2004; Landefeld, Palmer, Kresevic, Fortinsky, & Kowal, 1995; Ostir et al., 2013; A. Zisberg et al., 2011).

2.4.3 Section Summary

Research demonstrates that increasing the mobility levels of inpatients during acute hospitalisation improves health outcomes. Importantly, increasing mobility levels was found to be a safe and low cost intervention that did not demonstrated any adverse effects (Callen et al., 2004; Chair et al., 2007; Chandrasekaran et al., 2009; Kurabe et al., 2010; Larsen et al., 2009; Li et al., 2013; Mudge et al., 2008; Mudge et al., 2015; Mundy et al., 2003; Nakao et al., 2010; Pua & Ong, 2014; Raue et al., 2004; Rezaei-Adaryani et al., 2009; Stolbrink et al., 2014; Wood et al., 2014).

Low mobility levels of older adults and the development of hospital associated adverse outcomes are linked. These adverse outcomes can negatively impact the health and wellbeing of older adults after discharge. Providing an optimal acute healthcare experience including maximising the level of mobility is therefore an important aspect of health service development to maintain the fitness, wellbeing, and independence of the older population group.

2.5 Mobility Levels During Acute Medical Hospitalisation

Evidence suggests that increased mobility levels can positively impact on patient outcomes. Knowing how much patients walk before instigating clinical changes can provide a baseline from which to develop interventions. Several observational studies have recorded the mobility levels of older adults during acute medical hospitalisation. Data collection methods, fullness of published data and outcome measures are variable between previous studies.

2.5.1 Observational Studies

Focusing on adults aged 55 years and over, Callen et al. (2004) observed 235 consenting medical inpatients in a North American hospital. Observation periods lasted 3 hours and 8 sessions in total were performed on weekdays between 0800 and 2000. The researchers recorded the frequency and time spent walking in the ward's hallway; 28% of independently mobile participants mobilised outside of their rooms, as did 26 % of participants who were dependent on others to achieve hallway mobility. Those who did walk in the hallway spent a median of 5.5 minutes (range 1 to 36) mobilising out of their rooms.

In Australia Kuys, Dolecka, and Guard (2012) observed the activity levels of 76 inpatients receiving acute medical care. Participants were over 18 years with a mean age of 66.3 years. The researchers observed participants for a total of 450 minutes from 0830 till 1630 on weekdays. On average participants spent 315 minutes of their time lying in bed, 10 minutes sitting and 1 minute standing or walking.

Lastly Cattanach, Sheedy, Gill, and Hughes (2014) observed the physical activity levels of 24 participants aged 18 years and over in an Australian hospital under the care of acute medical services, every 10 minutes from 0800 till 1700. Observation recordings show that both dependent and independently mobile participants were sedentary for the vast majority of their hospital day. Independent and dependent participants spent 93% and 99% respectively of time lying or sitting

2.5.2 Retrospective Reporting Studies

Three studies based in North America and Israel recorded the mobility levels of adults during hospitalisation utilising the same retrospective outcome measure (Baird et al., 2010; Brown et al., 2004; Shadmi & Zisberg, 2011; Zisberg et al., 2011). Developed by Brown et al. (2004) this measure categorised the mobility level of inpatients for the preceding 24 hours and is outlined in Table 2.1. Mean hospital mobility level scores were categorised as low (scoring 4 or less), intermediate (scoring between 5 and 8) and high (scoring greater than 8).

Table 2.1. Hospital Mobility Scoring System Developed by Brown et al. (2004)

Activity	**Score**
Bed rest	0
Transfer bed to chair at least once	2
Transfer bed to chair more than once	4
Ambulation once with total assistance	6
Ambulation with total assistance more than once or ambulation once with partial assistance	8
Ambulation with partial assistance more than once	10
Independent ambulation more than once	12

Using nursing observations to score mobility, Brown et al. (2004) rated the mobility level of 498 participants, aged 70 or over and receiving acute care in a general medical unit. To gain an overall picture of mobility level during hospital stay, the mean of daily scores for each participant was calculated. From the cohort 52% had high levels of mobility, 32% intermediate and 16% low. Lower levels of mobility were associated with functional decline, institutionalisation and mortality.

Shadmi and Zisberg (2011) recruited 485 hospitalised older adults receiving acute medical care aged 70 years and over. Using the same scale to categorise mobility levels, data analysis showed a statistically significant correlation between mobility level and length of stay (p>.001). Length of stay was on average 1.5 days shorter for those who mobilised outside their room at least once per day than those who did not.

Zisberg et al. (2011) recruited 525 participants who were aged 70 years and over and admitted to an acute medical unit. Instead of using nursing notes to score mobility level, researchers interviewed patients or their support person to score themselves during hospitalisation. Debatably this technique reduces the comparability with the previously mentioned studies however the results were cognatic. Researchers reported 65% of participants had high levels of mobility during their entire hospitalisation, 16%

moderate levels, and 19% low levels of mobility. Lower levels of mobility were associated with hospitalisation-associated functional decline.

The observation tool used in these studies provides only gross information regarding mobility level. The definition of high mobility level incorporates a wide range of abilities. Patients categorised as having high levels of mobility include those who walked more than once during one 24-hour period with maximal assistance or independently. This scale fails to reflect distance or frequency in any detail. Results from these studies are therefore interpreted with caution and limits comparison with other commensurable studies.

2.5.3 Accelerometer Studies

Five published studies have used accelerometer technology to measure the mobility levels of older adults during medical hospitalisation (Fisher et al., 2011; Fisher et al., 2012; Fisher et al., 2010; Ostir et al., 2013; Sallis et al., 2015). Four of these studies originate from the same group of researchers in Texas, United States of America and data was largely collected over overlapping months. In these four studies, participants wore dual-axis accelerometers for the duration of their hospital stay. The fifth study was also North American but used an alternative accelerometer called Tractivity (Kineteks Corp., Canada) (Sallis et al., 2015). All accelerometers collected steps per day and time spent active data.

Fisher et al. (2010) recorded the mobility levels of older adults 65 years and over who were admitted to an Acute Care for Elders (ACE) unit for a medical, as opposed to a surgical or an orthopaedic presenting complaint. Their research aim was to compare steps taken per day with length of stay in hospital. Sample size was 162 and this study only presented the data for the first and second complete day of hospitalisation. The average steps per day was 662.1 steps (SD 784.9) and the mean step change from first to second day of observation 195 steps (SD 669.3). Mobility level data is compared to other studies with caution as it only included data from the first and second day of observation.

Fisher et al. (2011) published a further study, again using older adults aged 65 years and over who were receiving acute medical care in an ACE unit. Participants (*N*=239) were recruited on the day of admission and data was collected for each complete hospital day, that is to say 24 hours from midnight. Included data was recorded from midnight on the day of admission until midnight the day before discharge from hospital. Participants took 739.7 mean steps per day (IQR 89-1014) and on average spent 96% of each day inactive. On 50% of complete hospital days participants took less than 300 steps, and on 13% of complete hospital days participants did not walk at all.

Fisher et al. (2012) included orthopaedic and medical older adults aged 65 years and over (*N*=198). The sample recorded an average of 585 steps per day (SD 738.0). Analysis also showed that participants with an orthopaedic or neurological presenting condition walked less than those receiving care for a medical complaint.

Ostir et al. (2013) used accelerometer technology to record the mobility levels of older adults aged 65 and over during acute medical hospital stay in an ACE unit. On average participants (*N*=224) were inactive for 94% of each day of data collection. The median step count per day on the first day complete hospital day was 478 steps (IQR 1414) and 846 steps (IQR 1959) on the last.

Sallis et al. (2015) study involved 287 older adults hospitalised in an acute medical unit. During the first 24 hour period participants took on average 1004 steps (SD 1098, median 676) whilst on the last 24 hour period before discharge, participants walked a mean of 1367 steps (SD 1396, median 968). Comparing first to last 24 hour period of observation, the mean step gain for participants was 256 steps.

2.5.4 Wireless Activity Monitor Studies

Wireless activity monitors have been validated for use during hospitalisation (Brown, 2008). They involve the donning of two monitors; one on the thigh and the other at the ankle. Data provided by the monitors can ascertain movement in the vertical and horizontal plane. As such wireless activity monitors can inform researchers on the amount of activity spent lying, sitting, and standing or walking. This tool does not discern between standing and walking.

Brown et al. (2009) recruited 45 participants, aged 65 years and older, during acute medical hospitalisation in North America. The average time spent in bed was 83.9%, in sitting 12.9%, and standing or walking 3.8%. Furthermore 15 participants spent over 90% of their hospitalisation in bed.

In Denmark, Pedersen et al. (2013) used wireless activity monitors to record the activity levels of 49 older adults during acute medical hospitalisation. Alongside data from the activity monitors, the researchers also assessed each participant's basic mobility on day of recruitment and then daily using the Cumulated Ambulation Score (Foss, Kristensen, & Kehlet, 2006). Participants were classed as independent or dependent. This assessment quantifies an individual's level of independence getting in and out of bed, sit to stand from a chair and walking. In summary, all participants exhibited low levels of mobility; dependent participants spent 0.2 hours standing or walking compared with 1.1 hours for those independent on admission.

2.5.5 Summary of Relevant Research

Researchers measuring the mobility levels of older adults during acute hospitalisation have used varying methods of data collection. Some researchers observed participants during daytime hours, some for 24 hour periods. In most studies data was collected throughout participant's period of hospitalisation, in others observation lasted just for a day.

Clinical factors also varied between the studies. The majority of studies were performed in general medical units (Brown et al., 2004; Brown et al., 2009; Callen et al., 2004; Cattanach et al., 2014; Kuys et al., 2012; Pedersen et al., 2013; Shadmi & Zisberg, 2011; Zisberg et al., 2011). However some were conducted in geriatric units (Ferrando, 2000; Fisher et al., 2011; Fisher et al., 2012; Fisher et al., 2010; Ostir et al., 2013). Specialist geriatric units are designed to maximise the functional opportunities and independence for older adults (Barnes et al., 2012; Fox et al., 2012; Landefeld et al., 1995). This focus may affect the comparability of these studies to those performed in acute medical units.

Research measuring the mobility levels during acute hospitalisation have been performed in several countries; United States of America, Israel, Australia and Denmark. Healthcare environment, culture and funding systems could vary considerably, which may ultimately impact research results. Differences may include staffing levels, number of beds per room and local care practices. For example all studies were performed during acute care however median length of stay varied considerably between studies ranging from 3 to 16 days (Cattanach et al., 2014; Pedersen et al., 2013). This variation in length of stay suggests different acute care structures.

Despite these differences, the studies do share similar results. They all conclude that older adults perform low levels of mobility during acute hospitalisation. On average older adults spend most of their day inactive and taking minimal steps.

Observational studies provided only a snap shot of mobility levels during weekdays and are not a true indication of diurnal mobility levels or those performed over weekend days. As previously discussed, the retrospective reporting studies utilised a gross outcome measure that failed to give performance informatics concerning distance or frequency of walking. The wireless monitor studies provided more information on time spent performing different activities but again did not give information regarding mobility levels as time spent walking and standing could not be discerned. Accelerometer technology studies collected both steps per day and time spent mobilising. Therefore to answer the primary objective of describing the mobility levels of older adults during acute hospital stay, this study selected to use accelerometer technology.

The secondary objectives of this study were to explore for trends between mobility levels during acute hospital stay and patient specific characteristics that had been identified by previous studies. Reviewing the foregathered studies, specific patient characteristics were reported to effect mobility levels during hospitalisation. Several studies concurred that older adults with shorter lengths of hospital stay performed higher levels of mobility than those with comparatively longer periods of hospitalisation (Fisher et al., 2011; Fisher et al., 2010; Shadmi & Zisberg, 2011). Older adults with lower levels of mobility during acute hospitalisation were also found to experience higher rates of mortality in the months proceeding discharge (Brown et al., 2004; Ostir et al., 2013). As such this study hypothesised that longer lengths of stay and mortality following discharge would be associated with lower levels of mobility during hospitalisation.

One study did produce several statistically significant associations between mobility levels and patient characteristics. Fisher et al. (2011) found that steps per day were significantly related to mobility status before admission to hospital, history of falls, prior limitations in the ability to perform activities of daily living, and if they had physiotherapy input during admission. Results from other studies contradicted these associations (Callen et al., 2004; Cattanach et al., 2014; Pedersen et al., 2013). The method of statistical testing is postulated to account for this discrepancy.

Fisher et al. (2011) published 15 non parametric statistical tests results. Given the multiple statistical testing, this exposes the results to Type 1 error and the probability of a non significant result incorrectly being identified as significant (Pallant, 2007). The authors did not apply a correction method, lower the alpha value nor did statistical testing control for other factors that may have influenced the results such as age or severity of illness. Given the weakness in statistical analysis and the contradiction in statistical correlations from other studies, the current study hypothesised that older adults would exhibit low levels of mobility regardless of premorbid mobility, mobility status on admission and allied health involvement during hospitalisation.

2.5.6 Section Summary

In summary it is acknowledged that the published research recording the mobility levels of older adults have used differing data collection methods and recorded varying measures of activity within a heterogeneous group of inpatients. However taking the key points from each study, it is clear that during acute medical hospitalisation older adults spend the majority of time sitting or lying.

Low mobility levels are concomitant with increased length of stay in hospital and greater risk of functional decline, institutionalisation, and mortality. As such low mobility levels during hospitalisation are associated with disability, geriatric syndromes and frailty. This then begs the question, what is the definition of low mobility?

2.6 Defining Mobility Levels

To put the collated evidence of mobility levels during acute hospitalisation in context, it is important to consider the mobility levels of older adults when residing in the community. Does acute hospitalisation trigger reduced mobility or in some cases does it reflect usual mobility levels? To enable comparability, the following sections focus on research that has reported mobility levels in daily steps.

2.6.1 Community Mobility Levels

Several studies have explored and classified activity levels using varying objective markers. Relevant to the published literature measuring the mobility levels of older adults during acute hospitalisation, authors have categorised the number of steps per day to reflect the level of physical activity (Cavanaugh, Coleman, Gaines, Laing, & Morey, 2007; Cavanaugh, Kochi, & Stergiou, 2010; Depew, Novotny, & Benzo, 2012; Tudor-Locke et al., 2013). These studies have led to defining sedentary behaviour in adults as less than 5000 steps per day and basal activity as less than 2500 steps per day. Whilst there is no delineation specifically for older adults, researchers have recommended a guide (Cavanaugh et al., 2007; Cavanaugh et al., 2010; Taylor, 2014). Older adults achieving more than 10000 steps per day are considered highly active, 10000 to 5000 moderately active, and those taking less than 5000 steps per day inactive. Given these guidelines, does the performance of community residing older adults reflect activity recommendations?

Empirical studies suggest healthy older adults take on average 5300 to 9900 steps per day whilst older adults living with chronic disease or functional limitations take on average 3300 to 6200 steps per day (Cavanaugh et al., 2007; Cavanaugh et al., 2010; Coleman et al., 2013; De Melo, Menec, Porter, & Ready, 2010; Depew et al., 2012; Moy, Danilack, Weston, & Garshick, 2012; Moy et al., 2014; Shimizu et al., 2007). Recent research is congruent with a systematic review from 2001 where authors suggested the norms for community residing health older adults to be 6000 to 8500 steps per day and 3500 to 5500 for those living with disability and chronic illness (Tudor-Locke & Myers, 2001). Two studies also documented time spent inactive

(Cavanaugh et al., 2007; Ford et al., 2010). On average healthy older adults were inactive for 75% of the day and those with co-morbidities or functional limitations were inactive for 79%.

From this information, older adults taking less than 5000 steps are inactive but it is still undetermined what low mobility is. Bed rest, immobilisation and reduced activity research has considered the body's physiological response to imposed short term low mobility levels. Such studies provide more information on which to base the parameters of what is low mobility.

2.6.2 Short Term Reduced Activity

The deleterious effects of short term bed rest, even after just one day, are well documented and older adults have been shown to sustain more profound physiological changes than younger counterparts (Haeuber, Shaughnessy, Forrester, Coleman, & Macko, 2004; Hvid et al., 2013; Hvid et al., 2014; Kortebein, Ferrando, Lombeida, Wolfe, & Evans, 2007; Stephens, Granados, Zderic, Hamilton, & Braun, 2011; Tanner et al., 2015; Wall et al., 2014). Specific to older adults, short term bed rest has been shown to reduce muscle mass, muscle strength, muscle activation and aerobic exercise capacity (Coker, Hays, Williams, Wolfe, & Evans, 2015; Drummond et al., 2012; Drummond et al., 2013; Hvid et al., 2010; Kortebein et al., 2007; Kortebein et al., 2008; Suetta et al., 2009; Wall, Dirks, & Van Loon, 2013). Following ten days of bed rest Drummond et al. (2012) found healthy older adults experienced a reduction in physical function closely linked with activities of daily living; namely walking speed, stair climbing, sit to stand and floor transfers.

Bed rest does not accurately reflect low mobility levels as targeted by the current study. Several researchers have evaluated the physiological effects of a short term reduction in activity in young adults by reducing mobility levels by limiting step count by approximately 80% (generally to around 1500 steps per day). Studies have shown detrimental physiological impairments in insulin sensitivity and lipid metabolism, loss of lean muscle mass and aerobic capacity, neuromuscular fatigue, reduced popliteal and brachial blood flow and increased visceral fat after as little as five days of reduced mobility levels (Boyle et al., 2013; Krogh-Madsen et al., 2010; Olsen, Krogh-Madsen, Thomsen, Booth, & Pedersen, 2008; Restaino, Holwerda, Credeur, Fadel, & Padilla, 2015; Reynolds et al., 2015; Saunders, Larouche, Colley, & Tremblay, 2012; Thyfault & Krogh-Madsen, 2011). Indeed one day of inactivity has been shown to significantly reduce insulin action and place strain on the metabolic system in healthy young adults (Stephens et al., 2011).

Breen et al. (2013) studied the effect of a short term reduction in mobility levels in older adults. Participants were instructed to be as sedentary as possible, taking less than 1500 steps per day for two weeks. Recorded changes included significantly reduced lean leg mass, increased trunk adiposity, raised systemic inflammatory markers and impaired insulin sensitivity. In older adults such physiological changes are associated with impairments of muscle mass and strength, which is significant when sarcopenia is present in approximately 24% of older adults in acute care wards (Koster et al., 2010; Vetrano et al., 2014).

2.6.3 Section Summary

Older adults taking less than 5000 steps per day are considered to be inactive (Cavanaugh et al., 2007; Cavanaugh et al., 2010; Taylor, 2014; Tudor-Locke, Craig, Thyfault, & Spence, 2013). Empirical data suggests that older adults in good health generally exceed this threshold and those living with chronic conditions or mobility limitations are either above or approximate to it (Cavanaugh et al., 2010; De Melo et al., 2010; Depew et al., 2012; Moy et al., 2012; Moy et al., 2014; Shimizu et al., 2007; Tudor-Locke & Myers, 2001).

Short term reduced mobility research has interpreted reduced mobility as less than 1500 steps per day and older adults are included in this definition (Boyle et al., 2013; Breen et al., 2013; Krogh-Madsen et al., 2010; Olsen et al., 2008; Restaino et al., 2015; Reynolds et al., 2015; Saunders et al., 2012; Thyfault & Krogh-Madsen, 2011). Research has demonstrated physiological changes when older adults performed less than 1500 steps per day. Furthermore published data has recorded the mobility levels of older adults during acute medical hospital stay between 740 and 1367 steps per day (Fisher et al., 2011; Sallis et al., 2015). Using this information, the threshold for low mobility levels for the current study was therefore set at 1500 steps per day.

2.7 General Summary

Statistics have shown that more and more older New Zealanders are identifying as disabled suggesting an expansion of morbidity. The number of older adults is steadily growing and it is predicted that the over 85 years age bracket will be the fastest growing population group in New Zealand. With expansion of morbidity and increasing number of older adults, health services need to adapt and focus on optimising the fitness, wellbeing and independence of the older adults.

Current evidence shows that older adults struggle to recover from acute medical illnesses that lead to hospitalisation. The immediate focus of hospitalisation is to resolve the acute presenting condition that triggered admission. However for older adults, the very act of hospital admission can be detrimental and precipitate secondary health and wellbeing issues. Nosocomial impairments include the geriatric syndromes of incontinence, delirium, pressure injury, falls, and functional decline. As a result older adults are at greater risk of longer hospital stays, disability, re-presentation to hospital, the development or progression of frailty, morbidity and mortality. On discharge they commonly require increased formal supports and incur high healthcare costs.

One risk factor for development of geriatric syndromes whilst in hospital is reduced mobility. With large parts of the day spent either in bed or in a chair, older adults are susceptible to further complications such as geriatric syndromes and new or worsening frailty (Creditor, 1993; Gill et al., 2010; Murphy, 2011). International research has shown that older adults can spend up to 96% of their hospital day sitting or lying and are inactive, taking between 740 and 1367 steps per day (Brown et al., 2009; Fisher et al., 2011; Fisher et al., 2010; Pedersen et al., 2013; Sallis et al., 2015). This level of mobility is detrimental to older adults; even a temporary reduction in mobility levels to this extent has been demonstrated to produce negative physiological changes.

Maximising activity and mobility whilst in hospital has been suggested as the key to minimising iatrogenic decline whilst in hospital (Callen et al., 2004). Knowing how much older in-patients mobilise within current care practices may assist in providing local information to best direct future interventional studies. There is currently no published New Zealand data exploring this topic. The aim of this study was to describe the mobility levels of older adults during acute medical hospitalisation in Wellington Regional Hospital, New Zealand.

Chapter 3: Method

3.1 Introduction

The primary objective of this study was to describe the mobility levels of older adults during acute medical hospitalisation in Wellington Regional Hospital, New Zealand. The secondary purpose of this study was to explore for associations between mobility levels during acute hospital stay and patient specific characteristics that had been identified by previous studies. This chapter details the methods employed to achieve these objectives; namely the design, participants, eligibility criteria, recruitment, ethical considerations, outcome measures, procedure and data analysis for this study.

3.2 Study Setting and Design

This study was undertaken at Wellington Regional Hospital, Wellington, New Zealand. A prospective observational cohort study design was used to measure the mobility levels of older adults during acute medical hospitalisation. Adults over the age of 65 years admitted to Wellington Regional Hospital for an acute medical issue participated in this study. This was solely an observational study; there was no intervention.

3.2 Sample Size

To assist with sample size calculation an Auckland University of Technology statistician was consulted. Until research accrues sufficient data, the intra-cluster correlation of the repeated measures (steps per day) is currently unknown. As such the sample size could not be calculated by traditional methods. The statistician recommended the sample size for this study to be defined by a timeframe set for data collection, which was felt to be practical in terms of resources and timeframes. As such, data collection was set for five months from June to November 2014. It was estimated that this timeframe would allow for recruitment of a sample size of approximately 60 participants.

3.3 Participants

The participants were older adults who were admitted to Wellington Regional Hospital under the care of a medical physician.

3.3.1 Inclusion Criteria

Acute medical patients were eligible to participate in this study if they satisfied the following inclusion criteria:

- Over the age of 65 years
- Admitted to hospital within the preceding 24 hours
- Able to walk around their home in the two weeks prior to hospital admission
- Able to give informed consent

The ability to give informed consent was determined by each potential participant's medical team.

3.3.2 Exclusion Criteria

Patients were excluded from participating in this study if they experienced any of the following conditions:

- Estimated discharge date of less than two days after admission
- Severe bilateral leg oedema or infection
- Lower limb amputation
- Severe agitation

- Living in an aged care facility, for example rest home or private hospital level care
- Admitted to an isolation room due to infection status
- Non-English speaking
- Acute orthopaedic fracture
- Receiving palliative input due to imminent terminal illness

A monitor worn around the participant's ankle collected mobility level data. Due to skin integrity, potential participants with severe bilateral leg oedema or infection were excluded from the study. This research concentrated on older adults admitted to hospital for acute medical issues. Infectious diseases requiring isolation precautions, lower limb amputation and acute orthopaedic fractures had the potential to influence a participant's mobility levels and were therefore excluded from the study. Finally this project did not have access to interpreting services. The researcher wished to ensure the integrity of informed consent and therefore non-English speaking consumers were not approached.

3.4 Recruitment

Recruitment for this study was performed in the Medical and Planning Unit and Ward 5 South, Wellington Regional Hospital over five months between June and November 2014, Monday to Saturday.

A physician reviewed each acute medical patient on either the day of admission to hospital or the following morning. This ward round clearly documented each patient's presenting condition, home situation, problem list, medical plan and estimated day of discharge. This assessment assisted with the identification of older adults who were likely to meet the inclusion and exclusion criteria.

The Nurse In Charge of each medical ward made the initial contact with potential participants on the day of their admission or during the morning of their first full day in hospital. The Nurse in Charge gave a brief explanation of the study, a written information sheet (Appendix A) and answered any immediate questions. The Nurse In Charge sought verbal consent from patients who expressed interest in participating in the study before passing on their details to the researcher. This arrangement gave all potential participants time to consider the study before meeting the researcher.

On receipt of potential participant's details, the researcher reviewed the patient's records and liaised with the medical team to ensure each patient met the eligibility criteria. Once eligibility was established the researcher approached each potential participant in person. The study was explained in greater detail and if the patient was agreeable to volunteer, a written consent form (Appendix B) was completed. Initial assessment was then undertaken and the ankle monitor applied to the participant.

Throughout the recruitment process it was stressed to all potential participants that should they decline the invitation or choose to withdraw from the study at any time, their decision would not in any way affect their treatment whilst in hospital. Reasons for refusing to participate in the research were not sought from those who declined to partake. Any potential participants still undecided during their first full morning in hospital were thanked for their time and excluded from the research. All potential participants were provided with an information sheet and had the opportunity to ask questions throughout their engagement with the study.

3.5 Ethical and Cultural Considerations

This study was approved by the Auckland University of Technology Ethics Committee (reference number 14/122, Appendix C) and registered with the Research Department at Capital and Coast District Health Board. Additionally this study was approved by the Māori Partnership Board through the Research Advisory Group - Māori in Wellington. The Research Advisory Group - Māori consists of representatives from the Māori community and provides researchers with the opportunity to have their research proposals considered from a Māori perspective and is mandated by local Mana Whenua (Te Atiawa, Ngāti Toa, Te Atiawa ki Whakarongotai). All potential participants meeting the eligibility requirements for this study had equal opportunity to join this study irrespective of their ethnic background.

The primary aim of this study was to measure the mobility levels of older adults during acute hospitalisation. The research question required consent and participation from inpatients on their first full day of hospital admission. This study took place during an acute health event and for some potential participants this may have been a distressing time. Given the acute nature of hospital admission and at the potential participant's request, the investigator involved their family/whānau/support person in discussions about this study.

The researcher was a physiotherapist who worked in the medical wards of the hospital. A different physiotherapist managed any participant who required physiotherapy input during their hospital stay.

3.6 Instrumentation and Measures

This section describes the instrumentation used to record mobility levels and the measures to collect participant characteristic information.

3.6.1 StepWatch Step Activity Monitor

Activity monitors were used to measure mobility levels of older adults during acute hospital stay. The StepWatch Step Activity Monitor (Orthocare Innovations, Prosthetics Research Study, Seattle, WA, USA) is a research-grade dual-axis accelerometer for long-term assessment of ambulatory activity during day-to-day life. It is a small (75 x 50 x 20 mm; 38 grams), waterproof, self-contained device that was worn around the ankle and secured with a Velcro strap.

When compared to other wearable mobility monitors, the SAM was found to be feasible and comfortable to wear for older adult populations (Algase, Beattie, Leitsch, & Beel-Bates, 2003; de Bruin, Hartmann, Uebelhart, Murer, & Zijlstra, 2008). The SAM has been shown to be 94 to 99% accurate for a broad range of gait patterns as demonstrated in chronic stroke, Parkinson Disease and Multiple Sclerosis populations plus slow paced gait and when using a walking aid (Bergman, Bassett Jr, & Klein, 2008; Cavanaugh et al., 2007; Fisher et al., 2011; Haeuber et al., 2004; Hartsell, Fitzpatrick, Brand, Frantz, & Saltzman, 2002; Macko et al., 2002; Sandroff et al., 2014; Schmidt, Pennypacker, Thrush, Leiper, & Craik, 2011; Storti et al., 2008; Wendland & Sprigle, 2012).

The SAM recorded the number of strides taken per minute by the leg being monitored and the number of minutes spent performing activity. To calculate the number of steps taken by a participant, the number of strides recorded by the SAM was multiplied by two. This method is congruent with similar studies involving the SAM (Cavanaugh et al., 2007; Fisher et al., 2011; Fisher et al., 2012).

The sensitivity of the SAM was calibrated for each participant by specifying the subjects' height, weight and gait characteristics during programming. The SAM provided no feedback to the subject and thus did not encourage performance behaviour.

3.6.2 Anthropometric Measures

Weight was measured using hospital grade seated scales (Seca 952, Seca, Hamburg, Germany). Participants were weighed wearing hospital gowns with footwear removed. Measuring the height of older adults during acute hospital admissions can be problematic so to ensure standardisation a common alternative of measuring a participant's ulnar length was used, specifically from olecranon to styloid process (Elia, 2003; Madden, Tsikoura, & Stott, 2012). Predicted height was calculated using the following equations (Elia, 2003):

Men: Predicted height (cm)=79.2+ (3.60 x ulna length (cm))

Women: Predicted height (cm95.6+ (2.77 x ulna length (cm))

This method of measuring height was used for all participants. Madden et al. (2012) found moderately strong and significant correlation (r>0.6, p<.001) between actual standing height and predicted height measured using ulna length. This alternative method of measuring height in older adults has been employed by several researchers and is recommended in the Malnutrition Universal Screening Tool (Auyeung et al., 2009; Dunsky et al., 2012; Elia, 2003; Lorini et al., 2014; Reidlinger, Willis, & Whelan, 2015).

Body mass index (BMI) was calculated using height and weight measurements using the following equation:

$$BMI= Weight (kg)/Height (m)^2$$

BMI was then categorised into commonly accepted groups: underweight scoring less than BMI 18.5, normal weight BMI 18.5 to 24.9, overweight BMI 25 to 29.9 and overweight scoring over 30. Lorini et al. (2014) found the interclass correlation coefficient (ICC) for BMI calculated using ulna length was 0.890 (95% CI: 0.872-0.905).

3.6.3 Life Space

The University of Alabama at Birmingham (UAB) Study of Aging Life Space Assessment (Life space) is a validated self-reported measure of a person's mobility during the 4 weeks prior to assessment (Allman, Sawyer, & Roseman, 2006; Baker, Bodner, & Allman, 2003; Peel et al., 2005). Life space provides information regarding a person's mobility destination, frequency and assistance, which reflect their participation in society. This assessment addresses five incremental distances of mobility;

- Level 1- Other rooms of your home besides the room where you sleep
- Level 2- An area outside your home such as your porch, deck, hallway (of an apartment building), or garage, in your own garden or driveway
- Level 3- Places in your neighbourhood, other than your own garden or apartment building
- Level 4- Places outside your neighbourhood, but within your town
- Level 5- Places outside your town

Participants were asked if they had mobilised at each level within the preceding four weeks prior to admission to hospital. If yes, further clarification was sought for frequency per week. Level of performance was classified by no equipment or personal assistance, equipment only and personal assistance. A final score was then tallied.

In the current study, life space was measured based on the highest level of life space achieved (Baker et al., 2003; Peel et al., 2005). Life space maximum is the highest level attained regardless of equipment or assistance used. It is recommended for use in studies exploring the utility of equipment or personal assistance (Baker et al., 2003). Life space independent is the highest level attained without assistance from another person but with the use of equipment as required. It is recommended for use in studies researching associations between mobility and other factors (Baker et al., 2003).

Life space is correlated with gait speed (p<.001), comorbidity (p=.011), the development of frailty (p<.05), admission to aged residential care (p<.001) and mortality (p<.001) (Allman et al., 2006; P. A. Boyle, Buchman, Barnes, James, & Bennett, 2010; Mackey et al., 2014; Sheppard, Sawyer, Ritchie, Allman, & Brown, 2013; Xue, Fried, Glass, Laffan, & Chaves, 2008). The test-retest reliability of life space was high; compared to using baseline interview measurements with telephone interview two weeks apart, the interclass correlation coefficient was 0.96 (Baker et al., 2003).

3.6.4 Braden Risk Assessment Tool

The Braden Risk Assessment Tool identifies the degree of risk for development of a pressure injury (Bergstrom, Braden, Laguzza, & Holman, 1987). This clinical tool is part of the nursing care plan for all patients at Wellington Regional Hospital and is completed within eight hours of admission by a registered nurse. It involves the rater scoring each individual on six subscales: sensory perception, moisture, activity, mobility, nutrition and friction. It is scored out of 23 whereby a score of 19 to 23 equates to no risk and a score of 18 or less is deemed at risk of developing pressure injury.

The Braden score for each participant was recorded from the nursing assessment at admission. Varying registered nurses therefore assessed the Braden score. The inter-rater reliability was recently deemed substantial by Wang et al. (2015) with an ICC of 0.955 (95% CI: 0.922-0.978). Bergstrom et al. (1987) performed sensitivity and specificity testing for the Braden; in acute medical-surgical units, the tool was 100% sensitive and 90% specific. A more current review of recent literature supports the reliability and validity of the Braden tool citing inter-rater reliability ranging from 0.83-0.99, percentage agreement of 88% to 100% and sensitivity and specificity both up to 100% (Kring, 2007).

3.6.5 Identification of Seniors at Risk Screening Tool

The Identification of Seniors at Risk Screening Tool (Apisarnthanarak et al., 2007) is a self-reported measure that records a person's premorbid and acute change in function (McCusker et al., 1999). This frailty measure was developed for use in the emergency department to identify older adults at risk of functional decline after presentation to hospital (McCusker et al., 1999). It is a brief six question tool requiring yes/no answers; a score of two or more indicates a positive response. The ISAR has been shown to have strong concurrent validity for detecting functional decline, re-presentation to the emergency department and hospitalisation (Dendukuri, McCusker, & Belzile, 2004; McCusker et al., 1999; Salvi et al., 2012).

A recent systematic review found the sensitivity of the ISAR to vary from 73% to 94% and specificity between 33% and 47% (Warnier et al., 2015). Despite the ISAR's low specificity, when compared to other geriatric screening tools researchers recommended the use of ISAR in acutely hospitalised patients (Hoogerduijn et al., 2007; Inzitari et al., 2015; Warnier et al., 2015).

3.6.6 Elderly Mobility Scale

The Elderly Mobility Scale (EMS) is a commonly used measure of basic mobility that has been validated for use with older adults in acute in-patient settings (de Morton, Berlowitz, & Keating, 2008; Smith, 1994). This measure was selected as it reflected an individual's ability to perform functional tasks that are required for mobility within the hospital environment. Equipment required for this test was a standard hospital bed, a chair, stopwatch and a functional reach chart. Each participant was scored on their level of independence for lying to sitting, sitting to lying, sit to stand, and timed six metre walk. Participant's standing balance was assessed by asking them to stand unsupported with their feet close together whilst lifting their arms out to the side and up over their heads. If they were able to perform this independently then they progressed on to the functional reach test.

The functional reach test was demonstrated to the participant before attempting it. Standing perpendicular and close to but not leaning on a wall, the participant brought up the arm closest to the wall to shoulder height with elbow straight. They were asked to make a fist, lean as far forward as they could without taking a step and then return independently to the starting position. The distance of reach was measured and average of three reaches scored (Duncan, Weiner, Chandler, & Studenski, 1990).

The maximum score for the EMS was 20. Scoring less than 10 points was indicative of someone being dependent on assistance for basic functional tasks, 10 to 13 points was indicative of being borderline for requiring assistance with basic mobility tasks, and 14 and over was indicative of independence with basic mobility tasks (Smith, 1994).

Concurrent validity was established by Smith (1994) by correlating the EMS with the Functional Independence Measure and the Barthel Index; Spearman's rank correlation coefficient was p=.948 and p=.962 respectively. Later studies have reaffirmed concurrent validity with the Modified Rivermead Mobility Index (Spearman's rank correlation coefficient p=.887) and the Barthel Index (R^2=0.79, p<.001) (Nolan, Remilton, & Green, 2008; Prosser & Canby, 1997). Strong intra-rater reliability (Spearman's rank correlation coefficient p=.887) and inter-rater reliability (R^2=0.0051, p=1.00, signalling no statistical difference between raters) have also been demonstrated (Nolan et al., 2008; Prosser & Canby, 1997).

3.6.7 Clinical Diagnosis

Clinical diagnosis was determined by the clinical coders employed by Wellington Regional Hospital using the patient classification system Australian Refined Diagnosis Related Groups (AR-DRG) Version 6.0x (Australian Government, 2008). This study utilised the Major Diagnostic Category as the clinical diagnosis.

3.6.8 Other Measures Recorded

Following discharge the researcher reviewed each participant's notes for key characteristics that may have impacted on mobility levels during hospitalisation. Input from physiotherapy and occupational therapy during hospital stay may have indicated those participants with greater functional decline. Similarly several studies have indicated that allied health intervention increases the activity levels of older adults during acute hospitalisation (Courtney, 2012; De Morton, Keating, & Jeffs, 2007; Mudge et al., 2008; Mudge et al., 2015; Nolan & Thomas, 2008; Shearer & Guthrie, 2013). Input from physiotherapy and occupational therapy was therefore recorded. Other characteristic noted included if the participant fell during hospitalisation and total length of stay.

Re-admission and mortality rates 30 days, 3 months, and 6 months following discharge were also collected. Re-admission was classified as an overnight stay in hospital. Data was accessed using Wellington Regional Hospital's electronic clinical records.

3.7 Procedure

3.7.1 Staff Education

Before recruitment commenced, the researcher attended ward based nursing meetings to inform the nurses of the study and familiarise them with the SAM. Appendix D is the staff information sheet about the study including the don and doffing instructions for the SAM.

3.7.2 Commencement of Data Collection

Following recruitment to the study, participant specific information was collected and SAM fitted. All participant specific information and measures were collected on the data collection form (Appendix E). This initial assessment recorded demographic information, pre-admission function and characteristics at point of recruitment.

The time of donning the SAM was recorded on the data collection sheet. This time reflected the commencement of the first complete 24 hour hospital day of mobility level data collection. Participants were given verbal and written information as to the application and care of the SAM (Appendix F). Participants were also given a copy of their signed consent form. The researcher documented in the participant's medical notes their inclusion in the study, filed a copy of the consent form and informed their allocated registered nurse. The staff laminated information card was inserted at the front of the medical file for easy reference and had contact details for the researcher should any problems arise.

Although waterproof it was recommended the SAM be removed for showering and as required for clinical tests such as x-ray, CT and MRI. Registered nurses monitored the participant for any signs of pressure injury or skin irritation.

3.7.3 Monitoring

The researcher visited each participant mid morning Monday through to Saturday, whilst participating in the research. The purpose of this visit was threefold. Firstly to check the monitor was comfortable for the participant, secondly to change the strap should it be wet and lastly to monitor for day of discharge. When data collection was complete, the SAM was removed and a discharge assessment completed by the researcher.

3.7.4 Cessation of Data Collection

The last complete hospital day was defined as the last 24 hour period the SAM was worn for. The SAM was removed by the researcher if one of the below criteria was fulfilled:

- Day of discharge from Wellington Regional Hospital
- Seventh complete hospital day
- If the participant had a change in health status that met the exclusion criteria
- If the SAM became uncomfortable

The SAM was removed immediately from participants who found it uncomfortable or had a change in health status. For the participants who completed data collection, the time of removal was planned so that it was after the time of donning of the SAM and therefore ensuring a complete 24-hour cycle. Participant's actual discharge time from hospital was independent of this study. Mobility level recordings were then downloaded from the SAM with a standard computer via a docking station plugged into a USB port. The SAM and dock communicated through an infrared link, which allowed the SAM to be completely sealed, waterproof and impervious to tampering. In between participants the SAM was cleaned with a hospital grade product and Velcro straps hand washed.

3.8 Data Management

All data collected was de-identified and coded with a unique participant identifier in order to remain confidential and anonymous. The participant identifier register was securely stored in the Physiotherapy Team Leader's office separate from all other data. Only the researcher had access to the data. All written raw data was stored in the researcher's office in a locked cabinet. Computer based data was stored on a password protected hard drive and stored locked in a cabinet with the raw data. No identifying material was kept with the hard drive.

When reviewing and discussing data with supervisors, participants were only identified by their unique number, not their name.

3.9 Data Analysis

Raw data from the SAM computer programme was exported to an Excel spread sheet. Data analysis was performed using SPSS statistical software package (IBM SPSS version 22.0 for Windows, SPSS Inc., Chicago, USA). The SAM recorded steps in one minute intervals. This data was synchronised to a 24 hour time period and was reported by complete 24 hour hospital day, starting at time of donning. Mean steps per day per participant, time spent inactive, step change and the change in time spent active from first to last complete hospital day were calculated. Data were tested for normality using Shapiro-Wilk test and box plots. Box plots were noted to be asymmetrical and outliers present. Data were determined to be non-normally distributed. Nonparametric tests were therefore selected for statistical analysis and the median selected as the measure of central tendency. The alpha level was set at .05.

Data analysis involved three phases. Firstly the basic characteristics of the cohort were recorded, this included age, ethnicity and diagnosis on discharge. The mean and standard deviation of time from admission till donning of SAM, length of observation, length of hospitalisation and total number of observation days was calculated.

The second data analysis phase addressed the primary objective of the study. Descriptive analysis of the cohort's mobility levels during hospitalisation was performed. The median and interquartile range was calculated for steps per day, time spent inactive, step change from first to last day of observation and the difference in time spent active from first to last day of observation.

The third and final statistical testing was conducted to explore for associations between mobility levels during acute hospital stay and patient specific characteristics that had been identified by previous studies, therefore addressing the secondary objectives of the study. These characteristics included measures of premorbid community mobility, mobility status on admission, physiotherapy and occupational therapy involvement during admission, length of stay and mortality rates six months following discharge. Steps per day and the difference from first to last day of observation were used for statistical testing. Descriptive statistics for each variable were also calculated and recorded.

The Mann-Whitney *U* test was employed to test for statistical differences between the dependent variables of steps per day or step change from first to last day characteristics, with independent variables with two groups. For example the Mann-Whitney *U* test was used when analysing data by sex (male and female) (Pallant, 2007). The Mann-Whitney *U* test ranks the median values of the dependent variable across the two groups and calculates for statistical significance. The test statistic for the Mann-Whitney test is denoted *U*.

To compare dependent variables of steps per day and step change from first to last day to categorical independent variables with three or more groups, the Kruksall-Wallis test was used. For example to explore the statistical relationship between the dependent variable of steps per day against the independent variable of BMI which has four groups. This rank based test is the non-parametric alternative to one-way between groups analysis of variance (Pallant, 2007). The test statistic for the Kruksall-Wallis test is denoted x^2 (Chi-Square) as the sampling distribution of the test statistic is a Chi-Square distribution (Pallant, 2007).

Due to the large number of variables, it was acknowledged that statistical testing would involve multiple comparisons and therefore may have a high number of false positive results, exposing the data analysis to Type 1 error (Pallant, 2007). To control for the expected proportion of falsely rejected hypotheses i.e. the False Discovery Rate, the Benjamini-Hochberg procedure was employed (Benjamini & Hochberg, 1995). The Benjamini-Hochberg critical value for a FDR was set at 0.20.

Chapter 4: Results

4.1 Introduction

This chapter presents the results of this study. Firstly it discusses the recruitment and retention of the cohort. It provides an overview of the cohort's characteristic. Next this chapter addresses the primary objective of this study, which was to describe the mobility levels of older adults during acute medical hospitalisation. It was hypothesised that participants would exhibit low levels of mobility during acute hospital stay taking less than 1500 steps per day. Lastly, this chapter will present the relationship between participant's recorded mobility levels with individual characteristics. The secondary purpose of this study was to explore for associations between mobility levels during acute hospital stay and patient specific characteristics that had been identified by previous studies. It was hypothesised that all participants would exhibit low levels of mobility during acute hospital stay regardless of premorbid community mobility, mobility status on admission and physiotherapy and occupational therapy involvement during admission. It was also hypothesised that the mobility levels of older adults during acute hospital stay would be associated with length of stay and mortality rates six months following discharge.

4.2 Recruitment and Retention

During the recruitment period, 108 older adults were identified as meeting the eligibility criteria for this study and were approached as potential participants. After having the study explained in greater detail, four potential participants declined to participate. In total 104 participants were recruited.

Data collection was completed from June to November 2014. Of the 104 participants, 84 completed data collection. Six participants found the SAM uncomfortable and withdrew, three died or were withdrawn due to deteriorating health and the SAM malfunctioned with two participants. During data collection 11 participants were transferred from the care of the medical to the geriatricians. These participants were lost to follow up. Figure 4.1 summarises the recruitment and retention progress of the study.

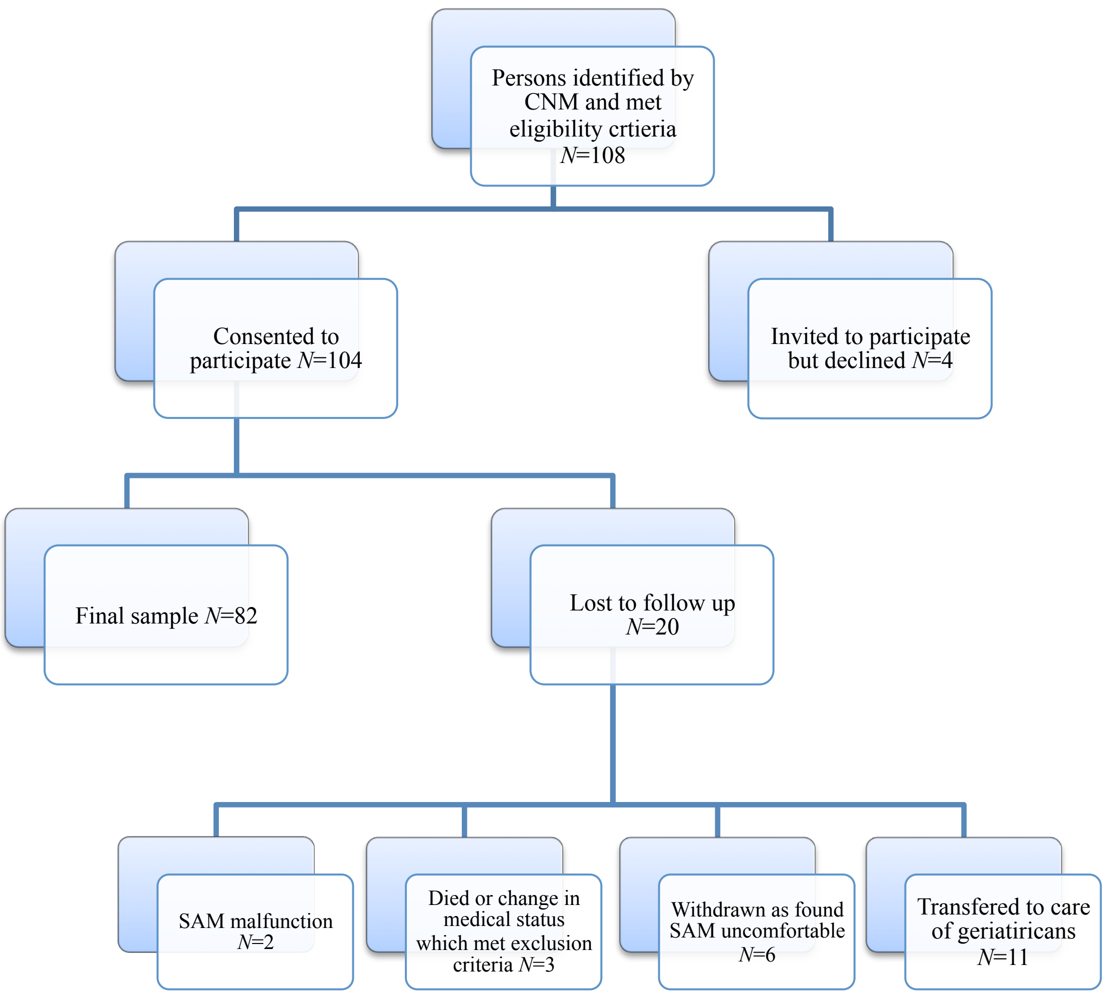

Figure 4.1. Participant recruitment and retention.

4.3 Basic Cohort Characteristics

The mean age of the sample was 81.3 years ranging from 65 years to 94 years (median 83 years); 38 participants were female and 44 male. On average, the SAM was donned 16 hours and 10 minutes after admission, standard deviation (SD) 5 hours and 35 minutes. The average length of hospital stay for the cohort was 5.6 days ranging from 1 to 39 days (SD 5.4 days). The SAM recorded mobility data for each complete hospital day lasted 24 hours. The mean number of complete hospital days was 3.7 days (SD 1.8 days). In total 301 complete hospital days were recorded from the 84 participants. Table 4.1 details basic characteristic information.

Table 4.1. Basic Characteristics of Cohort

Participant Characteristic		**Number of Sample**	**Percentage of Sample**
Ethnicity	New Zealand European/Pākehā	58	71%
	European	12	15%
	Pacific Island	7	9%
	Māori	3	4%
	Asian	2	2%
Age	65-74 years	16	20%
	75-84 years	36	44%
	>85 years	30	37%
Presenting condition	Respiratory system	37	45%
	Circulatory system	20	24%
	Kidney and urinary tract	7	9%
	Musculoskeletal system and connective tissue	5	6%
	Other	15	19%

4.4 Mobility Levels During Hospitalisation

The primary objective of this study was to measure the mobility levels of older adults during acute medical hospitalisation. It was hypothesised that participants would exhibit low levels of mobility during acute hospital stay taking less than 1500 steps per day. Table 4.2 summarises the cohort's results. Mobility data were found to be not normally distributed and, given the wide spread of data, this study used the median as the measure of central tendency when referring to the cohort and interquartile range (IQR) for spread.

Table 4.2. Summary of Mobility Level Data for Cohort

Measure	**Mean**	**Median**	**SD**	**IQR**
Steps per day	1164	1006	875	938
Time spent inactive	94.6%	95.6%	3.8%	2.1%
Step change first to last day	+249	+234	996	812
Time spent active change first to last day	+0.8%	+0.9%	3.5%	2.5%

Note. SD = Standard Deviation. IQR = Interquartile Range.

4.4.1 Steps Per Day

The cohort took a median of 1006 steps per day (IQR 938). Figure 4.2 presents a histogram depicting the percentage of participants achieving steps per day in incremental bands. Of the 82 participants, 76% (*N*=62) took less than 1500 steps per day during their hospitalisation, 50% (*N*=41) took less than 1000, 37% (*N*=30) less than 750 and 22% (*N*=18) less than 500 steps.

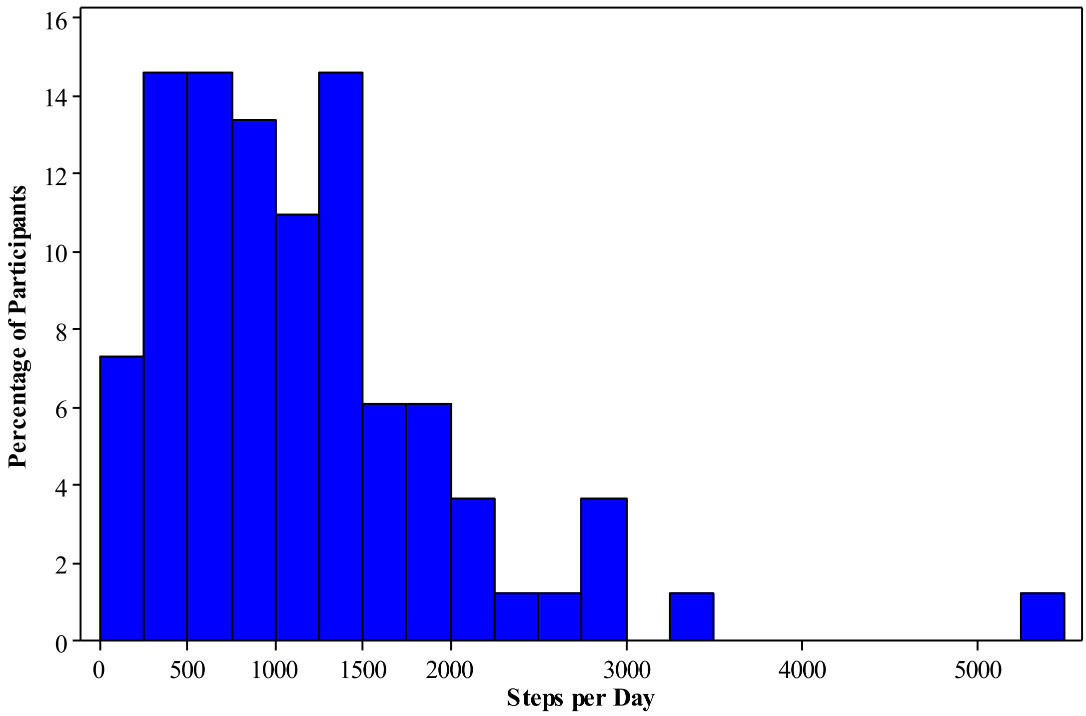

Figure 4.2. Percentage of participants steps per day in incremental bands.

Figure 4.3 displays the median steps per day stratified according to the number of complete hospital days. From the cohort, 13% of (*N*=11) participants spent one complete 24 hour day in hospital, 17% (*N*=14) were in hospital for two complete days, 20% (*N*=16) for three days, 18% (*N*=15) for four days, 12% (*N*=10) for five days, 10% (*N*=8) for six and 10% (*N*=8) for seven. Participants with shorter lengths of stay, and therefore fewer complete hospital days, tended to walk more on their first complete hospital day than those who were hospitalised for longer. Participants with shorter lengths of stay also displayed sharper increases in steps per day.

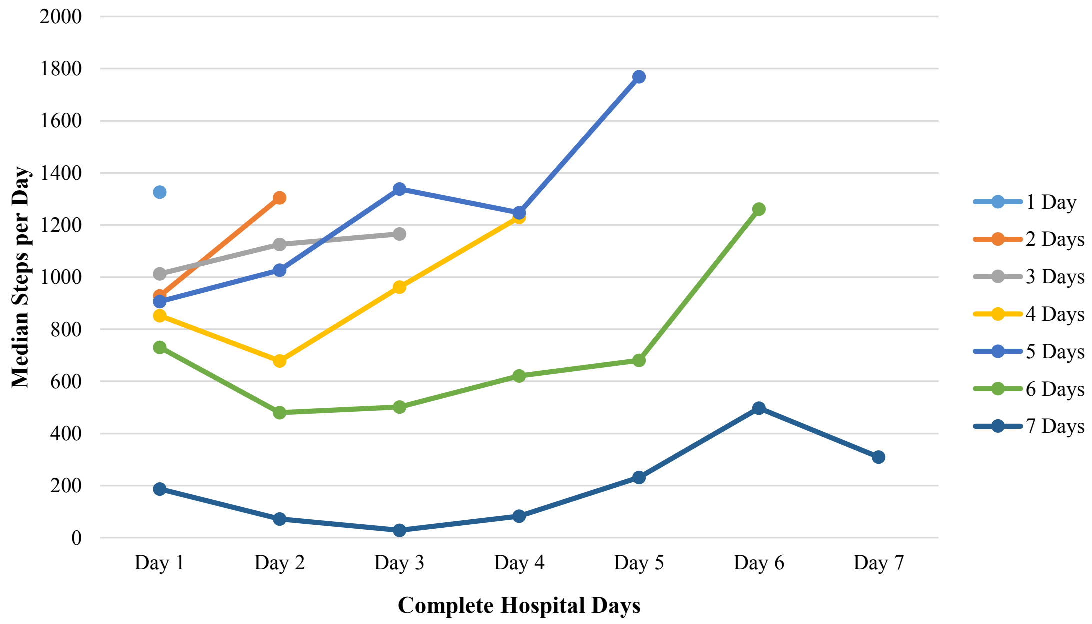

Figure 4.3. Median steps per day by complete hospital days.

4.4.2 Time Spent Inactive

Inactivity was defined as time not involved in ambulatory activity i.e. lying, sitting, or standing. The minutes of time spent inactive was recorded by the SAM and calculated as a percentage of each complete hospital day.

Participants were inactive for 95.6% of the day (IQR 2.1%). This corresponds to participants being active for 63 minutes over 24 hours. Figure 4.4 presents a histogram reflecting the percentage of participant's time spent in active per day. In total 56 participants (68%) were inactive for over 94% of each complete hospital day.

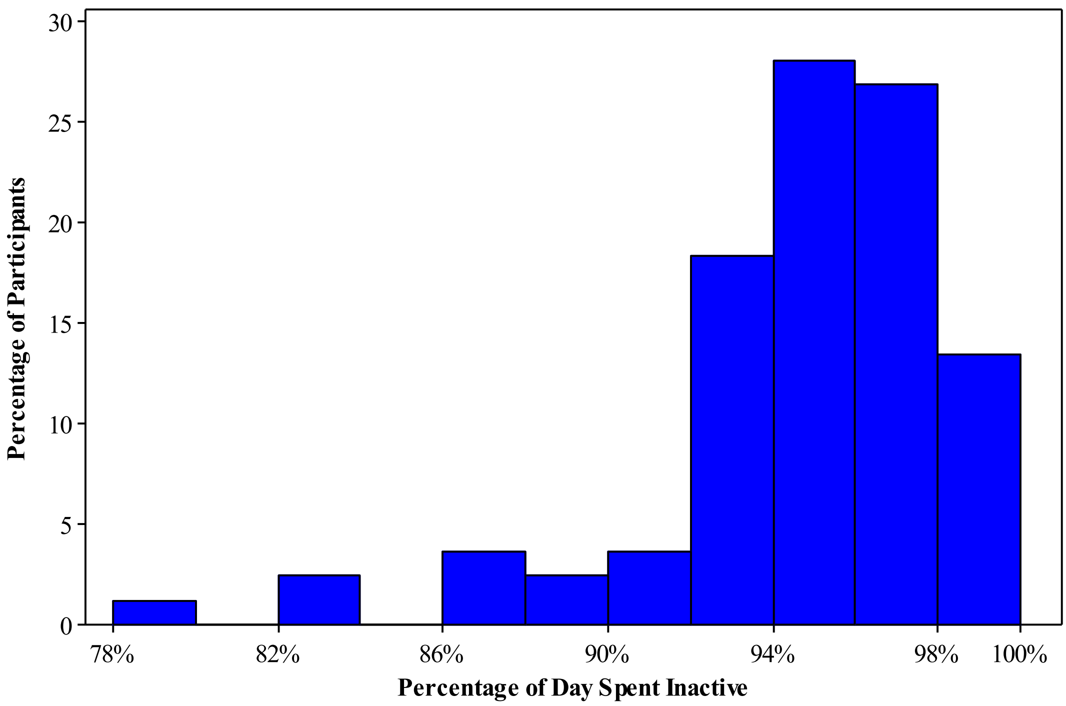

Figure 4.4. Percentage of participants time spent inactive.

4.4.3 Step Change First to Last Day

Step change between steps taken on the first and last complete hospital day was both calculated for all participants who were observed for two or more complete hospital days (*N*=71). Of the 71 participants, 66% (*N*=47) demonstrated an increase in steps taken per day from first to last day whilst 34% (*N*=24) exhibited a decrease in steps taken per day. The cohort walked more on their last complete hospital day than their first with a median step change of +234 steps. Data analysis revealed large variation within the sample with high IQR spread of 812 steps.

4.4.4 Time Spent Active Change First to Last Day

Participants spent more time mobilising on their last day than their first; the median gain was 0.9% of time (IQR 2.5%), which equates to 13 minutes (IQR 36 minutes). Similar to step change, not all participants spent more time being active. From the 71 participants who were observed for two or more days, 48 (68%) increased their time spent mobilising whilst 23 (32%) were observed to mobilise for less time on their final complete hospital day.

4.4.5 Mobility Levels and Primary Objective

The primary objective of this study was to describe the mobility levels of older adults during acute hospital stay. This section has described the mobility levels of the cohort. Participants displayed low levels of mobility and were largely inactive. The majority (76%) of the cohort took less 1500 steps per day; the median steps per day was 1006. These results support the hypothesis that participants would exhibit low levels of mobility during acute hospital stay taking less than 1500 steps per day.

4.5 Relationship of Mobility Levels to Characteristics

To address the secondary objective, data was analysed to determine if there was any relationships between participant specific characteristics and mobility levels during acute medical hospitalisation. Steps per day and the step difference from first to last complete hospital day were used for significance testing. Hypotheses were made based on those that had been identified by previous studies.

It was hypothesised that all participants would exhibit low levels of mobility during acute hospital stay regardless of premorbid levels of community mobility, mobility on admission and physiotherapy and occupational therapy input during admission. It was also posited that the mobility levels of older adults during acute hospital stay would be influenced by length of stay and mortality rates following discharge. It was hypothesised that those participants with shorter lengths of stay would record higher levels of mobility whilst participants who died within six months following discharge would have displayed lower levels of mobility during their hospital stay. The following sections group together characteristics in the following headings:

demographic and premorbid function, characteristics recorded at recruitment, characteristics recorded at discharge, and lastly characteristics recorded six months following discharge.

4.5.1 Demographic and Pre-Admission Function Characteristics

Demographic and pre-admission characteristics were statistically analysed with respect to steps per day and step change from first to last complete hospital day. Characteristics included age, sex, history of falls within the last year, mobility aid use, living situation, and levels of community mobility.

Descriptive data detailed in tables 4.3 and 4.4 show that participants were generally active and mobile in their communities. Most participants walked around their home without a walking aid (66%). Outdoors, 49% walked unaided. Utilising the life space questionnaire, the majority (96%) of participants achieved a maximum life space level 4 or above and 56% of the cohort achieved life space independence level 4.

4.5.1.1 Steps per day

Demographic and pre-admission function had no statistical significance on steps taken per day whilst in hospital. Sex, falls history, age, indoor mobility aid use and living situation did not impact on the mobility levels of this sample. Tables 4.3 and 4.4 detail descriptive and statistical testing results of demographic and pre-admission function characteristics compared to steps per day.

Table 4.3. Steps per Day by Sex, Falls History and Life Space Maximum Level

Characteristic	***N* (%)**	**Median**	**IQR**	***U***	***p***
Sex				666.5	.162
Male	44 (54%)	985	994		
Female	38 (46%)	1205	1074		
Falls history				793.5	.716
Yes	37 (45%)	887	1413		
No	45 (55%)	1024	1360		
Life space maximum level*				499.5	.087
Level 1	1 (1%)	1479	-		
Level 2	2 (2%)	745	-		
Level 3	-	-	-		
Level 4	56 (68%)	933	1046		
Level 5	23 (28%)	1219	1010		

Note. IQR= Interquartile Range. *U*= computed value of Mann Whitney Test. *p*= probability.
*Due to low numbers in Life space levels 1 and 2, levels 4 and 5 tested only.

Table 4.4. Steps per Day by Age, Living Situation, Indoor Aid, Outdoor Aid and Life Space Independent Level

Characteristic	***N* (%)**	**Median**	**IQR**	x^2	***p***
Age				.227	.893
65-74 years	16 (20%)	1058	1367		
75-84 years	36 (44%)	959	1108		
>85 years	30 (37%)	1020	943		
Living situation				1.004	.605
Alone	41 (50%)	992	1020		
With spouse	32 (39%)	1073	902		
With family	9 (11%)	674	1159		
Indoor aid				1.507	.471
Unaided	54 (66%)	1073	862		
Stick(s)	13 (16%)	674	1610		
Frame	15 (18%)	928	1084		
Outdoor aid				4.389	.111
Unaided	40 (49%)	1218	968		
Stick(s)	28 (34%)	903	947		
Frame	14 (17%)	703	945		
Life space independent level				1.458	.834
Level 1	6 (7%)	908	631		
Level 2	24 (29%)	991	1199		
Level 3	6 (7%)	100	1713		
Level 4	35 (43%)	979	922		
Level 5	11 (13%)	1219	929		

Note. IQR= Interquartile Range. x^2= computed value of Kruksall Wallis Test. p= probability.

These characteristics were not found to influence the number of steps taken per day during acute hospitalisation. Large interquartile ranges were recorded for all characteristics indicating considerable variability within the cohort.

4.5.1.2 Step change from first to last complete hospital day

Demographic and pre-admission function characteristics were also compared to the step change of participants from first to last complete hospital day (*N*=72). Tables 4.5 and 4.6 present the results of this analysis.

Table 4.5. Step Change From First to Last Day by Sex, Falls History and Life Space Maximum Level

Characteristic	***N* (%)**	**Median**	**IQR**	***U***	***p***
Sex				570	.562
Male	40 (56%)	161	807		
Female	31 (44%)	304	884		
Falls history				599	.747
Yes	33 (46%)	234	557		
No	38 (54%)	218	924		
Life space maximum level*				369	.042**
Level 1	1 (1%)	158	-		
Level 2	2 (3%)	312	-		
Level 3	-	-	-		
Level 4	48 (68%)	131	593		
Level 5	20 (28%)	405	1493		

Note. IQR= Interquartile range. U= computed value of Mann Whitney Test. p= probability. * *Due to low numbers in Life space levels 1 and 2, levels 4 and 5 tested only.*
** $p < .05$

Table 4.6. Step Change From First to Last Day by Age, Living Situation, Indoor Aid, Outdoor Aid and Life Space Independent Level

Characteristic	***N* (%)**	**Median**	**IQR**	x^2	***p***
Age				4.43	.109
65-74 years	16 (23%)	263	1292		
75-84 years	30 (42%)	73	650		
>85 years	25 (35%)	382	860		
Living situation				0.813	.666
Alone	37 (52%)	164	556		
With spouse	27 (38%)	234	1000		
With family	7 (10%)	360	370		
Indoor aid				0.539	.764
Unaided	47 (66%)	192	896		
Stick(s)	10 (14%)	246	930		
Frame	14 (20%)	181	607		
Outdoor aid				1.915	.384
Unaided	34 (48%)	134	1291		
Stick(s)	24 (34%)	276	687		
Frame	13 (18%)	-4	643		
Life space independent level				2.741	.602
Level 1	5 (7%)	84	300		
Level 2	21 (30%)	192	609		
Level 3	5 (7%)	-4	2294		
Level 4	29 (41%)	158	678		
Level 5	11 (15%)	548	1998		

Note. IQR= Interquartile Range. x^2= computed value of Kruksall Wallis Test. p= probability.

Participants who scored life space maximum zone of level 5 had a larger step change from first to last complete hospital day taking a median of 405 steps more on their last complete hospital day. This is compared to those participants classified as level 4 who took a median of 131 steps more on their last than first complete hospital day. It is noted that those in level 5 had a larger spread of data than those in level 4 (IQR=1493 and 593 respectively). Testing indicates the difference in step change from first to last day between the two groups was statistically significant (U=363, p=.042). No other statistically significant relationships were found.

4.5.2 Characteristics at Recruitment

Characteristics assessed at recruitment were statistically analysed to identify any significant factors that may correlate with mobility levels during acute hospital stay. These characteristics were the Braden Risk Assessment Tool, Identification of Seniors at Risk (Apisarnthanarak et al., 2007) Tool, Body Mass Index (BMI), and the Elderly Mobility Scale (EMS).

BMI was calculated for each participant and classified into subgroups. Of the 82 participants, 4% (N= 3) were underweight, 30% (N= 25) were of normal weight, 35% (N= 29) overweight and 30% (N= 25) obese. Using the ISAR, 78% of participants (N= 64) were classified at being at risk of functional decline. A large proportion of the cohort (61%) were independently mobile at recruitment, scoring 15 points or greater on the EMS. The Braden Risk Assessment Tool identified that 23% of participants were at risk of developing pressure injury. Tables 4.7 and 4.8 detail this information in greater detail.

4.5.2.1 Steps per day

The characteristics of the cohort assessed at recruitment were compared to steps per day; tables 4.7 and 4.8 present this analysis.

Table 4.7. Steps Per Day by Braden and ISAR

Characteristic	*N* (%)	Median	IQR	*U*	*p*
Braden				378	.019*
At risk	19 (23%)	658	874		
Not at risk	63 (77%)	1159	870		
ISAR				423	.087
At risk	64 (78%)	908	1004		
Not at risk	18 (22%)	1208	931		

Note. Mdn= median. SD= Standard deviation. IQR= Interquartile range. U= computed value of Mann Whitney Test. p= probability. ISAR= Identification of Seniors At Risk.
**p<.05*

Table 4.8. Steps Per Day by BMI and EMS

Characteristic	*N* (%)	Median	IQR	x^2	*p*
BMI				2.113	.348
Underweight and normal	28 (34%)	1008	1129		
Overweight	29 (35%)	946	1010		
Obese	25 (30%)	1020	1118		
EMS				5.228	.073
Independent	50 (61%)	1208	876		
Minimal assistance	14 (17%)	750	928		
Dependent	18 (22%)	862	1205		

Note. Mdn= median. SD= Standard deviation. IQR= Interquartile range. x^2*= computed value of Kruksall Wallis Test. p= probability. BMI= Body Mass Index. EMS= Elderly Mobility Scale.*

In this cohort, older adults who were at risk of pressure injury had significantly lower levels of mobility during hospitalisation as measured by steps per day when compared those who were not (*U*=378 *p*=.019). No other statistically significant results were found.

4.5.2.2 Step change from first to last complete hospital day

Braden, ISAR, BMI and EMS were all compared to the step difference from first to last complete hospital day. Tables 4.9 and 4.10 display the results of this testing. For this cohort of older adults, no statistically significant relationships were found.

Table 4.9. Step Change from First to Last Day by Braden and ISAR

Characteristic	***N* (%)**	**Median**	**IQR**	***U***	***p***
Braden				431	.543
At risk	18 (25%)	79	597		
Not at risk	53 (75%)	248	878		
ISAR				422	.618
At risk	54 (76%)	173	744		
Not at risk	17 (24%)	244	1365		

Note. Mdn= median. SD= Standard deviation. IQR= Interquartile range. U= computed value of Mann Whitney Test. p= probability. ISAR= Identification of Seniors At Risk.

Table 4.10. Step Change by BMI and EMS

Characteristic	***N* (%)**	**Median**	**IQR**	x^2	***p***
BMI				2.079	.354
Underweight and normal	23 (32%)	164	442		
Overweight	24 (34%)	405	879		
Obese	24 (34%)	143	986		
EMS				1.897	.387
Independent	40 (56%)	270	1007		
Minimal assistance	14 (20%)	-4	635		
Dependent	17 (24%)	182	690		

Note. Mdn= median. SD= Standard deviation. IQR= Interquartile range. x^2*= computed value of Kruksall Wallis Test. p= probability. BMI= Body Mass Index. EMS= Elderly Mobility Scale.*

4.5.3 Characteristics at Discharge

On discharge, relevant information regarding each participant's stay in hospital was collected. Characteristics included physiotherapy or occupational therapy input during hospital admission, diagnosis, and length of hospital stay.

From the cohort, 71% (*N*=58) received physiotherapy whilst in hospital and 29% (*N*=24) received occupational therapy. Two participants experienced a fall during their admission. With the exception of in-hospital falls, statistical analysis was performed and data was compared with steps per day and step change from first to last complete hospital day.

4.5.3.1 Steps per day

Tables 4.11 and 4.12 present the statistical testing for steps per day and physiotherapy and occupational therapy input, diagnosis and length of hospital stay. With the exception of length of stay, statistical significance was not found between these characteristics and steps per day.

Table 4.11. Steps per Day and Physiotherapy and Occupational Therapy Input During Hospitalisation

Characteristic	*N* (%)	Median	IQR	*U*	*p*
Physiotherapy during admission				604.5	.351
Yes	58 (71%)	985	1074		
No	24 (29%)	1142	956		
Occupational Therapy during admission				610	.480
Yes	23 (28%)	938	1320		
No	59 (72%)	1024	856		

Note. Mdn= median. SD= Standard deviation. IQR= Interquartile range. U= computed value of Mann Whitney Test. p= probability.

Table 4.12. Steps per Day by Diagnosis and Length of Stay

Characteristic	***N* (%)**	**Median**	**IQR**	**x^2**	***p***
Diagnosis				5.719	.221
Resp	37 (45%)	1250	1056		
Circ	20 (24%)	1037	1022		
MSK	7 (9%)	393	726		
KUT	5 (6%)	743	500		
Other	15 (19%)	1097	1058		
Length of Stay				13.98	.007*
1-2 days	13 (16%)	1250	783		
3-4 days	32 (39%)	1174	1061		
5-6 days	20 (24%)	1218	989		
7-13 days	12 (15%)	402	590		
>14 days	5 (6%)	357	920		

Note. IQR= Interquartile range. x^2= computed value of Kruksall Wallis Test. p= probability. Resp= diseases and disorders of the respiratory system. Circ= diseases and disorders of the circulatory system. KUT= diseases and disorders of the kidney and urinary tract. MSK= diseases and disorders of the musculoskeletal system and connective tissue.

Within this cohort, participants who had a shorter length of stay in hospital recorded higher mobility levels (x^2 =13.98 *p*=.007). To further analyse this significance, Mann Whitney *U* testing was applied to determine where this significance lay in terms of banding of length of stay. Five tests were found to produce *p* values of less than .05. To minimise Type 1 error, the Bonferroni correction method was applied and the significance value was calculated to be *p*<.005. From this testing it was found that those participants who stayed three to four days demonstrated higher mobility levels during hospital stay than those who were hospitalised for seven to thirteen days. Table 4.13 displays the results from these analyses.

Table 4.13. Significance Testing of Length of Stay and Steps per Day

Length of Stay Comparison	***U***	***p***
1-2 days versus 3-4 days	196	.764
1-2 days versus 5-6 days	125	.870
1-2 days versus 7-13 days	32	.011
1-2 days versus >14 days	11	.035
3-4 days versus 5-6 days	305	.778
3-4 days versus 7-13 days	70	.001*
3-4 days versus >14 days	28	.019
5-6 days versus 7-13 days	67	.040
5-6 days versus >14 days	21	.051
7-13 days versus >14 days	26	.721

Note. U= computed value of Mann Whitney Test. p= probability.
**p<.005*

To explore this relationship further, data was also considered as steps per day by complete hospital day and therefore length of data collection (Table 4.14). This data represented the first week of hospital stay. Older adults who recorded higher levels of mobility had shorter periods of hospitalisation (x^2=18.322, *p*=.005).

Table 4.14. Steps per Day by Number of Complete Hospital Days

Characteristic	***N* (%)**	**Median**	**IQR**	**x^2**	***p***
Number of complete hospital days				18.322	.005*
1 day	11 (13%)	1326	806		
2 days	14 (17%)	1176	1285		
3 days	16 (20%)	1187	926		
4 days	15 (18%)	1020	1149		
5 days	10 (12%)	1278	1222		
6 days	8 (10%)	827	814		
7 days	8 (10%)	341	317		

Note. IQR= Interquartile range. x^2= computed value of Kruksall Wallis Test. p= probability.
**p<.05*

Mann Whitney *U* testing was employed to determine where the significant relationship existed, this involved 21 tests. Again to mitigate Type 1 error, the Bonferonni correction was employed and statistical significance was set at $p<.0024$. Participants who stayed for at least seven days, and therefore recorded data for seven complete hospital days, had lower mobility levels than older adults who had one day of data (U=71, p=.001), two days (U=10, p=.001), three days (U=6, p=.0027), and five days (U=7, p=.002).

4.5.3.2 Step change from first to last day

The step change from first to last day was analysed by physiotherapy and occupational therapy input, diagnosis and length of stay. Tables 4.15 and 4.16 display the test results indicating there were no significant differences.

Table 4.15. Step Change and Physiotherapy and Occupational Therapy Input During Hospitalisation

Characteristic	***N* (%)**	**Median**	**IQR**	***U***	***p***
Physiotherapy during admission				410	.275
Yes	52 (72%)	246	670		
No	19 (28%)	104	1284		
Occupational Therapy during admission				439	.475
Yes	19 (26%)	158	592		
No	52 (74%)	246	821		

Note. Mdn= median. SD= Standard deviation. IQR= Interquartile range. U= computed value of Mann Whitney Test. p= probability.

Table 4.16. Step Change from First to Last Complete Hospital Day by Diagnosis and Length of Stay

Characteristic	***N* (%)**	**Median**	**IQR**	x^2	***p***
Diagnosis				1.21	.876
Resp	33 (46%)	234	647		
Circ	16 (%)	332	1268		
MSK	5 (7%)	14	1729		
KUT	6 (8%)	324	694		
Other	11 (15%)	104	736		
Length of stay				2.2	.699
1-2 days	2 (3%)	739	-		
3-4 days	32 (%)	79	691		
5-6 days	20 (28%)	298	858		
7-13 days	12 (17%)	137	890		
>14 days	5 (7%)	334	507		

Note. IQR= Interquartile range. x^2*= computed value of Kruksall Wallis Test. p= probability. Resp= diseases and disorders of the respiratory system. Circ= diseases and disorders of the circulatory system. KUT= diseases and disorders of the kidney and urinary tract. MSK= diseases and disorders of the musculoskeletal system and connective tissue.*

4.5.4 Characteristics at Six Months

Re-admission and mortality rates 30 days, 3 months and 6 months following discharge were statistically analysed with respect to steps taken per day and step difference from first to last day. After 30 days 26% (*N*=21) of the original cohort were readmitted to hospital at least once, 35% (*N*=29) after three months and 51% (*N*= 42) after 6 six months. In the following 30 days after discharge, 6% (*N*=5) had died. Three and six months following discharge, 9% (*N*=7) and 20% (*N*=16) respectively had died.

4.5.4.1 Steps per day

Steps per day and readmission to hospital were statistically analysed. Due to low readmissions and for the purpose of statistical testing, those readmitted two or more times were grouped together. No statistical relationship was found between steps taken per day and readmission and mortality rates at 30 days, 3 and 6 months. Tables 4.17 and 4.18 present this information.

Table 4.17. Steps per Day by Readmissions

Characteristic	*N* (%)	Median	IQR	*U*	*p*
Readmission 30 days*				1.269	.530
0	61 (74%)	1024	925		
1	17 (21%)	836	1083		
2	4 (5%)	1104	1207		
Readmission 3 months*				4.002	.135
0	53 (65%)	1196	836		
1	19 (23%)	673	1459		
2	5 (6%)	1159	1161		
3	4 (5%)	857	712		
4	-	-	-		
5	1 (1%)	2034	-		
Readmission 6 months*				.85	.654
0	40 (49%)	1005	817		
1	23 (28%)	1188	1129		
2	12 (15%)	1213	1314		
3	4 (5%)	550	876		
4	-	-	-		
5	2 (2%)	1461	-		
6	1 (1%)	120	-		

Note. IQR= Interquartile range. U= computed value of Mann Whitney Test. p= probability.
** Two or more readmissions grouped together for statistical testing.*

Table 4.18. Steps per Day by Mortality

Characteristic	*N* (%)	Median	IQR	*U*	*p*
Mortality 30 days				127	.215
Yes	5 (6%)	658	766		
No	77 (94%)	1024	987		
Mortality 3 months				148	.057
Yes	7 (9%)	462	535		
No	75 (91%)	1049	959		
Mortality 6 months				423	.219
Yes	16 (20%)	793	939		
No	66 (80%)	1022	938		

Note. IQR= Interquartile range. U= computed value of Mann Whitney Test. p= probability.

4.5.4.2 Step change from first to last complete hospital day

Table 4.19 presents the statistical information indicating there as was no relationship between step change from first to last day and hospital readmission in the 30 days, 3 months and 6 months following discharge. Due to low readmissions and for the purpose of statistical testing, those readmitted two or more times were grouped together.

Table 4.19. Step Change from First to Last Day by Readmission

Characteristic		***N* (%)**	**Median**	**IQR**	***U***	***p***
Readmission 30 days*					1.871	.392
	0	50 (70%)	170	660		
	1	17 (24%)	306	711		
	2	4 (6%)	782	1535		
Readmission 3 Months*					3.082	.214
	0	42 (59%)	143	745		
	1	19 (27%)	192	656		
	2	5 (7%)	434	1602		
	3	4 (6%)	512	1167		
	4	-	-	-		
	5	1 (1%)	1544	-		
Readmission 6 Months*					1.541	.463
	0	33 (46%)	182	1061		
	1	20 (28%)	175	530		
	2	11 (15%)	244	1052		
	3	4 (6%)	551	1128		
	4	-	-	-		
	5	2 (3%)	814	-		
	6	1 (1%)	304	-		

Note. IQR= Interquartile range. U= computed value of Mann Whitney Test. p= probability.
** Two or more readmissions grouped together for statistical testing.*

Table 4.20 demonstrates the statistical significance found between step change from first to last complete hospital day and mortality. Those participants with smaller, or negative step change from first to last complete hospital day had higher mortality rates within three (U=86, p=.022) and six months (U=261, p=.046) following discharge from hospital.

Table 4.20. Step Change from First to Last Day by Mortality

Characteristic	*N* (%)	Median	IQR	*U*	*p*
Mortality 30 days				77	.165
Yes	4 (6%)	-309	1068		
No	67 (94%)	244	742		
Mortality 3 months				86	.022*
Yes	6 (8%)	-325	556		
No	65 (92%)	248	722		
Mortality 6 months				261	.046*
Yes	14 (20%)	-56	634		
No	57 (80%)	292	788		

Note. IQR= Interquartile range. U= computed value of Mann Whitney Test. p= probability.
**p<.05*

4.5.5 Mobility Levels and Secondary Objectives

The secondary purpose of this study was to explore for trends between mobility levels during acute hospital stay and patient specific characteristics that had been identified by previous studies. It was hypothesised that all participants will exhibit low levels of mobility during acute hospital stay regardless of premorbid community mobility, mobility status on admission and physiotherapy and occupational therapy involvement during admission. It was also hypothesised that the mobility levels of older adults during acute hospital stay would be influenced by length of stay and mortality rates six months following discharge: those participants with shorter lengths of stay would demonstrate higher levels of mobility whilst those who died in the six months following discharge would record lower levels of mobility during hospital stay. As previously identified the cohort's mobility levels were low taking less than 1500 steps per day.

Premorbid community mobility was measured by indoor and outdoor walking aid, life space maximum level and life space independent level. These variables did not influence the number of steps participants took during their acute hospital stay. With the exception of life space maximum level, these variables did not influence the step change from first to last complete hospital day. Initial statistical testing found participants with level 5 life space maximum zone did walk more steps on their last complete hospital day than their first when compared to those scoring level 4 (p=.042).

The Elderly Mobility Scale measured mobility status on admission and on statistical testing no significant results were demonstrated. Participants requiring assistance to mobilise therefore recorded similar mobility levels than those who were more independent.

Mobility levels were found to have a statistically significant relationship with length of stay and mortality rates following discharge. Those with shorter lengths of stay exhibited higher levels of mobility than those who stayed in hospital for longer (p=.007). Additionally though there was no statistical difference in the steps taken per day, those who died within three (p=.022) and six months (p=.046) of discharge had smaller or negative step gains from first to last complete hospital day.

These results therefore support the hypotheses however data analysis involved multiple statistical tests and therefore may have a high number of false positive results (Type 1 errors). The Bonferroni correction method was previously applied to two statistical tests to control Familywise Error Rate. To address False Discovery Rate, the Benjamini-Hochberg procedure was applied.

From the 45 statistical tests performed, six statistically significant (p<.05) were uncovered with the largest significant p level equalling .046. For 45 tests where there is known to be no effect it was expected that 2.07 p values (45 x .046) less than or equal to .046 were false positives and the null hypothesis was incorrectly rejected. To calculate the FDR, the following calculation was made:

$$\text{FDR} = 2.07/5 = 0.414$$

This calculation means that 41.4% of the results may be Type 1 errors having rejected the null hypothesis when it was actually true. The ability for the results of this study to confidently reject or accept these hypotheses was therefore compromised. To restrict Type 1 errors, the FDR was set to 0.20. Two results remained significant; participants who had less hospital days and shorter periods of hospitalisation exhibited significantly higher levels of mobility. Table 4.21 shows the initially statistically significant results with FDR correction.

Table 4.21. Benjamini-Hochberg Correction

Variables	***p*-values**	**Benjamini-Hochberg Significance**	**Benjamini-Hochberg *p*-value**
No. of complete hospital days and steps per day	.005	Significant	.1575
Length of stay and steps per day	.007	Significant	.1575
Braden and steps per day	.019	Not significant	.2475
3 month mortality and step change	.022	Not significant	.2475
Life space maximum and step change	.042	Not significant	.345
6/12 mortality and step change	.046	Not significant	.345

4.6 Summary

This chapter has presented the findings from this observational study. It has described the mobility levels of older adults during acute hospital medical admission and compared mobility levels to key characteristics. The cohort demonstrated low levels of mobility and were inactive for the vast majority of their hospital stay which concurred with the hypothesis that participants would exhibit low levels of mobility during acute hospital stay taking less than 1500 steps per day. Whilst most participants increased mobility levels whilst in hospital, some did not and one third mobilised less on their last complete hospital day than on their first.

Statistical testing supported the hypothesis that all participants exhibited low levels of mobility during acute hospital stay regardless of premorbid levels of community mobility, mobility on admission and allied health input during admission.

It was hypothesised that the mobility levels of older adults during acute hospital stay would be influenced by length of stay and mortality rates six months following discharge. The results of this study found that participants with shorter periods of hospitalisation took significantly more steps per day than those with comparatively longer lengths of stay. Mortality rates six months following discharge did not correlated with mobility levels during acute hospital stay and therefore the null hypothesis was unable to be rejected.

Chapter 5: Discussion

5.1 Introduction

The primary purpose of this observational study was to measure the mobility level of older adults during acute medical hospitalisation at Wellington Regional Hospital. It was hypothesised that participants would exhibit low levels of mobility during acute hospital stay taking less than 1500 steps per day. The results of this supported this hypothesis; participants demonstrated low levels of mobility recording a median of 1006 steps per day.

The secondary purpose of this study was to explore possible associations between mobility levels during acute hospital stay and patient specific characteristics that had been identified by previous studies. Two secondary hypotheses were tested. It was hypothesised that all older adults would perform low mobility levels during their hospital stay regardless of their premorbid levels of community mobility, mobility status on admission and physiotherapy and occupational therapy input during admission. Results from this study supported this hypothesis. It also was hypothesised that the mobility levels of older adults would be associated with length of stay and mortality six months following discharge. The results indicated that older adults with shorter lengths of stay recorded significantly higher levels of mobility during hospitalisation than those who were hospitalised for longer. No significant relationship was found between mobility levels during hospital stay and mortality six months following discharge.

This chapter discusses potential influence the study sample and method may have had on the results, compares the study findings to previously reported research and reviews possible explanations for the results. This chapter considers the clinical implications and lastly directions for future research.

5.2 Study Sample

This study focused on older adults admitted to hospital for acute medical care. The inclusion and exclusion criteria were analogous to previous mobility level research to allow for both comparability with published studies and clinical applicability (Brown et al., 2009; Fisher et al., 2011; Ostir et al., 2013; Pedersen et al., 2013). The research was well received by the study sample with only four potential participants declining to participate in the study. In general the key characteristics of the study sample were similar to previously published research, such as length of stay and mobility aid use prior to admission (Brown et al., 2009; Fisher et al., 2011; Pedersen et al., 2013). The sample of the current study was slightly older when compared to similar studies. The mean age of participants was 81.3 years in comparison to previous research where mean age of samples ranged from 74 to 78.3 years (Brown et al., 2009; Fisher et al., 2012; Zisberg et al., 2011). Both the inclusion and exclusion criteria were broad and inclusive; the heterogeneous nature of the sample was an asset to this study due to general clinical applicability. However the diverse range of participants can also be viewed as a limitation.

As presented in the results chapter the study sample included a wide range of older adults, some who were normally very mobile and active, and others who were dependent on assistance to walk. The range of participants involved was also demonstrated by the large recorded standard deviations and interquartile ranges. It could be said that this, combined with the relatively small sample size (N=82), weakens the results of the current study. Indeed with a 95% confidence interval, the mean number of steps per day for the cohort has a margin of error of +/- 182 steps.

Previous research involving similar inclusion criteria with larger sample sizes were reviewed and confidence intervals with margins of error calculated. Based on a 95% confidence interval, the majority of studies exhibited margin of errors over +/-100 steps per day based on mean steps per day data. Indeed two were similar to the current study; the results from Ostir et al. (2013) revealed a margin of error of +/-189 steps (*N*=224, SD 1446), and Sallis et al. (2015) +/-225 steps (*N*=127, SD=1291). Interquartile ranges were not presented. Due to the very nature of this type of study, large standard deviations were to be expected. As demonstrated, increasing the sample size in these cases does not necessarily strengthen the confidence of the results.

Eleven participants were lost to follow up as their clinical care was transferred to the geriatricians. These participants were moved to wards that specialised in older adult health. The transfer of care from medicine to geriatrics was based on clinical need. It could be argued that those older adults who were most frail left the study. As such, this may have influenced the results and therefore comparability to previous research. However this does not distract from the local application of the results to the patients and current care practices at Wellington Regional Hospital.

The environment of the hospital wards where participants stayed was not controlled for the purposes of the current study. That is to say that some participants will have occupied single rooms and others in rooms with two to six beds. The distance from bedside to toilet facilities would vary from participant to participant. Lastly changing bed or ward is a common occurrence and participants rarely occupied the same bed they were admitted to until discharge. The purpose of this study was to document the mobility levels of older adults during acute medical hospitalisation at Wellington Regional Hospital within current care practices. Changing current care practices such as controlling environment and bed and ward transfers would limit the clinical implications and meaningfulness of this study. Moreover activity levels are similar in patients occupying single versus a shared room environment (Kuys et al., 2012).

5.3 Reliability of Instrumentation and Results

The SAM proved to be a feasible and reliable method of data collection in the acute clinical environment. On the whole participants found the SAM comfortable to wear during their hospital stay; as few as 6% of participants recruited to the study found the SAM uncomfortable. There were no adverse effects from donning the SAM and only two participant's data demonstrated SAM malfunction.

It is acknowledged that the donning of the SAM may have influenced participant's mobility level during data collection (Croteau & Richeson, 2006). The SAM has no feedback mechanism to the wearer and does not display results. At recruitment older adults were instructed to mobilise as per their preference whilst in hospital. The methods employed to minimise this limitation reflected those of previously published research (Brown et al., 2009; Fisher et al., 2011; Ostir et al., 2013).

Every effort was made to strengthen the statistical validity of this study. Employing the Bonferroni correction method and the Benjamini-Hochberg procedure to control for Type 1 errors was a conservative approach. Whilst strengthening the conclusions of statistical testing, it could be argued that this approach limited the study's findings. An alternative method of strengthening the results would have been to lower the *p* value to use a 1% significance value. Interestingly, this would have produced the same results. Another way to treat the initial results of the study was to consider this research as a hypothesis generating exercise. That is, an exploratory exercise looking for trends of effects. Although the results of this study should be considered with caution, they are concurrent with established and larger research.

5.4 Mobility Levels During Acute Hospital Stay

The primary objective of this study was to describe the mobility levels of older adults during acute medical hospitalisation at Wellington Regional Hospital. It was hypothesised that all participants would exhibit low levels of mobility during acute hospital stay taking less than 1500 steps per day. The results of the current study supported this hypothesis.

All participants in this current study lived in the community, were independently mobile before onset of acute illness and the majority were able to mobilise at time of recruitment to the study. They were active within their community in the four weeks before admission; almost all (96%) regularly travelled outside their local neighbourhood and half walked outdoors without the use of a walking aid.

Nonetheless the acutely admitted older adults displayed low levels of mobility. Although on average older adults increased their mobility levels during their acute hospital stay, one third decreased. The median step change from first to last day complete hospital day was +234 steps. Furthermore this study found older adults were largely sedentary spending 95% of their day lying, sitting or standing.

5.4.1 Comparison With Previous Research

North American studies with similar inclusion criteria to the current study recorded older adults taking on average 662 (SD 785) to 1367 (SD 1396) steps per day (Fisher et al., 2010; Sallis et al., 2015). Of note are the high standard deviations, which is consistent with the current study (SD 938). Step change from first to last complete hospital day also concurred with previously reported research. Studies reported step change ranging from +174 to +256 steps from first to last complete hospital day (Ostir et al., 2013; Sallis et al., 2015). Finally previous studies have shown older adults to be inactive, that is to say lying, sitting or standing, for on average 96% of each day of hospitalisation (Brown et al., 2009; Fisher et al., 2011). The results from the current study therefore agreed with previously reported data.

The mobility levels and amount of time spent active were far less than those reported for community dwelling older adults. Conservative mobility data for older adults in good health report mobility levels of 6500 to 8500 steps per day, with 75% of each day spent physically inactive (Cavanaugh et al., 2007; Tudor-Locke & Myers, 2001). For older adults who identify themselves as normally in good health, hospitalisation reduced their normal mobility levels by up to 88% and time spent physically active by almost 5 hours per day. Those living with chronic disease or functional limitations have been recorded to take 3500 to 5500 steps per day and spent 79% of day physically inactive (Cavanaugh et al., 2007; Ford et al., 2010; Tudor-Locke & Myers, 2001). For this group of older adults, hospitalisation reduced their normal mobility levels by up to 82% and time spent physically active by approximately 4 hours per day.

5.4.2 Clinical Implications of Low Mobility Levels

Older adults in the current study exhibited low levels of mobility during their period of acute medical hospitalisation at Wellington Regional Hospital. Although the duration of low mobility levels is unable to be determined from the available data, research strongly suggests that older adults who have been hospitalised with an acute medical health issue perform low mobility levels for longer than that of their length of stay.

In older adults with acute health problems, up to two thirds experience functional decline and reduced mobility levels prior to presentation at hospital (Covinsky et al., 2011; Mudge et al., 2010). One third of the current study sample demonstrated declining mobility levels during their period of hospitalisation. In the week following discharge a significant proportion of older adults continue to perform low mobility levels, taking less than 1500 steps per day (Fisher et al., 2013). The average length of stay of the study sample was 5.6 days (SD 5.4 days, range 1 to 30 days). For the average older adults hospitalised for acute medical issue, it is therefore judicious to assume that low mobility levels may be sustained for at least seven days.

Laboratory based researchers studying the physiological effects of low mobility levels defined reduced activity as performing less than 1500 steps per day (Breen et al., 2013; Krogh-Madsen et al., 2010; Thyfault & Krogh-Madsen, 2011). Adverse physiological changes have been found after just one day of reduced activity (Sallis et al., 2015; Stephens et al., 2011). In healthy young adults, after as little as five days of short term, reduced activity result in detrimental physiological impairments including insulin sensitivity and lipid metabolism, loss of lean mass and aerobic capacity, neuromuscular fatigue, reduced popliteal and brachial blood flow and increased visceral fat (Boyle et al., 2013; Krogh-Madsen et al., 2010; Olsen et al., 2008; Restaino et al., 2015; Reynolds et al., 2015; Saunders et al., 2012; Thyfault & Krogh-Madsen, 2011). In older adults, short term reduced activity is associated with impairments of muscle mass and strength (Breen et al., 2013).

The physiological ramifications of bed rest and reduced activity are more pronounced in older adults who are acutely unwell (Bautmans et al., 2005; Drummond et al., 2013; Ferrando et al., 2006; Hvid et al., 2013; Kortebein et al., 2007; Paddon-Jones et al., 2006). Furthermore, the recovery from bed rest and short term reduced mobility levels is more prolonged than in those who are unwell and older. Age and presenting condition influence recovery from temporary immobilisation (Cesari et al., 2004; Hvid et al., 2010; Hvid et al., 2014; Suetta et al., 2009). Older adults admitted to hospital and experiencing inflammation (as indicated by abnormal C-reactive portein levels) have demonstrated significantly worse muscle strength and fatigue than hospitalised older adults without inflammation (Bautmans et al., 2005). Despite successful treatment of the primary source of inflammation, reduced muscle strength and fatigue in older adults with inflammation does not improve during hospitalisation (Bautmans et al., 2005). Even with intensive rehabilitation programs, older adults take longer to recover from disuse atrophy than younger counterparts; indeed some older adults may not completely regain premorbid strength (Hvid et al., 2010; Suetta et al., 2009; Wall et al., 2013). Recovery is of particular relevance to older adults with repeated hospitalisations. After adjusting for chronic conditions and health behaviours, hospitalisation for more than eight days per year is associated with significant and accumulative changes in strength and body composition (Alley & Chang, 2010).

The participants in this study recorded low mobility levels of detrimental proportions. Reduced activity during times of acute ill health in older adults involves several complex physiological interactions. Physiologically, short term reduced activity in older adults leads to reduced blood flow, aerobic capacity, muscle weakness and strength. Such physiological changes are linked to the cycle of frailty (Fried et al., 2005). Clinically, low mobility levels are a shared risk factor for frailty and geriatric syndromes such as falls, incontinence, delirium, pressure injury and hospitalisation-associated functional decline. Short periods of low mobility levels are independent predictors of longer periods of hospitalisation, institutionalisation, readmission to hospital, and mortality (Brown et al., 2004; Fisher et al., 2010; Ostir et al., 2013). Optimising the mobility levels of older adults during acute hospitalisation is therefore of high clinical priority.

One group of researchers referred to low mobility levels during the hospitalisation of older adults to be an under recognised epidemic (Brown et al., 2009). Indeed the results of the current study support the view that it is a pandemic, succouring European research that this issue is not unique to North America but of international concern (Pedersen et al., 2013; Shadmi & Zisberg, 2011; Zisberg et al., 2011).

Intervention to target mobility levels during acute hospital stay are therefore of pressing clinical importance.

5.5 Characteristics Influencing Mobility Levels

The secondary objectives of the current study were to explore for associations between mobility levels during acute hospital stay and patient specific characteristics that had been identified by previous studies. Two secondary hypotheses were tested. It was hypothesised that participants would exhibit low levels of mobility during acute medical hospitalisation regardless of their premorbid level of community mobility, mobility status on admission and involvement of physiotherapy and occupational therapy during admission. The results of the study supported this hypothesis.

It was also posited that mobility levels during hospitalisation would be associated with length of stay in hospital and mortality six months following discharge. Specifically it was hypothesised that participants who recorded higher levels of mobility would have shorter periods of hospitalisation whilst participants who die in the six months following discharge would have recorded lower levels of mobility during hospitalisation. The current study agreed with the hypothesis that mobility levels were associated with length of stay however a relationship was not found between mortality and mobility levels and therefore the null hypothesis was unable to be rejected.

5.5.1 Premorbid Community Mobility

The sample recruited to the current study reflected older adults with a range of community mobility performance, measured by the life space assessment and walking aid use. The current study did not find any correlation between community mobility and mobility levels during acute hospital stay. Older adults who were mobile frequently and independently in and outside of their local community recorded the same low levels of mobility as older adults who required someone to help them leave their home. Similarly those who used a walking aid to mobilise in the community had comparable levels of mobility during acute hospital stay as those who were independently mobile without an aid. This finding is consistent with previous research (Pedersen et al., 2013).

5.5.2 Mobility Status on admission

Mobility on admission did not influence mobility levels during hospital stay. It may be surprising to consider that participants who were assessed as being able to mobilise out of bed and walk independently around the ward environment recorded similar mobility levels as those who were dependent on assistance to mobilise. However there was no association between mobility stats on admission and mobility levels during hospitalisation. This replicates the findings of previous research (Callen et al., 2004; Pedersen et al., 2013).

5.5.3 Physiotherapy and Occupational Therapy

Almost three quarters of the cohort received physiotherapy input during their hospital stay whilst one quarter had involvement from an occupational therapist. At Wellington Regional Hospital, patients are referred to physiotherapy and occupational therapy if changes in their usual mobility or functional task performance have been identified. The current study findings suggest that older adults with an acute change in mobility or functional performance recorded the same low mobility levels and step gain from first to last complete hospital day as older adults without deterioration in physical performance. These findings were concurrent with previous research (Callen et al., 2004; Fisher et al., 2011). These results also suggest that current physiotherapy and occupational therapy practices at Wellington Regional Hospital do not significantly increase the mobility levels of older adults.

5.5.4 Length of Stay

Participants who had longer periods of hospitalisation exhibited lower levels of mobility. The results of the current study demonstrated that participants who were hospitalised for seven or more days recorded significantly lower levels of mobility than those who stayed for one, two, three and five complete hospital days. Indeed those participants who were in hospital for one complete hospital day took almost one thousand steps per day more than those who were in hospital for seven or more days. No differences were found when exploring step change from first to last complete hospital day.

This finding is concomitant with previously published research where authors found that higher levels of mobility were significantly associated with shorter periods of hospitalisation (Fisher et al., 2011; Fisher et al., 2010; Shadmi & Zisberg, 2011). It is reasonable to assume that older adults who stay longer in hosptial do so due to the severity of acute health problem and that will increasing illness severity, mobility levels would be lower. However previous research indicates that where there was an association between length of stay and mobility, this relationship was independent of presenting condition illness severity, age, functional status and comorbidities (Fisher et al., 2011; Fisher et al., 2010; Shadmi & Zisberg, 2011). Other factors yet to be identified may explain the relationship between mobility levels and length of stay.

As previously discussed, the nature of the current and previously reported studies involve a wide ranging sample. With so much variation within the sample it is difficult to exclude potential external pressures and influences. As such, the correlation between length of stay and mobility levels cannot be inferred as cause and effect. To further explore this relationship, future study design should consider options to increase internal validity. For example using a control group or matched pair design when testing an intervention to increase mobility levels.

5.5.5 Six Month Mortality

The current study did not find a relationship between mortality six months after discharge and mobility levels during admission. Similar studies published statistically significant results related to in hospital mobility levels and mortality rate. Brown et al. (2004) based statistical analysis on deaths during hospitalisation. This in contrast to the current study whereby data from participants with deteriorating medical status or who died in hospital were not included in the final sample.

Ostir et al. (2013) reported on the increased risk of death in the proceeding two years following discharge. Similar to the current study, researchers measured mobility levels using the step change from first to last complete hospital day. However in contrast the current study, which utilised the Mann Whitney *U* Test for statistical analysis, researchers employed the Kaplan-Meier method to calculate the survival hazard ratio. This study found that older adult with smaller or negative step gains from first to last day complete hospital day had a higher risk of death in the two years following discharge. This method of data analysis does not allow for covariates that may have influenced the results over the two years proceeding discharge (Goel, Khanna, & Kishore, 2010). Indeed survival was found to be significantly associated with fewer comorbidities (Ostir et al., 2013).

Given the variation in method of data analysis between the current and previous studies, it is improvident to compare their results. Repeating data analysis with mortality data extending the follow up time to two years after initial discharge using the Kaplan-Meier method would further inform this hypothesis.

5.5.6 Clinical Implications of Participant Characteristics Influencing Mobility Levels

As previously discussed, low mobility levels are detrimental to the health and wellbeing of older adults. In the current study older adults who stayed longer in hospital performed statistically lower levels of mobility than those with shorter lengths of stay. Those with longer periods of hospitalisation are therefore at risk of greater physiological impairment.

It is acknowledged that when acutely unwell, reduced mobility levels are unavoidable, appropriate and to be expected. Previous studies however have not found statistical significance between mobility levels and illness severity, pain and comorbidities (Brown et al., 2004; Fisher et al., 2010; Fisher et al., 2011; Ostir et al., 2013; Pedersen et al., 2013; Zisberg et al., 2011). It is therefore postulated that the very act of hospitalisation evokes a reduction in mobility levels for older adults.

Collating the results from the current study with similar published international research, it is yet to be determined why older adults perform low mobility levels during acute medical hospital stay. The current health care practices and clinical environment at Wellington Regional Hospital currently promote low mobility levels for older adults admitted for an acute medical health issue. Those who could mobilise independently performed similar mobility levels as those who were dependent on equipment or others for basic mobility tasks. Indeed low mobility levels were common to the vast majority of older adults.

Acute hospitalisation is associated with the development and progression of geriatric syndromes, frailty, and disability. The results of this and similar studies propose that low mobility levels during hospitalisation may be a common pathway towards physiological, clinical and functional decline for older adults.

5.6 Future Research

The results from the current study concur with previously reported research. Older adults perform low levels of mobility during acute medical hospital stay. The only characteristic to demonstrate a relationship with mobility levels during hospitalisation was length of hospital stay. No other recorded characteristic demonstrated statistical significance.

Intervention based research addressing this topic has presented mixed findings and there is currently limited evidence or specific protocols on which to base service development initiatives (De Morton et al., 2008; Gordge et al., 2009; Hickman et al., 2007; Nolan et al., 2008; Parke et al., 2012; Timmer et al., 2014; Wood et al., 2014). With the goal of maximising inpatient mobility levels, further research should consider identifying modifiable intrinsic and extrinsic factors that may currently limit mobility levels of older adults within the acute hospital environment. These barriers are postulated to be complex and researchers are encouraged to consider the following issues:

1. The relationship between length of stay and mobility levels should be further explored. Ascertaining if the relationship is due to severity of illness or if other factors influence this correlation.
2. Future studies should consider a qualitative approach to explore the attitudes and expectations of older adults to mobilising whilst unwell and in an acute hospital environment may identify possible barriers.
3. Similarly, the attitudes and perspective of hospital staff should be sought. This information would add to current research to understand why older adults perform such low levels of mobility during acute hospitalisation.

4. Environmental and equipment factors have not been explored when measuring the mobility levels of older adults. Evaluating the acute ward environment and resources available may reveal barriers that limit mobility levels.
5. When assessing a possible intervention to increase the mobility levels of older adults during acute medical hospital stay, researchers should consider using a control group or matched pair design.
6. Interventional research should consider collecting mobility level data. Knowing how much intervention increased mobility levels would give more information for evidence based practice.

5.7 Conclusion

The current study has measured the mobility levels of older adults during acute medical hospital stay. Older adults in Wellington Regional Hospital performed low levels of mobility and were largely inactive during acute medical hospital stay spending most of their time lying, sitting or standing. Whilst most older adults increased their mobility levels during hospitalisation, one third performed less activity by the end of their hospital stay then at the beginning. These finding concur with similar international research. Such low levels of mobility are considered to be detrimental to older adult health and recovery from acute illness and the implications of low mobility levels have been discussed.

In agreement with previously published research, the mobility levels of older adults were not influenced by premorbid community mobility, mobility status on admission, or physiotherapy and occupational therapy involvement during hospitalisation. In contrast to other studies, mortality following discharge was not associated with low mobility levels though this may be due to the period of follow up set by the current study.

This study consolidated knowledge in this field and confirmed a relationship between mobility levels and length of stay. Older adults with shorter periods of hospitalisation recorded comparatively higher levels of mobility than those who stayed in hospital for longer.

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Appendix A: Patient Information Sheet

Participant Information Sheet

Date Information Sheet Produced:

08-01-2014

Project Title

"Back on your feet in no time": Measuring the Mobility Levels of Older Adults During Acute Hospitalisation.

An Invitation

My name is Gillian Watson and I am a physiotherapist at Wellington Hospital. You are invited to participate in a research project I am conducting. The research is part of my Masters in Health Science. Your participation in this research study is voluntary.

The purpose of this information sheet is to give you the information you need to be able to decide whether or not to take part in this research study. Participation in this study will not change your care whilst in hospital and if you require physiotherapy during your stay it will be performed by another physiotherapist. You may choose not to participate and you may withdraw your consent to participate at any time without having to give a reason. You will not be penalized in any way should you decide not to participate or to withdraw from this study.

What is the purpose of this research?

The purpose of this research is to measure the mobility levels of older adults during their hospital stay.

How was I identified and why am I being invited to participate in this research?

All adults over 65 years old who are normally mobile and are admitted to hospital because of a medical reason have been identified as potential participants. All potential participants are approached soon after admission by a health professional and given this information sheet. If you meet the criteria and are interested on hearing more, I will approach you directly and ask if you would like to participate in this research.

This criteria excludes people with swelling in both legs, leg amputation, imminent terminal illness, infectious conditions, severe agitation, don't speak English, and those who may go home within the 2 days or hospital admission. I only have a small number of monitors and if they are all in use when you come into hospital you may not be asked to participate in this study.

What will happen in this research?

Your participation will involve wearing a step monitor around your ankle during your hospital stay. It will record the amount of rest and activity you do. The data will be used for my thesis and may also be used in presentations and publications.

What are the discomforts and risks?

There are no known risks attached to this research but you may find the step monitor slighlty uncomfortable. Whilst it is very unlikely, the strap may cause some skin irritation.

How will these discomforts and risks be alleviated?

The monitor wil be held on your ankle by a comfortable strap around you ankle. Registered Nurses will monitor your skin and comfort during the study.

What are the benefits?

Some people become weaker whilst in hospital and we are unsure why. This study will give information as to how much activity is normal for patients.

This research is being performed by the researcher who is completing a Masters in Health Science through Auckland University of Technology.

What compensation is available for injury or negligence?

In the unlikely event of a physical injury as a result of your participation in this study, rehabilitation and compensation for injury by accident may be available from the Accident Compensation Corporation, providing the incident details satisfy the requirements of the law and the Corporation's regulations.

How will my privacy be protected?

All records I collect will be confidential, anonymously, and stored in a secure environment. Your identity will not be revealed in any report, publication or presentation on this study.

What are the costs of participating in this research?

This study will involve some of your time at the beginning of your hospital stay to take measurements and fit the monitor and again at end of your hospital stay to remove the monitor. The first meeting may be up to half an hour. Removing the monitor from your ankle will take a couple of minutes. There are no other costs associated with participating in this research project.

What opportunity do I have to consider this invitation?

This study involves measures that need to be taken soon after admission. After receiving this information sheet you will have up to 11am to consider this invitation.

How do I agree to participate in this research?

I will come and meet you at your hospital bedside. At this time you will be able to ask any further questions and given a consent form to consider and sign. I am happy to talk to you and you family/whanau or support person about this research and answer any questions or concerns you may have.

Will I receive feedback on the results of this research?

If you would like a summary of the results these will be sent to you at the end of the study. There may be several months delay between collecting information and letting people know about the results.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor Dr Denise Taylor, denise.taylor@aut.ac.nz, 09 921 9860

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz* , 921 9999 ext 6038.

Whom do I contact for further information about this research?

Researcher Contact Details:

Gillian Watson, Physiotherapy Department, Level 10 GNB, Wellington Hospital, Newtown, Wellington. Email gillian.watson@ccdhb.org.nz , telephone 04 385 5999 pager 2061.

Project Supervisor Contact Details:

Dr Denise Taylor, AUT University, Private Bag 92006, Auckland. Email denise.taylor@aut.ac.nz, telephone 09 921 9860.

Approved by the Auckland University of Technology Ethics Committee on *type the date final ethics approval was granted*, AUTEC Reference number *type the reference number*.

Appendix B: Consent Form

Consent Form For use when laboratory or field testing is involved.	AUT UNIVERSITY TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

Project title: **"Back on your feet in no time": Measuring the mobility levels of older adults during acute hospitalisation. Measuring mobility.**

Project Supervisor: **Dr Denise Taylor**

Researcher: **Gillian Watson**

○ I have read and understood the information provided about this research project in the Information Sheet dated 8 January 2014.

○ I have had an opportunity to ask questions and to have them answered.

○ I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.

○ I am not suffering from bilateral leg swelling, infectious disease, severe agitation, imminent terminal illness, or leg amputation.

○ I agree to wearing a step monitor around my ankle for the duration of the research.

○ I agree to take part in this research.

○ I wish to receive a copy of the report from the research (please tick one): Yes○ No○

Participant's signature: ....

Participant's name: ....

Date:

Approved by the Auckland University of Technology Ethics Committee on 5 May 2014 AUTEC Reference number 14/122.

Note: The Participant should retain a copy of this form.

Appendix C: Ethics Approval

AUTEC
SECRETARIAT

9 May 2014

Denise Taylor
Faculty of Health and Environmental Sciences

Dear Denise

Re: **14/122 Back on your feet in no time: Measuring the mobility levels of older adults during acute hospitalisation.**

Thank you for submitting your application for ethical review. I am pleased to confirm that the Auckland University of Technology Ethics Committee (AUTEC) has approved your ethics application for three years until 5 May 2017.

AUTEC thanks the researcher and applicant for the quality of the consultation undertaken in designing this research.

As part of the ethics approval process, you are required to submit the following to AUTEC:

- A brief annual progress report using form EA2, which is available online through http://www.aut.ac.nz/researchethics. When necessary this form may also be used to request an extension of the approval at least one month prior to its expiry on 5 May 2017;
- A brief report on the status of the project using form EA3, which is available online through http://www.aut.ac.nz/researchethics. This report is to be submitted either when the approval expires on 5 May 2017 or on completion of the project;

It is a condition of approval that AUTEC is notified of any adverse events or if the research does not commence. AUTEC approval needs to be sought for any alteration to the research, including any alteration of or addition to any documents that are provided to participants. You are responsible for ensuring that research undertaken under this approval occurs within the parameters outlined in the approved application.

AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to obtain this.

To enable us to provide you with efficient service, we ask that you use the application number and study title in all correspondence with us. If you have any enquiries about this application, or anything else, please do contact us at ethics@aut.ac.nz.

All the very best with your research,

Kate O'Connor
Executive Secretary
Auckland University of Technology Ethics Committee

Cc: Gillian Watson kwx4535@aut.ac.nz

Appendix D: Staff SAM Information

NOTE TO NURSING TEAM
This patient is involved in physiotherapy research

Measuring the mobility of older adults during acute hospitalisation

Gillian Watson is the physiotherapist performing this project. This research uses StepWatch Monitors (SAMs) which are worn by around each participant's ankle. We need your help to make sure we collect the right information.

•The SAM is held around the ankle with a neoprene velcro strap. It can go on either the left or right leg, and can sit on the inside or outside of the ankle. The SAM and must be worn with the rounded end up and should sit above the ankle bone resting on the flat aspect of the calf. Remove the SAM for CT and MRI scanning. Like every medical device, please check the skin regularly for any signs of redness or irritation

•Take the SAM off when showering. Although the SAM is waterproof the strap can get soggy. Take it off when you get into the shower and put it back on in the shower room when you are drying the patient. Don't worry if you forget to take it off, Gillian can get you a dry strap.

•The SAM can be worn through the night but can be taken off if your patient prefers.
•TIP: when in bed, it may be more comfortable to wear the SAM on the inside of the ankle
•If our patient prefers to remove it overnight, take the SAM off when your patient settles into bed for the night. Most importantly, put the SAM on before your patient gets up in the morning.

•If your patient is being discharged and still has their SAM around their ankle take it off, give it to the Nurse in Charge and let Gillian know where it is.

Each participant will also have information about wearing the SAM. Gillian can be contacted on #6207 during working hours or on 021 138 1998 outside normal working hours. Please do not hesitate to call if you have a question or want further information about this research.

Thank you for you help.

Appendix E: Data Collection Sheet

Participant ID Number

Participant Contact Sheet

Date		**Date of Admission**		**Time of Admission**	
SAM ID		**Time of SAM Application**		**EDD?**	
Discharge Date		**Date of SAM removal**		**Time of SAM removal**	

Living situation on admission	Alone RHLC	With Spouse HLC	With Family Other
Pre admit mobility level	Independent	Assistance of 1	Assistance of 2
Pre admit walking aid used? (detail indoors or out)	Unaided Crutches- 1 or 2	Stick -1 or 2 Walking Frame	Other
History of falls during past 1 year	Yes No	**Braden Score**	
Height	cm	**Weight**	kg

Ethnicity- please circle

10	European NFD	**30**	Pacific peoples NFD	**34**	Niuean	**40**	Asian NFD	**44**	Other Asian
11	New Zealand European / Päkehä	**31**	Samoan	**35**	Tokelauan	**41**	Southeast Asian	**51**	Middle Eastern
12	Other European	**32**	Cook Island Maori	**36**	Fijian	**42**	Chinese	**52**	Latin American / Hispanic
21	Mäori	**33**	Tongan	**37**	Other Pacific peoples	**43**	Indian	**53**	African (or cultural group of African origin)
								54	Other

Life Space Level			Frequency				Independence	Score
During the past 4 weeks have you been to….			**How often did you get there?**				**Did you use aids or equipment? Did you need help from another person?**	**Level x Frequency x Independence**
1. Other rooms of your home besides the room where you sleep?	Yes 1	No 0	Less than 1 /week 1	1-3 times / week 2	4-6 times / week 3	Daily 4	1= Personal assistance 1.5= Equip only 2 =No equip or personal assistance	____________
Score	_________	x	___________		x	___________ =		
2. An area outside your porch, deck or patio, hallway (of an apartment building) or garage, in your own garden or driveway?	Yes 1	No 0	Less than 1 /week 1	1-3 times / week 2	4-6 times / week 3	Daily 4	1= Personal assistance 1.5= Equip only 2 =No equip or personal assistance	____________
Score	_________	x	___________		x	___________ =		
3. Places in your neighbourhood, other than your own garden or apartment building?	Yes 1	No 0	Less than 1 /week 1	1-3 times / week 2	4-6 times / week 3	Daily 4	1= Personal assistance 1.5= Equip only 2 =No equip or personal assistance	____________
Score	_________	x	___________		x	___________ =		
4. Places in your neighbourhood, but within your town?	Yes 1	No 0	Less than 1 /week 1	1-3 times / week 2	4-6 times / week 3	Daily 4	1= Personal assistance 1.5= Equip only 2 =No equip or personal assistance	____________
Score	_________	x	___________		x	___________ =		
5. Places outside your town?	Yes 1	No 0	Less than 1 /week 1	1-3 times / week 2	4-6 times / week 3	Daily 4	1= Personal assistance 1.5= Equip only 2 =No equip or personal assistance	____________
Score	_________	x	___________		x	___________ =		
							TOTAL (ADD)	

ISAR Tool To be completed with patient or caregiver		
Before the illness or injury that brought you to hospital, did you need someone to help you on a regular basis?	□ Yes □ No	1 0
Since the illness or injury that brought you to hospital, have you needed more help than usual to take care of yourself?	□ Yes □ No	1 0
Have you been hospitalized for one or more nights during the past 6 months (excluding a stay in the Emergency Department)?	□ Yes □ No	1 0
In general, do you have good vision?	□ Yes □ No	1 0
In general, do you have serious problems with your memory?	□ Yes □ No	1 0
Do you take more than three different medications every day?	□ Yes □ No	1 0
	TOTAL SCORE TOTAL (ADD)	

Elderly Mobility Scale			
Task	**Score**	**Task**	**Score**
Lying to Sitting **2** Independent **1** Needs help of 1 person **0** Needs help of 2+ people		**Sitting to lying** **2** Independent **1** Needs help of 1 person **0** Needs help of 2+ people	
Sit to stand **3** Independent in under 3 seconds **2** Independent in over 3 seconds **1** Needs help of 1 person (verbal or physical) **0** Needs help of 2 + people		**Standing** **3** Stands without support & reaches within arms length **2** Stands without support but needs help to reach **1** Stands, but requires support e.g. uses upper limbs to steady self **0** Stands, only with physical support (1 person)	
Gait **3** Independent (incl. use of sticks) **2** Independent with frame **1** Mobile with walking aid but erratic/ unsafe turning **0** Requires physical assistance or constant supervision		**Timed walk** **3** Under 15 seconds **2** 16-30 seconds **1** over 30 seconds	
Functional Reach **4** Over 20cm **2** 10-20cm **0** Under 10cm or unable		**TOTAL (ADD)**	

Notes Review Post Discharge			
Sex	M F	Date of Birth	
Falls during in-pt stay?	Yes No	DRG on coding	
OT input?	Yes No	PT input?	Yes No

Appendix F: Patient SAM Information

Information for Research Participants

Measuring the mobility of older adults during acute hospitalisation

Gillian Watson is the physiotherapist performing this project. This research uses StepWatch Monitors (SAMs) which are worn by around your ankle. We need your help to make sure we collect the right information.

•The SAM is held around the ankle with a neoprene velcro strap. It can go on either your left or right leg, and can sit on the inside or outside of the ankle. The SAM must be worn with the rounded end up and should comfortably sit just above the ankle bone resting on the flat aspect of the calf. The SAM will be removed for CT and MRI scanning.

•Take the SAM off when showering. Although the SAM is waterproof the strap can get soggy. Take it off when you get into the shower and put it back on in the shower room when you are drying. Don't worry if you forget to take it off, the staff can get you a dry strap.

•The SAM can be worn overnight. One comfort tip is to wear the SAM on the inside of the able.

•If it is uncomfortable for you, take the SAM off when you settle into bed for the night. Most importantly, put the SAM on before you get up in the morning.

•If your are discharging from hospital and about to leave the ward but still have the SAM around your ankle, please let your nurse know. They will remove it and put it somewhere safe.

If you have a question or want further information about this research please do not hesitate to mention this to your nurse or physiotherapist.

Thank you for you help.