A Study of patient flow through inpatient rehabilitation and potential for improvements

Peter Wayne New

MBBS, M CLin Epi, FAFRM (RACP)

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Department of Epidemiology and Preventive Medicine

Faculty of Medicine, Nursing and Health Sciences

School of Public Health and Preventive Medicine

and the Southern Clinical School

Monash University

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ABBREVIATIONS

AROC	Australasian Rehabilitation Outcomes Centre
ICF	International Classification of Functioning, Disability and Health
KPI	Key Performance Indicators
LOS	Length of Stay
NHHRC	National Hospital and Health Reform Commission

SUMMARY

Problems with patient flow are well documented in Emergency Departments and acute hospitals but poorly studied in rehabilitation. Barriers to rehabilitation patient flow can have adverse consequences for patients and reduce access in acute hospitals and Emergency Departments.

A literature review found that relatively little is known about problems with rehabilitation patient flow. There is no published system for classifying this or accepted benchmarks for its measurement. The extent of the problem is also poorly studied. These issues are important to address to facilitate research and because demand for rehabilitation services will increase significantly with population aging.

In this thesis the development of a definition of barriers to discharge from inpatient rehabilitation is described along with a classification system for the main causes. In addition, key performance indicators for rehabilitation patient flow are proposed.

A web-based survey of key stakeholders found that half the respondents (n=101) reported barriers to admission into subacute hospitals (including rehabilitation) as moderate, severe or extreme, and 81% reported a similar degree of severity for barriers to discharge. There was a much higher prevalence of problems reported among rehabilitation physicians. The most common barriers to admission were availability of beds (61%) and environment or equipment inadequacies (62%). The most common barriers to discharge were waiting for a more appropriate setting of care (76%) and funding for home modifications, equipment or carers (55%).

A retrospective study was conducted of patients admitted into two rehabilitation units in Melbourne, Australia (n=360; females =51.7%; mean age = 58.4 years). There was a median of 7 (interquartile range [IQR] 4–13) days from acute hospital admission till rehabilitation referral and a median of 1 (IQR 0–3) day from been deemed ready for transfer till admission into rehabilitation, with 20% of patients waiting more than 3 days. Overall, patients spent 12.0% of their acute admission waiting for a rehabilitation bed.

A prospective study of the above patients studied the occurrence of inpatient rehabilitation discharge barriers, their causes and duration of unnecessary hospitalisation. Fifty-nine (16.4%) patients had a

discharge barrier. The most frequent causes were: non-weight bearing after lower limb fracture (5.6%), family deliberations about discharge planning (3.6%), waiting for suitable accommodation (2.5%) or home modifications (2.5). Overall, 21.0% of all inpatient rehabilitation bed-days were occupied by patients with a discharge barrier.

A computer model was developed to estimate potential improvements in acute and rehabilitation hospital length of stay for rehabilitation patients from hypothetical scenarios that address barriers to patient flow. Most scenarios resulted in significant improvements compared with baseline. The effect size for the changes was typically small to medium and was larger when multiple barriers were addressed simultaneously. It is suggested that health system modelling can inform reforms to models of care and assist with cost benefit analyses.

Similar to other components of the hospital system – rehabilitation has numerous barriers to optimal patient flow. In this thesis the major barriers are identified, classified and measured. Potential solutions are identified and areas for further research proposed.

PROLOGUE

The components of this thesis had their origins as quality improvement projects to address clinical challenges and concerns that hospital management and executive staff at the time did not appear to me to be motivated to address. With my developing insight, knowledge and understanding over time I realised there was the potential to expand and join these projects to form a unified body of work for this thesis.

Below I provide detailed background to the various component projects that formed the motivation for this thesis.

General Rehabilitation Unit

The Monash Institute of Health Services Research (MIHSR) was employed from March till August 2007 as a consultant by Monash Health (then called Southern Health) to suggest changes to models of care that would help improve the hospital journey for sub-acute patients. The scope of the project included the process from admission to acute hospital through to transfer into sub-acute inpatient care, and subsequent community discharge. As head of rehabilitation at Monash Health I was involved in numerous discussions during the course of the project with the MISHR consultants. One aspect of the project involved addressing strategies to improve the flow of patients from acute hospital to sub-acute hospitals and barriers to discharge from sub-acute care. During the MIHSR project some formal documentation of barriers to discharge occurred in a different ward to where I had clinical responsibilities. In discussing these results with the MIHSR team I was inspired to plan my own project documenting the occurrence and causes of barriers to rehabilitation patient flow.

Spinal Rehabilitation Service

The Spinal Rehabilitation Service at Caulfield Hospital (Alfred Health) was established in approximately 1977. The Spinal Rehabilitation Service offers a Statewide service that specialises in the management of patients with non-traumatic spinal cord injury. I have been the clinical head of the Spinal Rehabilitation Service since 1998. Over the years I have experienced increasing difficulty with having patients who are ready for admission into the service admitted in a timely manner. Discussions with hospital management indicated that they did not believe this to be a problem. Management were using an average waiting time for admission as a performance measure and there was no data collected on specific sub-groups of patients, particularly those from other health Networks. I believed that this was important because approximately 80% of admissions came from other Networks. In response, in

October 2006 I started collecting data on the time patients spent waiting for admission after they had been deemed ready for admission to the Spinal Rehabilitation Service.

The Victorian Government Department of Human Services and the Transport Accident Commission initiated a project in May 2006 that was directed at improving the management of patients with spinal cord injury in the state. The Australian Institute of Primary Care, Latrobe University School of Public Health, was commissioned to carry out a "systemic review of the delivery of services to Victorians with a Spinal Cord Injury and development of a strategic framework". This review was completed in July 2007. I was the Alfred Health representative on the steering group that was responsible for guiding the review. In meetings that followed the release of the review and in planning for new services for patients with spinal cord injury I raised concerns regarding problems that the team in the Spinal Rehabilitation Service at Caulfield Hospital was experiencing regarding barriers to the discharge of patients from rehabilitation due to circumstances not related to the team's activities and not within the control of the team to address. The Head of Sub-acute Care in the Department of Human Services commented that unless I was able to produce data to substantiate my concerns it was not possible to address these at a higher level. This was a catalyst for me to start data collection from January 2008 on barriers to discharge encountered by the patients admitted under my care in the Spinal Rehabilitation Service at Caulfield Hospital.

Inspiration from Colleagues

In May 2007 I attended the Australasian Faculty of Rehabilitation Medicine 15th Annual Scientific Meeting in Sydney. At this conference I attended two 'free paper' presentations by Associate Professor Chris Poulos that looked at process barriers for patients transferred from acute hospital to rehabilitation and the use of a utilization tool to provide guidance on the optimal timing of when patients would hypothetically been ready for transfer from acute hospitals to rehabilitation. His research provided further impetus to develop my own interest in this area. Subsequent discussions with Associate Professor Poulos led to a collaboration that resulted in an opinion piece published in the *Medical Journal of Australia* on inefficiencies in the Australian Rehabilitation System that had a focus on rehabilitation patient flow issues. (Appendix 2) [1].

Formalising the thesis

The above three parallel influences helped foster my interest in patient flow problems in rehabilitation. Over time I expanded some of the elements in the data collection process. In mid-2009 I was planning a web-based survey on patient flow. I realised that there was potential to publish a number of publications on patient flow issues in rehabilitation from the various projects I was involved with in the Spinal Rehabilitation Unit at Caulfield Hospital and the General Rehabilitation Units in Monash Health that addressed different aspects of patient flow. I then became aware of the possibility of completing a PhD by publication. Subsequent inquiries with the Department of Epidemiology and Preventative Medicine, Monash University, with whom I had a long standing Honorary Appointment, resulted in my enrolment.

Early in my PhD candidature I realised that I had more than enough publications to meet the requirements for a thesis by publication (potential for up to 12 publications regarding the general and spinal rehabilitation groups). Subsequently, after deliberation and discussion with my supervisors, I decided to omit the projects related to the Spinal Rehabilitation Service at Caulfield Hospital from the program of research conducted for this thesis and limit the focus of the thesis to patient flow in the general rehabilitation units at Monash Health. I have, however, continued to collect data regarding barriers facing the spinal cord injured patients admitted to the Spinal Rehabilitation Service independently of this thesis and some of this work has since been published [2-4]. (Appendix 3).

ACKNOWLEDGEMENTS

I am indebted to many people who have provided me with support, encouragement and guidance in dealing the challenges associated with undertaking this higher research degree.

I would like to express my gratitude to the following:

- My Doctoral Supervisors for their insight, wisdom and guidance, each encouraging and assisting me in different ways:
    - Professor Johannes Stoelwinder, for providing a broad perspective about the health system and valuable guidance throughout.
    - Professor Peter Cameron, for his perspectives as an emergency physician confronted with patient flow problems at the contrasting 'bookend' to the health system to my rehabilitation field.
    - Professor John Olver, for providing an additional rehabilitation perspective to patient flow problems confronting rehabilitation patients.
- Expert statistical advice was provided by the late Associate Professor Damien Jolley, with whom it was a privilege and inspiration to work with, albeit for only a relatively short time. Dr Nick Andrianopoulos provided additional statistical advice, for which I am very grateful.
- Professor Fary Kahn gave me the gentle prod that I needed to enroll in this PhD. I was planning on working on the related projects anyway and I thank her for the suggestion to use these for my PhD by publication.
- A special mention needs to be made of Keith Stockman, formally of the Monash Institute of Health Services Research (MIHSR) and currently with the Department of Medicine, Monash Health. Keith was formative in me developing an interest in patient flow problems in rehabilitation, he encouraged me to develop formal research into this area, and assisted greatly with the computer modelling of rehabilitation patient flow that formed one of the publications that formed this thesis (see chapter 6). It has indeed been a privilege to collaborate with Keith and I look forward to further projects with him.
- There are numerous people who assisted with the refinement of the definition of barrier to sub-acute patient flow, development of the classification of discharge barriers, and the formulation of the survey questions, and I would like to thank and acknowledge all of these people, who are listed in the relevant publications.

- My family and friends who encouraged me and ensured a balance in my life throughout this journey.
- My children, André, Marcel and Martine, who provided a welcome distraction, fun and enjoyment, as well as challenges, along the way.
- Finally, to Michele, my wife, for many reasons, including her unconditional love and support, patience, tolerance and encouragement; her wisdom and objectivity; and ability to keep a balanced perspective – which were vital to the completion of my thesis.

GENERAL DECLARATION

PART A: General Declaration

Monash University

Declaration for thesis based or partially based on conjointly published or unpublished work

General Declaration

In accordance with Monash University Doctorate Regulation 17.2 Doctor of Philosophy and Research Master's regulations the following declarations are made:

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

This thesis includes 5 original papers published in peer reviewed journals. The core theme of the thesis is to study rehabilitation patient flow, with a focus on admission barriers to rehabilitation and subsequent barriers to discharge. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the candidate, working within the Department of Epidemiology & Preventive Medicine, Monash University, under the supervision of Professor Johannes U Stoelwinder.

The inclusion of co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges input into team-based research.

In the case of chapters 2-6 my contribution to the work involved the following:

Thesis chapter	Publication title	Publication status	Nature and extent of candidate's contribution
2	Defining barriers to discharge from inpatient rehabilitation, classifying their causes, and proposed performance indicators for rehabilitation patient flow.	Published Arch Phys Med Rehabil. 2013;94:201-208	I conceived the project, performed the literature search, coordinated the iterative process of developing the definition and classification, designed the survey, arranged the data collection, and performed the analysis. I wrote the first draft of the manuscript and consolidated revisions into the final version.
3	Inpatient subacute care in Australia: perceptions of admission and discharge barriers.	Published Med J Aust. 2011; 195: 538-541	I conceived the project, designed the survey, arranged the data collection, and performed the analysis. I wrote the first draft of the manuscript and consolidated revisions into the final version.

Thesis chapter	Publication title	Publication status	Nature and extent of candidate's contribution
4	Reducing the length of stay for acute hospital patients needing admission into inpatient rehabilitation: a multicentre study of process barriers.	Published Intern MedJ.2013; 43:1005 -1011	I conceived the project, supervised and coordinated the data collection, and performed the initial analysis. I wrote the first draft of the manuscript and consolidated revisions into the final version.
5	A prospective multicentre study of barriers to discharge from inpatient rehabilitation.	Published Med J Aust. 2013;198:104-108.	I conceived the project, supervised and coordinated the data collection, and performed the initial analysis. I wrote the first draft of the manuscript and consolidated revisions into the final version.
6	Computer simulation of improvements in the hospital length of stay for rehabilitation patients.	Published J Rehab Med. 2015; 47: 403–411	I conceived the project, developed the baseline for the computer model and played an active role in developing the computer model used to simulate patient length of stay. I performed the validation checks of the computer model and developed the hypothetical scenarios that were simulated. I analysed the results of the simulations, wrote the first draft of the manuscript and consolidated revisions into the final version.

I have not renumbered sections of published papers presented within the thesis.

Signed:

Date: 1/6/2015

PUBLICATIONS, PRESENTATIONS, AWARDS

Listed below are the candidate's first-author and co-authored publications, conference posters and presentations, awards and professional roles that are relevant to the period of candidature.

Publications

Manuscripts

1. New PW, Olver J, Cameron P A, Stoelwinder J U. Inpatient subacute care in Australia: perceptions of admission and discharge barriers. Med J Aust. 2011; 195: 538-541
2. New PW, Cameron PA, Olver JH, Stoelwinder JU. Defining barriers to discharge from inpatient rehabilitation, classifying their causes, and proposed performance indicators for rehabilitation patient flow. Arch Phys Med Rehabil. 2013; 94: 201-208
3. New PW, Jolley DJ, Cameron PA, Olver JH, Stoelwinder JU. A prospective multicentre study of barriers to discharge from inpatient rehabilitation. Med J Aust. 2013; 198: 104-108.
4. New PW, Andrianopoulos N, Cameron PA, Olver JH, Stoelwinder JU. Reducing the length of stay for acute hospital patients needing admission into inpatient rehabilitation: a multicentre study of process barriers. Intern Med J. 2013; 43: 1005-1011
5. New PW, Stockman K, Cameron PA, Olver JH, Stoelwinder JU. Computer simulation of improvements in the hospital length of stay for rehabilitation patients. J Rehab Med. 2015; 47: 403–411

Letters

New PW. Speeding up patient flow in rehabilitation. *BMJ* 2015; 350 doi: http://dx.doi.org/10.1136/bmj.h1290 (Published 10 March 2015) Cite this as: BMJ 2015;350:h1290 (Response to: Royal college calls on hospitals to tackle emergency department "exit block" to hospital beds J Wise. BMJ 2015;350:h849). http://www.bmj.com/content/350/bmj.h849/rr (Appendix 4.1)

Abstracts

New PW, Olver J, Cameron P, Stoelwinder J. A National web-based survey of perceived barriers to admission and discharge from inpatient sub-acute care in Australia. International Journal of Medicine 2010; 40 (Suppl 1):145

Presentations

Invited presentations

- Better Understanding of Hospital Patient Flow, Hospital Reform Summit 2010, 17th August 2010, Melbourne.
- How I came to be doing a PhD titled "A Study of patient flow through inpatient rehabilitation and potential for improvements" and what I have found so far? The Monash Ageing Research Centre (MONARC) Seminar. 11th October 2012, Kingston Centre, Melbourne.
- What I learnt from doing a PhD in patient flow through inpatient rehabilitation and potential for improvements. The Monash Ageing Research Centre (MONARC) Seminar. 30th June 2014, Kingston Centre, Melbourne.

Oral presentations – free papers at conferences

- New PW, Olver J, Cameron P, Stoelwinder J. A National web-based survey of perceived barriers to admission and discharge from inpatient sub-acute care in Australia. 'Best of Both Worlds' Rehabilitation Conference 8th October 2010, Melbourne.

Other presentations

- A study of patient flow through inpatient rehabilitation and potential for improvements. 3 Minute Thesis Presentation, Department of Epidemiology and Preventive Medicine (Alfred Hospital campus), Monash University. 23rd July 2010.

Posters

- New PW, Olver J, Cameron P, Stoelwinder J. A National web-based survey of perceived barriers to admission and discharge from inpatient sub-acute care in Australia.
  - World Congress of Internal Medicine, 23rd March 2010, Melbourne.
  - Southern Health Research Week, 10-14th May, 2010, Melbourne
  - Caulfield Hospital (Alfred Health), Caulfield Week (research), 2-6th May, 2011, Melbourne

- New PW, Olver J, Cameron P, Stoelwinder J. A Literature Review of Patient Flow in Rehabilitation.
    - 'Best of Both Worlds' Rehabilitation Conference 6-8th October 2010, Melbourne
    - Caulfield Hospital (Alfred Health), Caulfield Week (research), 2-6th May, 2011, Melbourne
    - Combined Australian and New Zealand Spinal Cord Society - Australasian Faculty of Rehabilitation Medicine Annual Scientific Meetings, 13-16th September 2011, Brisbane.
- New PW, Stockman K, Cameron PC, Olver JH, Stoelwinder JU. Hypothetical modelling of process changes for improvements to patient flow in rehabilitation.
    - 21st Annual Scientific Meeting of the Australasian Faculty of Rehabilitation Medicine, 17 – 20th September 2013, Sydney, NSW
    - Monash Health Research Week, 25-29th November, 2013, Melbourne

Prizes related to thesis

2013 Henry Burger Prize for Clinical Research (Monash Health Senior Medical Staff). Awarded for the best published clinical research by a member of the Senior Medical Staff, with preference given to work with a strong and direct bearing on clinical medicine. Prize given in relation to the publications (2-4 above) published during 2013.

Grants related to thesis

Awarded the RACP 2014 Pfizer Research Entry Scholarship ($35,000) towards the project "Computer modelling of changes to process and systems of care that simulate the potential for improvements in the flow of patients from acute hospital to rehabilitation" that was the basis for the work presented in chapter 6 of this thesis.

Other activities related to thesis

<u>Interview by international health management organisation</u>

I was interviewed on 22/6/2012 by representatives (Joyce Yao and Keren Johnson) from *Advisory Board* (www.advisory.com), a healthcare management research organisation based in Washington DC. Advisory Board serve over 3,000 hospitals and health systems worldwide. As part of preparing for their annual executive roundtables (attended by hundreds of clinicians and senior management) held in

Australia and New Zealand in October and November 2012, Advisory Board interviewed local experts, to help inform the presentations at these meetings. The 2012 research agenda focused on strategies to improve throughput efficiency, smooth discharge processes and optimise care transitions for chronic/elderly patients and patients with difficulty in transferring in a timely manner. The interviewers reported that my insights, results, and recommendations were very useful. They requested results of analyses that I had conducted to date and copies of future publications. Some of my findings and recommendations were included in the publication distributed to attendees. [5]

Peer-review of journal articles

Although over the years I have reviewed many manuscripts for peer-review medical journals, during this thesis I have been asked to review a number of manuscripts related to patient flow, most of which were regarding rehabilitation patients. These included the following:

- Canadian Journal of Aging. May 2013. ("Analysis of the influencing factors associated with being designated alternate level of care")
- Saudi Medical Journal. January 2014. ("The broken link: Admission criteria for inpatient rehabilitation and some common misconceptions")
- MJA. February 2015. ("Inequities in access to rehabilitation: exploring how acute stroke unit clinicians decide who to refer to rehabilitation")

Media interest

- Short article in the August 2013 edition (page 9) of the Magazine of the Australian Medical Association of Victoria on manuscript 3 above. (Appendix 5)

Other research related to thesis

When this thesis was being conceived, there was a concept early on that a complementary data collection and series of manuscripts would be planned that involved patients with spinal cord damage and injury. These planned manuscripts included an international survey of spinal rehabilitation units regarding perceived barriers to rehabilitation admission and discharge. Furthermore, data collection had previously commenced on some items in 2006 and this was expanded in 2008, coinciding with this these, to included the same key variables collected for this thesis. In addition, in collaboration with a colleague, Dr Narelle Warren (Department of Psychology, Monash University), a qualitative project was

project was planned and conducted that involved Psychology Masters students. The students interviewed spinal rehabilitation patients who experienced a delay in their admission into or discharge from specialised spinal rehabilitation unit and explored the psychological and emotional consequences on patients. Although it was decided that these additional manuscripts would not be included in this thesis work continued on these projects. So far 3 publications have arisen from this work and there are 3 additional manuscripts at various stages of preparation. The manuscripts published to date include:

- New PW, Scivoletto G, Smith É, Townson A, Gupta A, Reeves RK, Post MWM, Eriks-Hoogland I, Gill ZA . International survey of perceived barriers to admission and discharge from spinal cord injury rehabilitation units. Spinal Cord. 2013; 51: 893-897. (Appendix 3.1)
- New PW, Reducing process barriers in acute hospital for spinal cord damage patients needing spinal rehabilitation unit admission. Spinal Cord. 2014; 52: 472-476. (Appendix 3.2)
- New PW. Prospective study of barriers to discharge from a spinal cord injury rehabilitation unit. Spinal Cord. 2015; 53: 358-362. (Appendix 3.3)

CHAPTER 1: INTRODUCTION

"the first law of improvement: every system is perfectly designed to achieve the results it achieves".

Don Berwick, A primer on leading the improvement of systems. BMJ. 1996;312:619-622

This thesis studies patient flow related to inpatient rehabilitation and the potential for improvements. In particular, the focus is on process barriers to patient flow from acute hospital to inpatient rehabilitation and subsequent barriers to discharge. As such, it intends to highlight opportunities to improve this flow and contribute to the efficiency of hospital systems.

This first chapter has five sections.

- The first section of this chapter provides a **background** outlining key issues concerning patient flow in hospitals generally and gives an overview of rehabilitation in this context. It outlines factors influencing the reduced capacity and increased demand for hospital admissions, the consequences of this problem, and some response to address this challenge. Rehabilitation is then discussed in general terms and a few specific details regarding rehabilitation services in Australia are presented. This section provides a context for the thesis overall.
- The second section of the chapter describes a **literature review** of patient flow in rehabilitation. Based on this review key priority areas for research regarding patient flow in inpatient rehabilitation are identified.
- The third section presents the **aims** of the thesis. These are based on the key priority areas identified for research in patient flow in rehabilitation.
- The fourth section summarises the **methods** used in this thesis. A full explanation of the methods used is also given in each of the publications produced for this thesis.
- The final section of this chapter provides an **overview** of what the subsequent chapters cover and how they relate to the aims of the thesis.

1.1 BACKGROUND

Problems regarding the flow of rehabilitation patients are very poorly understood, as will be highlighted in the literature review later in this chapter. Furthermore, the relevance of problems regarding rehabilitation patient flow to the wider hospital system is not well appreciated. The timely and efficient transfer of patients from one hospital setting to another is crucial for optimising patient flow. This section provides some important background to the capacity and demand for services in Australia in general, including terminology issues related to patient flow and unnecessary hospital bed days. It then discusses rehabilitation in general and explains aspects of rehabilitation medicine in Australia, including the importance of rehabilitation medicine to optimising patient flow in the wider hospital system.

1.1.1 Reduced capacity and increased demand for hospital services in general

1.1.1.1 Hospital beds, population profile, disability and hospital demand

There are multiple reasons reported for the reduced capacity and increase in demand for hospital services that have contributed to the problem of inefficient patient flow through the hospital system. These include: a lack of hospital beds; ageing population; increasing prevalence of chronic disease; there are increasing expectations of medical care from the general public; a genuine demand for emergency admissions by patients who can only be adequately managed in hospitals; and improved survival from serious disease and trauma. [6]

Between 1995-96 and 1999-2000 there was a steady reduction in acute-care public hospitals beds in Australia, from 3.3 to 2.8 per thousand population – a net decrease of 11%. [7] In 2008, when the data collection for this thesis commenced, the ratio was 2.6 per 1000 thousand population, which is about 30% less than it was 20 years ago. [8]

Globally, the population profile is undergoing a dramatic change that will evolve over the coming decades, with the aging of the population. [9] In Australia for example, it is estimated that between 2004 and 2051 the population aged 65 years and over will double from 14% to 26%.[10]

Between 1997-98 and 2007-08, Australia's expenditure on health in real terms, after adjusting for inflation, grew at an average of 5.2% per year, compared with average growth in Gross Domestic Product of 3.5% per year. [11] Over the longer term the increase is even more dramatic, with health expenditure as a proportion of Gross Domestic Product increasing from 6.3% in 1981-82 to 9.1% in 2007-08. In 2007-8 total health expenditure grew by 6.0% in real terms. The largest component of this increase was public hospital services, accounting for 32.5% of the increase. This trend is predicted to increase with the aging population. [12] Given the current and projected longer-term economic situation in most developed countries, there is substantial pressure to limit increases in public hospital funding and to use available resources more efficiently.

Chronic illness is responsible for the major burden of disease in Australia. [13] About 55% of people aged 65-84 years have five or more chronic health conditions. [14] Chronic disease is associated with disability, and over a fifth of the Australian population has a disability. [15] About 17% have specific restrictions and 15% core activity restrictions. Over 6% of the population have a profound or severe core activity limitation. The

prevalence of disability, especially severe disability, increases dramatically with older age and disabled people are much more likely to require health or hospital care. [16]

Admissions into public hospitals are currently increasing at 3.2% annually and private hospital admissions are increasing by 5.0%. Most of these admissions are for acute care (87%) or rehabilitation care (8%). [17] People 65 years or older make up a disproportionate proportion of all hospital admissions — accounting for 38% of hospital admissions and 48% of patient days. For people aged 85 and over, admissions are rising by 41% compared with 15% for all other age groups. [17]

Over the past 2 decades, against the background of the aging population, increases in disability, and fewer acute-care beds, hospital admissions in Australia have increased by almost twice the rate of population growth while the length of stay (LOS) has almost halved, from an average of 6.2 to 3.3 days. [8] This increase in productivity has been achieved largely by progress in medical technology, a massive increase in the number of same-day admissions – now accounting for 56% of all hospital episodes [18] – case-mix funding, and the growth of postacute services. This increase in productivity has resulted in faster processes creating additional challenges for improving the transfer of patients between settings of care.

As a result of the challenges described above, and factors such as workforce shortages, [19] the Australian health system has come under increasing pressure to meet demands placed upon it. [20, 21]. It is predicted that between 2005 and 2050 the demand for hospital bed-days will grow by about 80%. [22]

The challenges of meeting the increase in demand for public hospital services are reflected by the following summary from the Australian State of Public Hospitals report [18]:

- Hospital admissions have increased by 33% since 1998-99
- Emergency department presentations increased by 34% compared to 1998-99
- Elective surgery waiting times exceeded the recommended time in 16% of cases, including 12% recommended for surgery within 30 days and 25% of those recommended surgery within 90 days.
- Emergency department waiting times exceeded the recommended time in 30% of cases, including 22% of emergency and 35% of urgent cases. With similar results reported from another source. [23]

As well as in Australia, the demand for hospital services straining the capacity of health systems has been reported elsewhere, particularly in North America and Europe. By far the greatest focus of research to date

on the imbalance between the demand for hospital services and the ability to meet this has been in the emergency department. [24, 25] [23] As well as individual hospitals reporting problems, [26] [27] [28] [29] many discrete areas of inpatient hospital care have reported problems with inadequate access to beds to meet their demand. This includes general medical units [30-33], intensive (critical) care, [34], psychiatry,[35], aged care [36, 37] and paediatrics. [38]

1.1.1.2 Adverse impact of inability to meet hospital demands.

There are adverse consequences from an inability of hospitals to meet demand. In the emergency department access block has been reported to be associated with a range of problems, [24] [39] including increased treatment time for patients [38, 40], increased subsequent hospital LOS [41, 42] and increased mortality. [43-45] Access block affecting intensive care units has also been reported to be associated with increased mortality and LOS. [34]

Iatrogenic injury and adverse events are relevant to the problem of inefficient patient flow and unnecessary days in hospital because the longer patients are in hospital the more likely they are to experience an adverse event, further prolonging their hospital admission.[46] Iatrogenic injury and adverse events occurring in hospital are unfortunately too common and result in inefficiencies and poor quality of care. [47, 48]. In an Australian study, 17% of acute hospital admissions were reported to be associated with an unintended injury caused by health care management – rather than the patient's underlying disease – of which half were considered preventable. These events resulted in prolonging the LOS in hospital by an average of 7 days, causing permanent disability in 14% of cases and death in 5%. [49] A USA study reported that the likelihood of an adverse event increased by about 6% for each day in hospital. [46]

1.1.1.3 Hospital demand responses

In Australia, most of the response to increasing hospital demand to date have focused on increases in the number of acute-care hospital beds, [50] improved community capacity to manage complex medical patients outside hospitals (especially those patients with chronic diseases), and improved processes within the emergency department. [51]. State Governments recognise the need to improve data regarding patient flow in order to fully optimising the patient journey, the importance of better management of the acute patient admission process, including strategies to divert patients from hospital admission, the need to optimise the care process during acute hospital stay and to better manage the discharge process from acute hospitals. [52] International studies have highlighted the need to address the problem of demand management using a

multi-factorial process [53] and emphasised the need to focus on quality improvement, change management and organisational learning principles with collaborative hospital governance. [29]

The focus of most research and projects to better manage hospital demand and improve patient flow has been in the emergency department and acute hospital setting. [25, 54-60]. Important principles from the emergency department includes critical pathways, process-mapping, triage according to severity, bedside registration of patients, improved management approaches and statistical modelling and simulation.[25] A study from an acute hospital medical unit reported that improvements in patient flow as a result of a sustained and multifaceted systematic approach to addressing barriers to patient flow was associated with a reduction in the hospital standardised mortality rate. [61] The strategies implemented included the following: changes to medical staff practices, including increased frequency and consistency of ward rounds to daily with the same consultant; appointing a discharge facilitator and multidisciplinary ward based discharge planning training; nominating a discharge date on or shortly after admission; improved discharge medication dispensing process; training to improve the management of the acutely unwell and palliative care patients. Another study emphasised standardising the admission and discharge processes to improve patient flow. [57] Improvement principles from surgical research include daily multidisciplinary ward rounds, [62] redesigning care processes, separate elective and emergency beds, and limits to the number of elective admissions.

1.1.1.4 Patient flow and unnecessary hospital bed days

The issue of unnecessary hospital bed days is very important to consider within the topic of patient flow. If patients are in hospital unnecessarily, then this will reduce a hospitals ability to meet demand.

A proposed definition of patient flow, based on an earlier suggestion [63], is the "systematic process of attending to patients, from the time they enter a medical care to the time they leave medical care. Patient flow includes both medical and administrative functions, which may often overlap." Patient flow is analogous to traffic flow in that it can be efficient, for example when travelling without delay along a freeway. Or it can be inefficient and frustrating, such as when stuck in a traffic jam. The optimising of patient flow seeks to provide the necessary care in a timely and effective manner. Organisation, communication and resource problems can compromise patient flow. [58, 59, 63, 64]

In Australia, a census of 5 major acute hospital general and speciality medical units reported that of 956 patients, 25% were believed to be ready for discharge, but only 50% of these were actually being discharged

on that day, leaving 13% unnecessarily in hospital. [33] Another study used a utilisation review tool to determine the appropriateness of acute hospital care in 242 patients referred for rehabilitation found that about 69% of acute hospital bed-days did not meet the criteria for acute-care. [65]. International studies using the same utilisation review tool referred to above reported findings that are not dissimilar regarding the proportion of acute hospital patients not requiring acute level of care – the proportions reported were over a third in a USA study [32] and almost 40% in a Canadian report. [31]

1.1.1.5 Terminology issues

Defining unnecessary bed days is not straightforward. The range and availability of social and disability support services in the community to facilitate timely discharge from hospital is a contributing factor to unnecessary bed days and these vary from one setting to another. There are obviously regional, national, and international variations in the availability of these social and disability services. There is also a degree of subjectivity involved in determining unnecessary bed days. [66] This was highlighted by a retrospective study that found that about one third of patients initially reported as unnecessarily being in hospital were found to still require rehabilitation and another third required further medical attention after review by other staff. [67]

A discussion of the meaning of 'access to health care' has pointed out that it is a complex concept and proposed that it be measured across at least four dimensions.[68] These included: the availability of a service when it is wanted or needed; the personal, financial and organisational barriers to utilisation of services; accessing the 'right service at the right time in the right place' and with effective health outcomes; and that access be equitable along lines of fairness and social justice.

The timely access to an appropriate hospital bed is widely acknowledged as important for the efficient use of hospital resources and preventing adverse outcomes. [69] When this doesn't occur, various terms have been applied in different settings and countries. Common terms that have been used to describe this situation include 'access block', 'bed block', and 'hospital overcrowding'. These terms all imply problems with both the number of hospital beds and patient flow, or transfer, through the hospital system. One definition of 'access block' has described it as when acute hospital occupancy is greater than 85%, which results in greater risk of emergency department overcrowding creating increased risk of delayed admission, longer LOS and higher mortality. [70] A suggested definition of access to rehabilitation from the Institute of Medicine in the USA is the 'timely use of rehabilitation services to achieve the best possible health outcomes'.[71]

Patients who have their discharge from hospital delayed after they have been deemed by the treating unit to be ready for discharge have been referred to as 'bed-blockers'.[67] The intent behind the use of this term is not to blame the patient but the wider health and hospital systems and process, as well as the social policies that create the circumstances that result in the flow inefficiencies that create the 'bed-block'. In response to concern that the term 'bed blockers' may be considered by some to be derogatory, in the UK the term 'delayed discharge' has been adopted. [66] Another term that has also been used to describe these patients is 'stranded patients'. [72]

[73] This refers to the situation where they are stranded in a setting where they do not belong.

1.1.1.6 Reduced capacity section conclusion

Patient flow problems have been highlighted as a problem in the emergency department and many acute hospital departments. The responses to date have failed to consider problems with patient flow in sub-acute care, particularly rehabilitation.

1.1.2 Rehabilitation Medicine

An understanding of rehabilitation medicine and the Australian rehabilitation system is necessary to fully appreciate the aims and results of this thesis. Although rehabilitation patients comprise a small proportion of multi-day hospital admissions, their long LOS in comparison with that of other patient groups – both acute hospital and combined acute and rehabilitation – has a major impact on acute hospital bed availability.

1.1.2.1 Rehabilitation: Introduction, definitions and background

There are a number of definitions of rehabilitation medicine. A recent definition has been proposed that is based on the World Health Organisations' International Classification of Functioning, Disability and Health (ICF). [74] Using this classification, in the context of health:

- Impairments are problems in body function or structure, such as significant deviation or loss.
- Activity is the execution of a task or action by an individual.
- Activity limitations are difficulties an individual may have in executing activities.
- Participation is the involvement in a life situation.
- Participation restrictions are problems an individual may experience in involvement in life situations. The Activities and Participation component covers the complete range of domains denoting aspects of functioning from both an individual and a societal perspective.

- Personal and Environmental factors are the components of contextual factors that make up the physical, social and attitudinal environment in which people live and conduct their lives. Environmental factors have an impact on all components of functioning and disability and are organized in sequence from the individual's most immediate environment to the general environment. Personal Factors is also a component of Contextual Factors but they are not classified in ICF because of the large social and cultural variance associated with them.

In the context of ICF, rehabilitation has been defined as "*the health strategy that, based on the WHO's integrative model of human functioning and disability, aims to enable people with health conditions experiencing or likely to experience disability to achieve and maintain optimal functioning in interaction with the environment.*

It achieves its goal by applying and integrating biomedical and engineering approaches to optimize a person's capacity, approaches that build on and strengthen the resources of the person that provide a facilitating environment, and that develop performance in the interaction with the environment.

Rehabilitation is the core strategy for the medical speciality Physical and Rehabilitation Medicine, a major strategy for the rehabilitation professions and a relevant strategy for other medical specialities and health professionals, service providers and payers in the health sector. It is also a relevant strategy for professionals and service providers across sectors, including education, labour and social affairs caring for or interacting with people with health conditions experiencing or likely to experience disability." [75]

Rehabilitation is a Human Right that is enshrined in the United Nations convention on the rights and dignity of persons with disabilities. [76] This Convention has been ratified by many countries, including Australia.

From a public health perspective, the rehabilitation paradigm can be conceptualised as one of four main healthcare strategies: preventive (primary prevention), curative (secondary prevention), rehabilitation (tertiary prevention) and supportive strategies. [77] It is an individualised, patient-centred activity focused on improving patients' ability to function in society in the face of disability. It is what happens after a person survives a serious disabling injury or illness and makes the life saved worth living.

In the context of this thesis, rehabilitation refers to the provision of multi-disciplinary, medically directed services that aim to improve the functioning (physically, psychologically, socially and economically) of an individual after illness or injury and that are evidenced by comprehensive assessment of function and realistic and negotiated goals. [78-80] The objective of rehabilitation is to reduce the impact of impairments and optimise the ability of the person with a disability to perform activities and minimise participation restrictions. Personal factors, including social supports, and environmental barriers and enablers are considered in the process. A key target includes returning the person to the least restrictive care setting, with returning to the home always the preferred option. Where the person requires assistance in order to return home, training is also provided to carers. As well as the patient and their significant others, the most common members of the multi-disciplinary rehabilitation team include the following: Rehabilitation Physician, nursing, physiotherapy, occupational therapy, social work, speech therapy, psychology and dietetics. Other health care professionals may be involved as well, depending of the impairments of patients and the focus of the specific rehabilitation program. The rehabilitation process involves comprehensive individual assessment, treatment and therapies, regular review of progress, discharge planning, community integration, and follow-up of patients after discharge.

Rehabilitation is effective in improving the functional abilities of persons with disabilities. [81] There is growing evidence that rehabilitation is cost-effective. [82] The consequences of a lack of rehabilitation include both human and economic. With inadequate rehabilitation there is increased disability in society, which places additional demands on community resources and long-term care and reduces participation in society, including the workforce.

Rehabilitation is part of sub-acute care (referred to as post-acute care in some other countries), which in Australia also includes palliative care, geriatric assessment and management, and psycho-geriatric. [83]

1.1.2.2 Overview of rehabilitation medicine services in Australia

Australia, generally speaking, has a well-regarded system of established rehabilitation services. There are, however, numerous limitations of current services that impact on the efficiency of rehabilitation and health care that have been described. [1 84] In many parts of Australia, especially rural and remote regions, there is very poor availability of rehabilitation services, while the capital cities and major regional centres in Victoria and New South Wales have the best availability. [84]. Other problems include the location of many inpatient rehabilitation services in small, stand-alone hospitals; a lack of options for managing younger people with

severe acquired disability in the community; and deficiencies in government programs for the supply of aids, equipment and home modifications. [1]

In 2008, when data collection for the main part of this thesis commenced, the Australasian Rehabilitation Outcomes Centre (AROC) annual report of the state of rehabilitation in Australia reported that there were 170 inpatient rehabilitation units – 96 public sector and 74 in the private sector. These provided over 60,000 episodes of inpatient rehabilitation for adults.[85] The average age of patients was 74 years and the average LOS was 18.9 days. The most recent annual report for 2013 describes the outcomes and trends for these inpatient episodes. [86] Most (about 60%) patients were admitted to private rehabilitation services. The three most common categories of rehabilitation were orthopaedic (49%), reconditioning following severe illness or major surgery (24%) and stroke (8%). Since 2000 there has been a steady increase in the number of admissions, and the average age of patients, but with a reduction in the average LOS. Patients in private rehabilitation facilities have a shorter LOS – a reflection of the limit on inpatient rehabilitation LOS that the private insurers will reimburse.

Traditionally, rehabilitation has been largely delivered as an inpatient service. It has focused on providing care for a range of impairments, typically focusing on stroke, brain injury, spinal cord injury and diseases, and other neurological diseases, fractures, joint arthroplasty, limb amputation, and debility after server illness or major surgery. Rehabilitation has also had a role in community-based service-delivery, especially focusing on the ongoing care for patients with the above impairments, but also including chronic pain, the problems of people with developmental and congenital disability, and work-related injury. In the past decade there has been a large increase in ambulatory, or non-inpatient rehabilitation services, both centre-based and home-based programs. There has also been an expanding focus on the use of these services as a way of shortening inpatient LOS.

1.1.2.3 Demand for health care and rehabilitation in Australia

Inpatient rehabilitation admissions are increasing at an annual rate of approximately 8-10%. [85-87], with the most recent annual report for 2013 by the Australasian Rehabilitation Outcomes Centre reporting over 100,000 inpatient episodes. [86] This is more than double the rate of increase in acute hospital admissions reported above. [17] It has been argued that the health system has tended to put a strong focus on acute and community care, and not adequately considered the vital role that inpatient rehabilitation has to play in optimising the delivery of health care to Australians. In particular, regarding the interaction with acute

hospitals and inefficiencies that affect patient flow through the hospital system. [1] Rehabilitation services have been described as the "glue" [88] and "missing link" [21] between hospital and community services.

The submission from the Australasian Faculty of Rehabilitation Medicine to the National Hospital and Health Reform Commission (NHHRC) recommended that there be a minimum of 30 inpatient rehabilitation beds per 100,000 population, provided in either public or private sectors. [89] This represented an increase of 43%, or 1,871 beds nationally, in order to meet current and future demands. The final report from the NHHRC subsequently recommended a substantial increase in sub-acute services, including inpatient and ambulatory rehabilitation. [21]

1.1.2.4 Local demand for rehabilitation hospital admissions

In Australia it is estimated that about 8% of public hospital admissions are for rehabilitation care. [17] In order to obtain an overview of the importance of rehabilitation flow to relation to the context of this thesis, information was obtained from the two major health networks in Melbourne, Victoria, where the PhD Candidate has clinical appointments. The health information departments at Monash Health and Alfred Health provided data on the number of multi-day acute hospital admissions for the 2014 calendar year. Elective, same-day admissions, emergency department presentations that were not subsequently admitted to hospital, maternity, paediatric (< 16 years of age), psychiatric and psycho-geriatric admissions were excluded. The rational for excluding these patient groups was because their demands on the hospital system and potential need for rehabilitation was believed to be very different from other acute hospital patients. In addition, information was requested regarding the number of patients transferred from these acute hospital into their inpatient rehabilitation and aged care wards. The number of aged-care admissions was obtained because many of the patient flow challenges affecting rehabilitation patients also apply to aged-care patients and many patients overlap both specialty areas in terms of suitability for admission, with the routine practice in both hospitals is to dual-list these patients for admission into either stream of care. The results are presented in table 1.

Table 1. Summary of the number of patients admitted for multi-day acute hospital admission and subsequent transfer into rehabilitation or aged care wards in two major health networks.

Clinical group	**Monash Health** **n, %**	**Alfred Health** **n, %**

Acute hospital (multi-day)	57,529	30,859
Inpatient rehabilitation	1,195, 2.1%	1,335, 4.3%
Inpatient aged-care	2,155, 3.7%	2,801, 9.1%
Combined rehabilitation and aged care	3,350, 5 .8%	4,136, 13.4%

Although the first impression may be that the number of patients transferred from acute hospital into subacute (rehabilitation and aged care) hospital beds is small and insignificant, it is important to emphasis that the efficient transfer of these patients is very important to the overall efficiency of the hospital system. This is because these patient groups have much longer acute hospital LOS than patients discharged home from acute hospitals and they typically have fairly long inpatient admissions in subacute care.

1.1.2.5 Rehabilitation medicine section conclusion

In light of the demand for hospital services generally, and especially the increase in rehabilitation admissions mentioned above, in planning to optimise patient flow in the hospital system and efficiently meet the anticipated demand for inpatient rehabilitation services in the future there is an imperative to examine factors affecting the efficiency of rehabilitation. Vital aspects of this are issues involving timely access to inpatient rehabilitation and barriers to discharge after the patient is deemed ready for discharge from rehabilitation. In order to help fully understand these issues, as well as inform future research in this area, it is important to identify what we currently know about patient flow in rehabilitation. Therefore, a literature review of patient flow in rehabilitation is presented in the next section.

1.2 LITERATURE REVIEW OF PATIENT FLOW IN INPATIENT REHABILITATION

This section describes a literature review of patient flow for adults in inpatient rehabilitation. The focus of the review is on barriers to accessing inpatient rehabilitation and barriers to discharge from inpatient rehabilitation. As well as identifying relevant publications and summarising important findings, the purpose is also to highlight major knowledge gaps in this area, identify problems and shortcomings of research to date, and therefore set a research agenda for improvements.

1.2.1 Methods for literature search

1.2.1.1 Literature search of peer-reviewed publications

An electronic literature search was performed of Medline (1950 – 2009), Embase (1980 – 2009) and CINAHL (1992 – 2009). Search terms used were “patient flow”, “patient discharge”, “admission barriers”, “access block”, “bed occupancy”, “bed block”, “patient transfer” and “rehabilitation”. The search was performed in early 2010 and serves as a benchmark against which the findings of the thesis will be assessed in the conclusion section.

All publications in English that included issues related to barriers for admission into, or discharge from, adult inpatient rehabilitation were included. It was determined that all study methods and reports covering this topic would be included. This decision was made because it was anticipated that there would be a lack of high quality studies in this field. It was determined not to include publications covering the processes or systems of care involved in the actual inpatient rehabilitation therapy program, teamwork, or related process changes that could also improve patient flow because these were considered beyond the scope of this thesis even though these are all important. Publications covering projects set wholly in the community were also excluded, because the desire was to focus on hospital-related barriers. Publications dealing with paediatric hospitals were also excluded. The reference sections of all relevant articles identified were examined for additional potentially useful publications.

Potentially relevant publications were first screened by the PhD Candidate by reading the title and abstract. If there was any uncertainty regarding the relevance of the publication the full publication was read. All publications that were identified by the PhD Candidate for inclusion were examined by a supervisor of this thesis (Professor John Olver) to confirm that the publications met the inclusion criteria. Furthermore, the title and abstract of all publications identified by the literature search but excluded by the PhD Candidate from the review were also screened by the supervisor to confirm that the publications did not meet the inclusion criteria.

1.2.1.2 ‘Grey literature’ search

Because of the expected small number of publications directly involving rehabilitation medicine inpatients located by the above search it was also planned to search the ‘grey’ literature for relevant information. This was performed using four different methods:

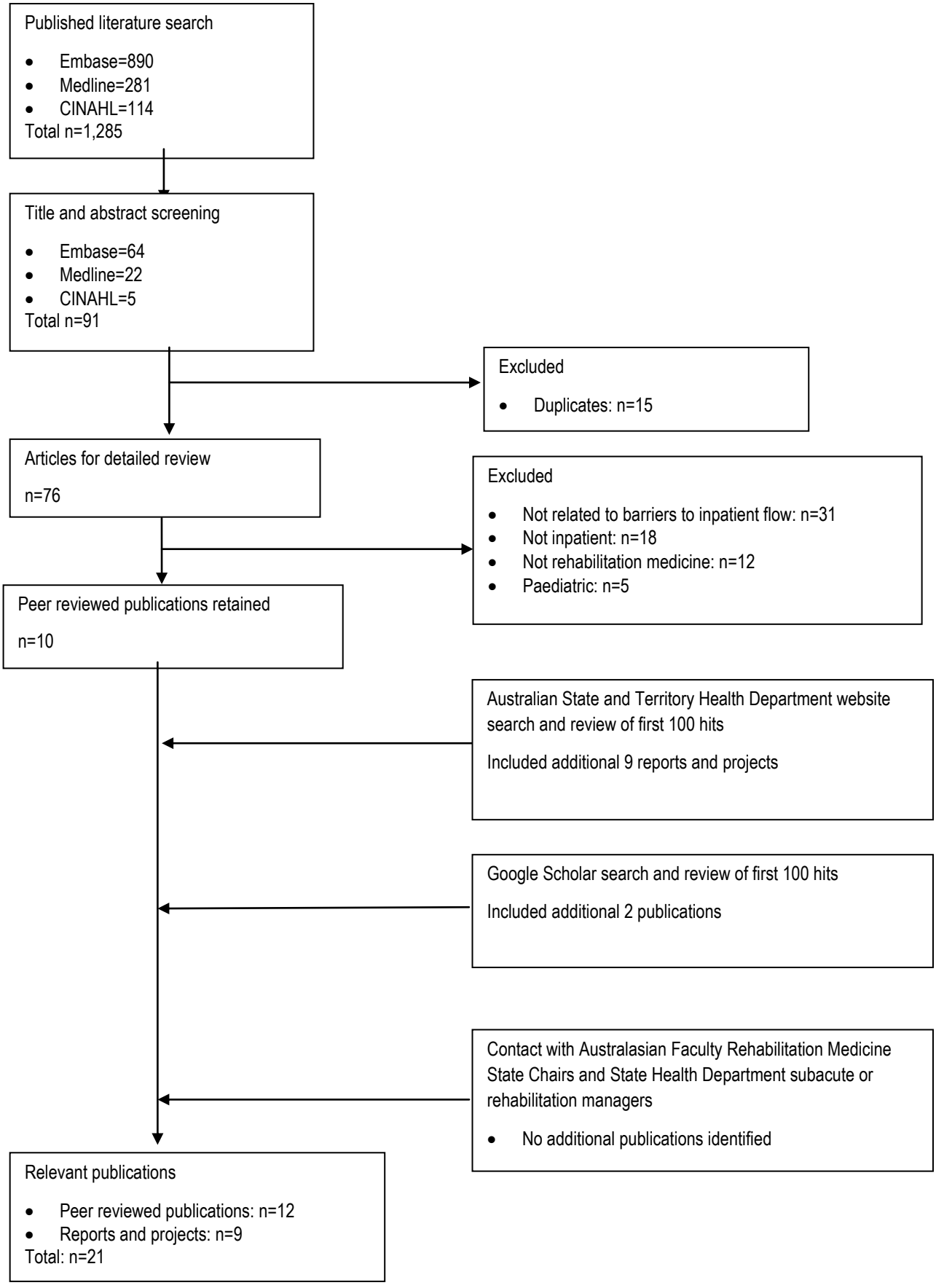
1) The websites of Health Department in each of the Australian States and Territories were searched for potentially relevant publications or projects. The same search terms listed above were used. The first 100 'hits' were screened for potential relevance.
2) A search was performed using the 'Google Scholar' search engine using and the same methodology as the Health Department searches above.
3) Each of the Australian State Health Department mangers with responsibility for rehabilitation were contacted and requested to provide copies of documents relevant to this search if these had not already been identified by previous search strategies.
4) The Australasian Faculty of Rehabilitation Medicine State branch chairs were contacted and asked about their awareness of projects in their State regarding this topic, any relevant publication, and if they knew of any key senior health department personnel involved in projects in this field. When provided, these contacts were also approached with a request to assist with potentially relevant information.

Given the anticipated dearth of rehabilitation-specific publications concerning patient flow no formal systematic review of the literature was planned. Instead, a thematic synthesis of the literature and relevant issues will be presented.

1.2.2 Results of literature search

A flow chart of the search methodology and overview of results is shown in figure 1.

Figure 1. Flow chart of the literature search methodology and overview of results.



1.2.2.1 Published literature search

There were 1,285 potentially relevant publications identified by the search of Medline, Embase, and CINAHL. Of these, only 10 met the inclusion criteria. [1, 65, 90-97] As expected, the methodological quality of identified publications did not permit a formal systematic review. The literature search did not identify any randomised or controlled clinical trials involving barriers to admission or discharge of rehabilitation patients from inpatient units. An overview of the relevant papers, including the author surname, year and country of publication, and brief summary is presented in Table 2.

The studies identified by the literature search included a number of review papers. These covered methodologies for studying patient flow, [90] the role of utilization review tools in determining level of care needs, which has the potential to highlight inappropriate bed days in different settings of care, [93] and indicators of access to post-acute care (which includes rehabilitation) in the USA, including outcome measures. [96, 97]. One of these specifically highlighted the need for process measurement in postacute quality improvement activities to include those that lead to more health care utilization and delays to discharge, but no specific indicators were proposed. [97] Three observational studies reported on patient flow from acute to rehabilitation hospitals in the UK,[92] Canada [91] and Australia. [94] These all indicated problems in this area. Another publication using utilization review found that only a third of patients in acute care met criteria for care in this setting. [65] An opinion paper discussed access to postacute care in the USA being influenced by non-clinical factors. [95] Another opinion paper, written by this author prior to starting this thesis, highlighted problems with rehabilitation in Australia that included numerous examples of barriers to patient flow from acute to rehabilitation and barriers to discharge without classifying these or quantifying the duration of the delays.

1.2.2.2 'Grey literature' search

There were 9 reports and projects located by searching Australian State Health Department websites. [98 99 100 101 102 103 104 105 106]. The State of origin, report name, year of publication and brief summary are presented in table 3. No relevant documents or programs were identified from the Northern Territory, Australian Capital Territory or Western Australia. The health departments of the other States had publications that indicated an acknowledgement of the need to improve patient flow in hospitals. Only Queensland, New South Wales and Victoria included any mention of the need to consider rehabilitation medicine in the systems change processes to improve patient flow and mentioned problems with rehabilitation patient flow. However, no specific quantification of this problem was given. One report commented that there was a need to ensure the efficient use of sub-acute beds through the use of performance indicators, however, no specific indicators

were proposed. [103] One report gave details of specific problems regarding rehabilitation patient flow and outlined solutions to address these. [106] A project from Victoria more than a decade ago provided the most detailed investigation into the acute to sub-acute interface and identified efficient and inefficient processes. [104] It also highlighted the need to optimise these processes in order to help meet future demands for hospital care.

Two relevant documents that met the inclusion criteria were located by using the 'Google Scholar' website that had not been located by the other strategies. Table 4. These were peer-reviewed publications from Canada that reported on delayed discharge for non-medical reasons in stroke patients. [107, 108] Both reported an important proportion of patients were in hospital unnecessarily.

No additional publications or other relevant documents that had not been identified by other strategies were located as a result of the contact with the State Health Department mangers with responsibility for rehabilitation or from the contact with the Chairs of the Australasian Faculty of Rehabilitation Medicine State branches.

1.2.2.3 Implications for future research regarding rehabilitation patient flow

Although numerous authors and reports have highlighted concerns regarding inefficiencies in rehabilitation patient flow there were very few formal studies of barriers to rehabilitation patient flow identified. There are many knowledge gaps that need to be addressed. No formal definition of barriers to discharge from inpatient rehabilitation (or sub-acute care) were located in the literature search. Neither was any proposed classification of the causes for barriers to rehabilitation admission or discharge. These are important in order to measure the extent of the problem in these areas. Furthermore, it is not known to what extent there is a problem with rehabilitation patient flow, what are the most common causes of barriers to admission or discharge, and what are their impact on outcomes, including hospital LOS. Although the duration of key process in the patient journey from acute hospital to inpatient rehabilitation have been reported, [94] no accepted benchmarks or indicators for acceptable or unacceptable barrier durations have been reported. These are all vital because by measuring and documenting the nature and extent of barriers to rehabilitation patient flow it would then be possible to systematically try and address these. This would have the potential to improve health care and hospital efficiency, reduce LOS and costs, as well as hopefully improving patient outcomes.

Table 2. Relevant publications located by the literature search of Medline, Embase and CINAHL.

Author	Year	Country	Summary
Millard [90]	1998	UK	Review. Discusses problems of measuring and forecasting rehabilitation activity, including multiple interventions that can change during the course of an admission and the difficulty in measuring the impact of interventions. Gives explanations about the problems that arise from reporting the average length of stay because it is not normally distributed. Provides explanation of behavioural models of flow using methodologies analogous to those used in pharmacokinetics, demonstrate the differences in the flow of patients between acute, rehabilitation and long-term care. Outlines how modelling can be used to pre-test the impact of changes to bed allocation in different settings or length of stay in hospital for patients at different levels of care.
Siros [91]	2004	Canada	Retrospective open cohort study of severe trauma patients admitted between 1/4/1994 and 31/3/1999 and transferred to inpatient rehabilitation. Patients who did not experience transfer delays caused by administrative barriers and were transferred to rehabilitation sooner had shorter inpatient rehabilitation admissions and improved cognitive functioning.
Bradley [92]	2006	UK	Prospective open cohort study of consecutive admissions to a 60-bed neurosurgical unit over 5 months. For patients aged 16 – 70 years old, 42% of bed days did not require acute neurosurgical ward management, but were more appropriate for alternative care settings. Of these patients, almost all (40%) were deemed appropriate for some type of rehabilitation, indicating a large unmet need for specialist neuro-rehabilitation inpatient services. This compromises acute neurosurgical service efficiency.

Author	Year	Country	Summary
Poulos [65]	2007	Australia	Utilisation review is a method to assess the appropriateness of the care provided, including the setting of care and length of stay. This paper describes the use of a USA utilisation tool in a prospective open cohort study of sample of 242 acute hospital patients admitted with a stroke, hip fracture, limb amputation, or who were referred for rehabilitation. Only 31% of patients met the criteria for acute care. There was minimal delay between referral for rehabilitation and consultation, and between deemed ready for transfer and actual transfer. Most patients did not meet the criteria for acute care at the time of referral.
Poulos [93]	2007	Australia	Literature review on the potential role of utilisation review in defining levels of care and in facilitating appropriate care, with a focus on the interface between acute care and rehabilitation. High levels of inappropriate bed days are consistently reported in international studies using standardised utilisation review tools. This includes both inappropriate admission to acute care and inappropriate continuing days of stay. The potential for utilisation review to improve the efficiency of health care and improve patient flow in the Australian setting is discussed.
Poulos [94]	2007	Australia	Case study describing the development and implementation of a clinical information management systems across a network of rehabilitation and aged care hospitals. The systems improved the management and tracking of referrals, consultations and transfer to rehabilitation. This decreased the time to consultation and transfer. After implementation, 82% of patients were seen within 1 weekday and 94% were seen within 2 weekdays of referral. The time from been deemed ready for transfer to rehabilitation or subacute care admission was 1 day for 68% of patients and 2 days for 77% of patients.

Author	Year	Country	Summary
Buntin [95]	2007	USA	Opinion paper that discusses access to postacute rehabilitation in USA, including rehabilitation facilities, skilled nursing facilities and long term care. Examines factors that influence access to the most appropriate setting of post acute care and the intensity of care being influenced by non-clinical factors, such as provider supply and financing.
Ottenbacher [96]	2007	USA	Review of access to postacute care services, focused on the USA systems. Classified indicators of access to rehabilitation into financial, personal, structural and attitudinal categories. These are suggested as a framework for possible indicators of access. No specific details, however, are provided about what these possible indicators may be.
Duncan [97]	2007	USA	Review of commonly used postacute outcome measures and review of new methodologies for postacute assessment. Discusses factors that influence validity and usefulness of postacute measurement to influence policy. Supports using the framework of structure, process and outcomes for assessing outcomes and quality of postacute care. Includes in suggested process elements for measurement those that lead to more health care utilisation and delay community discharge. Also suggests that simultaneous monitoring of process and outcomes would provide feedback that could lead to improvement or highlight structural factors that need addressing.
New [1]	2008	Australia	Opinion paper that discusses improvements to the efficiency and effectiveness of the Australian health care system that could be made by addressing a range of perceived problems. These include the following: the lack of consideration of preventing functional decline and secondary complications in acute hospitals; delays in acute hospitals engaging rehabilitation, lack of community-based rehabilitation; difficulty providing adequate post-discharge care options for severely disabled younger aged people; difficulty funding aids, equipment and home modifications; and the absence of a broader range of inpatient subacute care options.

Table 3. Relevant patient flow publications and reports identified from searching State Health Department websites.

State	Document title	Year	Summary
Qld	Queensland Health Systems Review Final Report [98]	2005	Includes recommendation to redesign patient flow for acute hospital services, however, no specific mention of the need to include rehabilitation medicine or sub-acute care as part of this reform process.
Qld	Qld Statewide Rehabilitation Medicine Services Plan 2008–12 [99]	2008	Includes identification of a perceived problem with access block for inpatient rehabilitation services, particularly specialty streams, as well as perceived problems of barriers for inpatient discharge due to inadequate community rehabilitation services. Discussion of solutions that includes increase to inpatient bed numbers and improved ambulatory and home based rehabilitation.
Tas	Rehabilitation services in Tasmania: current situation and future plans. [100]	2007	Includes recommendations for increased inpatient and community rehabilitation to meet current and future demand. No formal discussion of access or discharge barrier issues.
SA	Statewide Rehabilitation Services Plan 2009-2017 (South Australia.) [101]	2009	Alludes to perceived problem of access to some specialty rehabilitation streams, and perceived problems of barriers for inpatient discharge due to inadequate community rehabilitation services. Discussion of solutions that includes increase to inpatient bed numbers and improved ambulatory and home based rehabilitation.
NSW	Access issues at NSW public hospitals – key strategies [102]	2003	Identifies reasons for access problems and proposes immediate and longer term solutions. Includes focus on care for older patients, chronic disease management, expanded ambulatory and community care as alternatives to hospital care, and improved teamwork and discharge process. No specific mention of rehabilitation or sub-acute care.

State	Document title	Year	Summary
NSW	Sustainable access plan [103]	2004	Summary of various access block improvement programs aged care, emergency department, workforce, and public health initiatives. Makes reference to the need to ensure efficient use of sub-acute beds through the use of performance indicators. No specific indicators proposed.
VIC	Sub-acute/Acute interface project: Final report [104]	2001	The project investigated the boundaries and relationships between the acute and sub-acute service systems, identified efficient and effective service models and practices and recommended strategies to improve management of current and future service demand. It involved a service review and consultation with a wide range of clinical staff from both the sub-acute and acute sectors. Key Findings were: 1. A lack of focus and coordination in referral to and provision of sub-acute services, which affects throughput and efficiency. 2. Communication blocks between and within acute and sub-acute services, which affect patients' progress through the continuum of care. 3. Significant numbers of patients waiting for transfer to residential care in both acute and sub-acute beds, which affect both patient management and service delivery. 4. A lack of equitable access to home-based care and community services, which affects the ability of sub-acute services to discharge appropriately. A number of recommendations were made that focused on changes in practice and increased flexibility. No formal measurement of barriers to patient flow were reported or recommended.

State	Document title	Year	Summary
VIC	Evaluation of the Interim Care Program Final Report. Victorian Department Of Human Services 2002. [105]	2002	Evaluation of a program of alternative care options for patients no longer needing hospitalisation. Recommended continuation to help improve access to care
VIC	Patient flow collaborative final report. [106]	2006	Whole of health system collaboration project to educate health managers with skills to design projects to address patient flow problems. Limited mention of rehabilitation-specific projects. Contained examples of improvements to the wait for admission into rehabilitation from acute hospital.

Qld=Queensland, NSW=New South Wales, ACT=Australian Capital Territory, Vic=Victoria, Tas=Tasmania, SA=South Australia, WA=Western Australia, NT=Northern Territory

Table 4. Relevant literature search results from Google Scholar not identified in Medline, Embase, CINAHL or Australian State Health Department websites.

Author	Year	Country	Summary
Mayo [107]	1997	Canada	Retrospective cohort study to determine amount of time spent by stroke patients in acute-care hospitals not justified for medical reasons and to identify mechanisms contributing to nonmedical bed-days. 2232 persons admitted into one of 13 hospitals in Montreal, Canada, during 1991. Almost 50% of the cohort remained in the hospital after meeting criteria for medical discharge, resulting in 43% of total bed-days not accounted for medically. Fifty percent of persons with delayed discharge did not go home but were discharged to another acute-care hospital or to rehabilitation or long-term care, accounting for 66% of the nonmedical bed-days.
Gubitza [108]	1999	Canada	Canadian study of problems with patient flow in Acute Stroke Unit between 1/1/1994 and 31/12/1996. 729 patients admitted. Discharge was delayed in 29% of survivors. Of the survivors, 24% went home after alterations to the home environment, 62% were transferred to a rehabilitation facility, and 14% to a nursing home. The cost of the delayed discharges was estimated at $1.5 million per year.

1.3 AIMS OF THESIS

The aims of this thesis are:

1. Develop a definition of barriers to discharge from inpatient rehabilitation and a classification system for the main causes.
2. Develop a selection of key performance indicators (KPIs) for rehabilitation patient flow, including barriers to admission and discharge.
3. Determine the perceived severity of barriers for admission into rehabilitation from acute hospitals and barriers to discharge from rehabilitation in Australia.
4. Study the duration of process barriers for acute hospital patients needing inpatient rehabilitation.
5. Study the causes of barriers to discharge from inpatient rehabilitation and their impact on the duration of hospital admission.
6. To develop a computer model that simulates rehabilitation patient flow and use this is to calculate the impact on LOS from a number of hypothetical scenarios that address the major process delays for transfer from acute hospital to rehabilitation and barriers to discharge from rehabilitation by way of alternate care pathways.

1.4 METHODS

This thesis used a number of different research methods in a range of settings to achieve the aims listed above.

- A multi-disciplinary, iterative, consensus process was used to develop a definition of barriers to discharge from inpatient rehabilitation and a classification system for the main causes (**aim 1**).
- A National web-based survey of key stakeholders was used to develop a selection of KPIs for rehabilitation patient flow (**aim 2**) and to determine the perceived severity of barriers for admission into rehabilitation from acute hospitals and barriers to discharge from rehabilitation (**aim 3**). A copy of the survey is found in appendix 6.
- A retrospective cohort study was used to study the process barriers for acute hospital patients needing inpatient rehabilitation (**aim 4**).

- A prospective cohort study was used to study the causes of barriers to discharge from inpatient rehabilitation and their impact on the duration of hospital admission (**aim 5**).
- Finally, computer modelling was used to calculate the impact on acute hospital and inpatient rehabilitation LOS from a number of simulation models to address the major process delays for transfer from acute hospital to rehabilitation and barriers to discharge from rehabilitation by way of alternate care pathways (**aim 6**).

The data collection all took place in Australia. The survey was National while the rest of the project was conducted in Melbourne, Victoria. The multi-disciplinary consensus process took place across in the sub-acute sector, involving rehabilitation and aged-care staff, at two major health Networks. The data collection for the retrospective and prospective cohort studies involved two hospitals that are part of Monash Health, the largest health Network in Victoria.

The methods of data collection and analysis are reported in detail in each of the publications, so will not be described here.

There were no previously known datasets that could have been used to conduct this project before it's commencement. Although a previous study described the duration of key process for patients transferring from acute hospital to rehabilitation, [94] no data was collected about these patients regarding subsequent barriers to discharge. As mentioned above in the literature review, there are no previous reports of a definition of rehabilitation discharge barrier, classification of the causes of rehabilitation discharge barriers, or KPIs for rehabilitation patient flow.

1.5 THESIS OVERVIEW

The next chapter of this thesis, **chapter 2,** describes the development of a definition of barriers to discharge from inpatient rehabilitation and a classification system of the causes (**aim 1** of this thesis), along with suggesting a range of proposed KPIs for rehabilitation patient flow, (**aim 2**). This definition and proposed KPIs are essential in order to progress formal study of barriers to discharge from rehabilitation.

In **chapter 3** the survey results for the perceived severity of barriers for admission into rehabilitation and aged-care units from acute hospitals and subsequent barriers to discharge are reported (**aim 3**). The major reasons for barriers to patient discharge from acute and rehabilitation hospitals are also presented. The survey allows a comparison to be made between the responses of rehabilitation and aged-care physicians that work in these units and hospital managers with responsibility for patient flow in this sector. The results substantiate the need for formal study of rehabilitation patient flow in hospitals.

Chapter 4 uses some of the KPIs suggested in chapter 2 in a retrospective study of the process barriers for acute hospital patients who are subsequently admitted to inpatient rehabilitation (**aim 4**). The rationale for this study is based on the results of the literature search reported above and responses to the survey reported in chapter 3.

In **chapter 5** the causes of barriers to discharge from inpatient rehabilitation and their impact on the duration of hospital admission are reported (**aim 5**). This work relied on the definition of barrier to rehabilitation and the classification of causes reported in chapter 2 and was also informed by some of the KPIs suggested in chapter 2. The rational for this study is based on the results of the literature search reported above and responses to the survey reported in chapter 3.

Chapter 6 reports the development of a computer model that simulates rehabilitation patient flow, from acute hospital admission through to discharge from rehabilitation. The model is used to calculate the impact on acute hospital and inpatient rehabilitation LOS from a number of simulations of alternate care pathways (**aim 6**). The alternate models address the major process delays for transfer from acute hospital to rehabilitation and barriers to discharge from rehabilitation using data and results from the studies reported in chapters 4 and 5.

The thesis concludes with **chapter 7**, which discusses of the salient findings and the contribution the thesis findings have made to the knowledge and understanding of the topic. Practical applications, implications and limitations of thesis are also discussed. Directions for future research in the field are also explored.

2 CHAPTER TWO: DEFINITION & CLASSIFICATION OF DISCAHRGE BARRIERS, AND KEY PERFORMANCE INDICATORS FOR PATIENT FLOW

"When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot express it in numbers your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts advanced to the stage of science."

William Thompson, 1st Baron Kelvin (1824 – 1907)

2.1 Declaration B: Chapter 2

PART B: Suggested Declaration for Thesis Chapter

Monash University

Declaration for Thesis Chapter 2

New PW, Cameron PA, Olver JH, Stoelwinder JU. Defining barriers to discharge from inpatient rehabilitation, classifying their causes, and proposed performance indicators for rehabilitation patient flow. Arch Phys Med Rehabil. 2013;94:201-208

Declaration by candidate

In the case of Chapter2, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
I conceived the project, performed the literature search, coordinated the iterative process of developing the definition and classification, designed the survey, arranged the data collection, performed the analysis and wrote the first draft of the manuscript.	85%

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

Name	Nature of contribution
Peter Cameron	Provided constructive suggestions on revisions to the manuscript.
John Olver	Provided constructive suggestions on revisions to the manuscript.
Johannes Stoelwinder	Provided constructive suggestions on revisions to the manuscript.

Candidate's Signature	[redacted]	Date 14/3/13

Declaration by co-authors

The undersigned hereby certify that:

(1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.
(2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
(3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
(4) there are no other authors of the publication according to these criteria;
(5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
(6) the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s)	[redacted] Rehabilitation, Kingston Centre, Warrigal Rd, Cheltenham 3192	
Signature 1	[redacted]	14/3/13
Signature 2	[redacted]	5/4/13
Signature 3	[redacted]	16/3/13.

2.2 CHAPTER 2: Introduction

The literature review in Chapter 1 highlighted that there was no published definition, or classification, of barriers to discharge from inpatient rehabilitation and no published accepted key performance measures for benchmarking or process improvement. These are essential for facilitating research and clinical systems improvements in this important area.

This chapter describes the iterative, multidisciplinary process that was used to develop a definition and classification of barriers to discharge from inpatient rehabilitation, which was the first aim of this thesis. The chapter also describes the results from a survey of rehabilitation medicine and aged-care physicians and hospital managers with responsibility for patient flow that was used to propose key performance indicators for sub-acute patient flow, the second aim of this thesis. A copy of the survey questions is found in appendix 6.

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SPECIAL COMMUNICATION

Defining Barriers to Discharge From Inpatient Rehabilitation, Classifying Their Causes, and Proposed Performance Indicators for Rehabilitation Patient Flow

Peter W. New, MBBS, M Clin Epi, FAFRM (RACP),[a,b,c,d] Peter A. Cameron, MBBS, MD, FACEM,[a] John H. Olver, MBBS, MD, FAFRM (RACP),[b,d] Johannes U. Stoelwinder, MBBS, MD, FRACMA[a]

From the [a]School of Public Health and Preventive Medicine, Department of Epidemiology & Preventive Medicine, and [b]Epworth-Monash Rehabilitation Medicine Unit, Monash University, Melbourne; [c]Rehabilitation and Aged Services, Medicine Program, Southern Health, Melbourne; and [d]Rehabilitation Services, Caulfield Hospital, Alfred Health, Melbourne, Victoria, Australia.

Abstract

There is little research literature on patient flow in rehabilitation. Accepted definitions of barriers to discharge and agreed performance measures are needed to support research and understanding of this topic. The potential of improved patient flow in rehabilitation to assist relieving demand pressures in acute hospitals underscores its importance.

This study develops a definition of barriers to discharge from postacute care and classifies their causes using a multiphased iterative consultation and feedback process involving physiatrists, aged-care physicians, and senior nursing and allied health clinicians. Key performance indicators (KPIs) for postacute patient flow are then proposed, the development of which were informed by the available literature and a survey (n = 101) of physiatrists, aged-care physicians, and hospital managers with responsibility for patient flow who were questioned about the use of relevant KPIs in this setting. Most (>70%) respondents believed that using KPIs (eg, waiting time from acceptance by postacute care and ready for transfer until admission, percentage of postacute bed days occupied by inpatients with a discharge barrier) to measure aspects of patient flow could improve processes, but few reported collecting this information (45% admission KPIs, 19% discharge KPIs).

By using the definition and classification of discharge barriers prospectively to document and address barriers, in conjunction with appropriate KPIs, postacute patient flow and the efficiency of hospital resource utilization can potentially be improved. Our commentary aims to stimulate interest among others to develop a more robust evidence base for improved flow through postacute care.

Archives of Physical Medicine and Rehabilitation 2013;94:201-8

Patient flow problems in the postacute (subacute) sector, including rehabilitation and aged care, have received relatively little attention to date. In particular, the study of "access block," or barriers for admission into postacute care from acute care, and "exit block," or barriers to discharge from inpatient postacute care when treatment in that setting is no longer deemed necessary, has been neglected. In recent years, however, a number of authors have highlighted problems in these areas.[1-5] Given the pressures on acute hospitals, and the potential for adverse patient outcomes from iatrogenic complications resulting from unnecessarily prolonged admissions,[6,7] there are patient-centered, ethical and financial imperatives to expand research on patient flow in postacute care. In trying to redesign health systems to better meet the demand on hospital services, as well as improving postacute services, it might be more cost-effective to divert funding into programs that address barriers to admission and discharge from postacute care than fund additional hospital beds.

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We have recently reported survey results indicating that in Australia, 87% of physiatrists believed that there were moderate, severe, or extreme discharge barriers for inpatients in their rehabilitation unit compared with 41% who reported the same degree of problems with barriers to admission.[5] A systematic search of the literature performed in May 2010 using MEDLINE (1950–2009), Embase (1980–2009), and CINAHL (1992–2009) databases and using terms related to patient flow and rehabilitation revealed only 10 publications[1-4,8-13] on barriers for admission into, or discharge from, rehabilitation. Four of these[3,8,12,13] had content relating to methodologic aspects of studying patient flow in inpatient physical medicine and rehabilitation. None included principles for measuring barriers to admission or discharge from inpatient rehabilitation or relevant definitions. One publication[13] highlighted the need for process measurement in postacute quality improvement activities to include those that lead to more health care utilization and delays to discharge, but no specific indicators were proposed. A definition of discharge barriers is required if research is to inform practice. In this commentary, we focus on barriers to discharge because of the above-mentioned evidence of these being a greater problem than barriers to admission.

Furthermore, in Australia and, we expect, in other countries, there are no accepted benchmarks for minimizing access or discharge barriers in postacute inpatient services, in contrast to access to emergency care and elective surgery.[14] Key performance indicators (KPIs) of structure, processes, and outcomes of health care[15] have been used to help improve health systems.[16] The measurement of postacute patient flow barriers, setting KPIs around these, and developing strategies to resolve them could improve hospital efficiency and resource utilization.

In this commentary, we first describe an iterative process to develop a definition of discharge barrier and classification of the causes. These are a prerequisite for research in rehabilitation patient flow translating into improvements in this area. We then report on a survey of key stakeholders regarding their use of KPIs of patient flow. Finally, we make recommendations regarding principles for future research on rehabilitation patient flow. This includes how the use of the definitions, classification, and measurement of barriers to patient flow in rehabilitation could facilitate improvement in the flow of patients through hospital systems.

Methods

Definition of discharge barrier and classification of causes

A definition and classification system of discharge barriers was developed in a multiphased, multidisciplinary, iterative process. Previous studies in other areas have used the terms "discharge barrier" and "clinically ready for discharge" to cover the same situations. In developing our definition and classification, we regarded these terms to be interchangeable and approached the development from the perspective of all postacute inpatient care settings, particularly rehabilitation and aged care. The focus in developing this definition and classification was not on blaming the patient, but on the systems problems that were believed to be responsible for discharge barriers.

List of abbreviations:

ICF	***International Classification of Functioning, Disability and Health***
KPI	**key performance indicator**
LOS	**length of stay**

First, a definition of discharge barrier and a classification system of causes were drafted. The classification was devised to be clinically relevant. We sought to balance the need for detail, in order to target reducing the impact of the barriers as well as being relevant to other postacute settings, with the need to limit the number for data collection and analysis reasons.

Then, during a 4-month period, the reasons given by senior medical, nursing, and allied health clinicians for prolonged length of stay (LOS) for rehabilitation and aged-care inpatients were monitored at weekly meetings established to review these occurrences at a major public hospital in the state of Victoria, Australia. Patients identified as no longer requiring inpatient care had the reasons classified and criteria defined. These were cross-referenced with those identified in a similar meeting held at another major hospital elsewhere in Victoria that also cared for both rehabilitation and aged-care patients. The reasons and criteria given at both these meetings were used to refine our classification and criteria.

A 3-month pilot phase then prospectively monitored all rehabilitation patients admitted to a general inpatient rehabilitation ward to validate and further refine the categories and criteria. A revised draft of the definition and classification was then distributed to a number of senior physiatry colleagues for feedback and suggestions. After this, 2 separate prospective projects monitored the occurrence and category of discharge barriers in consecutive admissions ($n>600$) to inpatient rehabilitation using the devised classification system. During this period, a few of the criteria underwent very minor amendments to the wording clarifying their intent. It is believed, however, that none of the changes have affected the validity of the data collected.

Finally, in early 2009, the Australasian Rehabilitation Outcomes Centre (http://ahsri.uow.edu.au/aroc/index.html) ran a series of multidisciplinary workshops involving physiatrists and senior allied health clinicians to develop adjunct datasets that included a definition of barrier to discharge. The proposed definition, classification, and the criteria developed through the processes described above were considered as part of the workshops and follow-up discussions. The feedback obtained was used for making further minor refinements.

We planned to classify the discharge barriers into factors intrinsic to the hospital organization (intraorganizational) and those that were extrinsic (extraorganizational). The causes of discharge barriers were also classified according to the *International Classification of Functioning, Disability and Health* (ICF), which provides a framework and classification from the patient perspective, at both the individual and population level.[17] The ICF has been used to identify categories relevant to acute hospital patients[18] and to rehabilitation[19] and geriatric patients in early postacute care.[20] In these publications, a literature review of general ICF uses,[21] and a recent overview of the current state of implementing the ICF in rehabilitation medicine,[22] no mention has been made of the possible use of the ICF for classifying barriers to hospital discharge. To facilitate the use of the ICF in studies of barriers to discharge, we planned to perform a thematic analysis and classify the discharge barriers identified here against the environmental factors coded in the ICF.

Survey of KPIs of postacute patient flow

Survey methods

A survey was developed by 1 of the authors (P.W.N.) of perceived barriers to admission and discharge from inpatient postacute care in Australia (copy available on request). The web-based survey[a] was conducted over 10 weeks between May and July 2009. It consisted of Likert scales and closed questions with a few open-ended questions allowing free-text answers. The survey was targeted at all physiatrists and aged-care physicians working in adult inpatient units, and senior hospital management with responsibility for patient flow involving postacute care in Australia. These groups were selected because it was considered important to obtain the opinion of those with clinical and management expertise in this area in order to optimize acceptance, both of the survey and the subsequent results. Further information has recently been reported about the survey methodology and the perceptions of respondents regarding both the extent of problems for acute hospital patients accessing inpatient postacute care and the subsequent discharge barriers for these patients, along with nominated reasons for these barriers.[5]

One section of the survey asked respondents about the types of data their unit, hospital, or organization collected regarding access and discharge process barriers for postacute care; opinions regarding nominated KPIs for access and discharge to postacute care; and suggestions regarding alternative KPIs to those proposed.

Survey analysis

Results were analyzed descriptively. Comparisons were intended to assess whether there was an influence on responses from either (1) the number of years postspecialization (physiatrists and aged care) or working in patient flow (hospital management), or (2) the position of the respondent (ie, physiatrist, aged-care or hospital management).

Categorical responses were analyzed using the chi-square test, with the Fisher exact correction used where appropriate. Data that were not normally distributed (eg, number of years since completing specialist training or working in patient flow management) were analyzed using the Kruskal-Wallis H test. The relationship between continuous variables that were not normally distributed (eg, years posttraining and suggested time frames for the various KPIs) was analyzed using the Spearman correlation test.

The P values of less than .05 were deemed statistically significant. Approval for the project was obtained from the human research ethics committees at Southern Health and Monash University.

Results

Proposed definition of discharge barriers and classification of causes

The following is our definition of an "inpatient rehabilitation discharge barrier": *A discharge barrier is considered to occur when the treating team believes that there are no longer any goals of therapy or treatment that require inpatient rehabilitation, and yet the patient is unable to be discharged.* In applying this definition the following assumptions are made:

- The patients' activity limitations, body functions, and structures dysfunction have been addressed to an adequate degree, including safety considerations, such that it is no longer necessary to continue rehabilitation in an inpatient setting.
- Environmental barriers and facilitators for discharge have been optimized within the limit of readily available resources.

This definition allows the team to consider a barrier to exist when resources or services (eg, carers, funding for equipment or home modifications, ambulatory rehabilitation) are not readily available to enable discharge to proceed, but the patient no longer needs inpatient care. Although the treating team should, as part of routine discharge planning, refer to the necessary services and resources to meet the ongoing needs of the patient after hospitalization, it is considered inappropriate that the team also be responsible for obtaining these when they are not readily available. That is the rationale for the approach taken, which was supported by participants in the development process. The definition allows flexibility for teams in different settings, with different resources, to determine when they believe a discharge barrier exists.

The classification of the causes of postacute discharge barriers, their criteria, and corresponding ICF codes are shown in table 1. In the prospective use of the classification of discharge barriers in 2 projects, in only 1% of situations where a discharge barrier was noted did the classification system not include the nominated reason for the barrier. We have applied the ICF coding at a minimum of the 2-level scheme. We have not included the ICF qualifiers, as these would depend on the specific situation, but they would obviously always be negative. Likewise, we have not indicated the severity of the barriers to discharge, for the same reason.

Results of the survey on KPIs

A total of 101 completed surveys were included in the analysis. The response rates were 24% (39/160) for rehabilitation physicians, 41% (41/100) for aged-care physicians, and unknown for hospital managers (n = 21) because of an inability to determine the potential number of eligible respondents for this group.[5] Some organizations had multiple staff members respond. The maximum number from any 1 organization was 5. These multiple respondents often included representatives from the different target groups. Overall, 34 health organizations had respondents who completed the survey.

Only 45% of respondents reported that their unit, hospital, or organization collected data related to the timeliness of acute hospital patients accessing postacute beds as KPIs for benchmarking or quality improvement purposes. However, 70% either agreed or strongly agreed that this information would be useful for benchmarking, and only 9% disagreed or strongly disagreed. There was no relationship between answers and respondents' positions ("currently collect": $\chi^2 = 15.8$, $P = .09$; "would be useful": $\chi^2 = 3.4$, $P = 0.2$). The types of information that respondents reported were being collected related to the timeliness for acute hospital patients being able to access postacute beds are shown in table 2. Respondents' endorsement of 3 proposed KPIs for timeliness of admission into postacute care and their nominated benchmark targets for these are shown in table 3.

Only 19% of respondents reported that their unit, hospital, or organization collected data related to discharge barriers for postacute inpatients that were used for KPI purposes. Similar to above, however, 71% of respondents either agreed or strongly agreed that

Table 1 Classification of barriers to discharge from inpatient postacute care, criteria, and ICF codes

Classification and Criteria of Discharge Barriers	ICF Codes
Intrinsic	
Family: Negotiations and discussions with family members regarding discharge planning issues that delay discharge processes. In particular, but not limited to, whether family will provide care for the patient or whether the patient will be discharged to a care facility.	e310.4, e315.4, e410.4, e415.4
Non—weight-bearing: Patient non—weight-bearing after lower limb fracture(s). No longer needing inpatient rehabilitation therapy because of lack of benefit in improving function in mobility and transfers. Team recommends maintenance therapy until able to increase weight-bearing; however, no alternative setting of care available, and patient unable to return to the community.	s730.4, s740.4, s750.4, d420, d450.4, d455.4
Occupational therapy home assessment: Patient no longer needs inpatient rehabilitation, but home visit not yet conducted and believed to be necessary before discharge to confirm and optimize safe access and internal environment.	e355.4
Competency assessment: Patient requires neuropsychology assessment for competency in decision making before proceeding with discharge options.	d177.4e355.4
Specialist review: Patient requires medical or surgical review to determine critical changes in his/her management deemed necessary to delay discharge planning process.	e355.4
Ambulatory rehabilitation:* Patient waiting assessment and/or availability of ambulatory rehabilitation services and no longer needing intensity of inpatient rehabilitation, but the team feels patient is not able to be discharged until ambulatory rehabilitation is confirmed and available.	e355.4, e5800.4, e5801.4, e5802.4
Extrinsic	
Home modifications: Patient waiting home modifications that are essential to ensure safe access and care at home after discharge. Includes funding and completion of modifications.	e525.4, e570.4, e580.4, e1550.4, e1551.4, e1552.4, e1650.4, e5150.4, e5152.4
Equipment: Delay waiting for necessary equipment to be available, after specific equipment needs have been identified and prescribed, that is essential to ensure safe care after discharge. Includes funding and supply of equipment.	e570.4,e580.4, e1151.4, e1201.4, e1251.4, e1650.4
Carer funding: Patient waiting funding for carers to ensure safe care after discharge.	e570.4, e1650.4, e5700.4, e5701.4, e5702.4, e5750.4, e5751.4, e5752.4
Carer recruiting and training: Waiting for recruiting and training of carers to ensure safe care after discharge.	e340.4, e5700.4, e5701.4, e5702.4, e5750.4, e5751.4, e5752.4
Accommodation: Patient has no available suitable accommodation options.	d610e5250.4, e5252.4, e570.4
Guardian/power of attorney appointment: Application made for determining power of attorney or guardian for making a decision that is blocking discharge planning, and patient not competent and no nominated person existing. Also includes subsequent delay in decisions being made by nominated guardian regarding discharge planning.	e330.4, e555.4, e360.4, e550.4, e570.4
Long-term and supported care or services and equipment assessment/approval: Patient referred to a service or organization for confirmation of appropriateness and necessity of supported care (nursing home or hostel) or long-term services or equipment. Includes waiting for the assessment; determination of level of care or range of services and equipment; related paperwork; and where relevant, confirmation that no option available for alternative care, where this process is required.	e355.4, e360.4, e555.4, e570.4, e580.4
Alternative setting of care: Waiting for high-level (nursing home) or low-level (hostel, supported residential service) residential care accommodation to be available.	d610e5800.4, e5801.4, e5802.4, e570.4, e580.4

Abbreviations: b, body functions; d, activity or participation; e, environmental factors; s, body structures.
* Could be intrinsic or extrinsic.

Table 2 Types of information regarding postacute access and discharge barriers respondents reported collecting

KPIs	n (%)*
Current KPIs collected regarding acute to postacute access†	n = 45
Time ready for transfer from acute until transfer into postacute	26 (58)
Referral to postacute services until assessed	19 (42)
LOS in acute hospital‡	8 (18)
Time between assessed by postacute services until admitted‡	6 (13)
Current KPIs collected regarding discharge from postacute beds§	n = 19
Time between ready for discharge from postacute care until discharge (with/without recording causes for delay)	6 (32)
Number of patients/time waiting for high-level care bed	5 (26)
LOS in postacute care‡	3 (16)
Time/number of patients waiting for Aged Care Assessment Service review to determine eligibility for entry to residential care	3 (16)

NOTE. Totals do not equal 100% because multiple responses could be given and not all nonvalid suggestions are included in the table.

* Proportion of those who indicated that they collected these data.

† Numerous other suggestions deemed invalid KPI measures included the following: number of patients referred for postacute care, number of patients admitted to postacute per day or per month, number of patients on the waiting list for admission to postacute care, time from onset of impairment until postacute admission, time from admission to acute care until referral for postacute care, and time from referral for postacute care until admission.

‡ KPI measure deemed by authors to be of questionable face validity for benchmarking postacute patient admission or discharge barriers.

§ Numerous other suggestions deemed invalid KPI measures because of questionable face validity included the following: time between Aged Care Assessment Service review and discharge, review of patients with long LOS, time since estimated discharge date, and number of patients waiting for guardian appointment.

this information would be useful for benchmarking, and only 10% disagreed or strongly disagreed. There was no relationship between answers and respondents' positions ("currently collect": $\chi^2 = 0.5$, $P = 0.8$; "would be useful": $\chi^2 = 13.3$, $P = .05$). The types of information that respondents reported were being collected that related to barriers to discharge are shown in table 2. Their endorsement of 2 proposed KPIs for barriers to discharge from postacute care and their nominated benchmark targets for these are shown in table 3.

There was no relationship between the endorsement of the various KPIs or nominated benchmark targets for these and the number of years in their position or their professional group ($P > .05$ for all comparisons).

Discussion

Our multiphased, multidisciplinary iterative consultation and feedback process developed and validated a definition of barrier to discharge from rehabilitation and a classification of causes. Most barriers to discharge identified were environmental and generally reflected planning inefficiencies or inadequacies in the availability of social, health, or disability services. As such, with adequate resources and systems reorganization they are potentially preventable.

Our definition of discharge barrier and the proposed classification system mapped to the ICF may need to be validated and refined to optimize use in other countries.

Table 3 Respondents' endorsement of suggested KPIs for access into and discharge from postacute care

Suggested KPIs	Respondents' Responses (n = 101)
Access barriers postacute KPI	
Support any of the following 3 options as KPI for postacute access	68
1. Median waiting time for an acute hospital referral to be assessed for postacute admission	47
Suggested waiting time for an acute hospital referral to be assessed for postacute admission (d)	2 (2—3)
2. Median waiting time from acceptance by postacute care and ready for transfer until admission	61
Suggested waiting time from acceptance by postacute care and ready for transfer until admission (d)	3 (3—4)
3. Percentage of acute hospital LOS spent waiting for postacute bed	13
Suggested target maximum percentage of acute hospital LOS spent waiting for postacute bed	10 (5—15)
Discharge barriers postacute KPI	
Support any of the following 2 options as KPI for postacute discharge barrier	48
1. Target percentage of postacute inpatients with a discharge barrier	35
Suggested target maximum percentage of postacute inpatients with a discharge barrier	10 (5—20)
2. Target percentage of postacute bed days occupied by inpatients with a discharge barrier	40
Suggested target maximum percentage of postacute bed days occupied by inpatients with a discharge barrier	10 (5—15)

NOTE. Values are percentages or median (interquartile range).

Discussion of survey findings

There was infrequent use of KPIs for reporting access or discharge barriers among survey respondents, despite there being strong support for these. The survey results suggest that it would be useful to establish benchmarks for indicators of efficient (or inefficient) patient flow from the acute hospital into postacute care, and from postacute care into the community. We suggest that these should be national benchmarks that are developed within each country to suit the nuances of their health system.

Poulos et al[3] measured the time taken for key processes in the patient journey from the acute hospital to inpatient rehabilitation. These were days from acute hospital admission until each of the following events: referral for rehabilitation, rehabilitation consultation, deemed ready by the rehabilitation service, and transfer to the rehabilitation unit. All of these events and the corresponding time intervals between them have relevance to key processes that can be barriers to patient flow. Two of these, "referral until assessment" and "ready until transfer," were endorsed by our survey respondents as appropriate KPIs.

The various access and discharge barrier KPIs reportedly used by hospitals included a number that we believe are of questionable face validity as a measure of the patient flow process. This assessment was based on the literature and our expertise in this field. Although the suggested KPIs may measure part of the patient journey across the hospital continuum, they did not reflect an aspect of the process that is discrete. For example, the time from when a patient is referred or assessed for admission until transfer is not an appropriate measure of patient flow if the patient is not medically stable and ready for transfer for some of this time. Having a target number of admissions or discharges per week does not improve flow or address barriers. In reality, the actual number typically varies widely and depends on a whole range of factors. Simply recording the number on a waiting list without knowing how long they have been waiting can give a misleading perspective of access issues. Measuring short-term waiting trends is similarly misleading. Likewise, the total hospital LOS or the acute and postacute LOS separately are influenced by many factors. If the patient requires hospital care, LOS alone is not a valid KPI for barriers to patient flow. Strategies to improve patient flow can only be developed by measuring key impediments to flow, identifying the specific causes for delays, and addressing process, systems, or policy constraints that contribute to unnecessary hospitalization for these patients.

Important concepts for improving patient flow from the nonrehabilitation setting

Some principles and concepts for improving patient flow from other settings have relevance for postacute care, including rehabilitation. These should be considered as part of any comprehensive systems-wide approach to process improvement of postacute patient flow. These principles include the following: reducing the length of decision cycles, such as ward rounds[23] and team meetings; understanding and mitigating system-generated variation in health care processes[24,25]; and the lean thinking and Six Sigma paradigm inspired by manufacturing engineering and operations research, which focuses on eliminating non–value-added activities and waste and improving processes.[26] It is also important that there be closer involvement between clinicians responsible for patient care (and who are often very aware of the causes of problems with patient flow) and the health system managers responsible for improving systems operation, as well as the systematic application of systems engineering approaches to reforming and improving health care delivery.[26,27]

LOS and flow measurement

Information about hospital access and duration of hospitalization is only useful if it serves the purpose of improving health system processes. Unfortunately, measurement is often undertaken without a full appreciation of factors contributing to the results and the reasons behind them.

LOS is an extremely common process measure used when describing hospital discharges and care outcomes. As highlighted in the "Discussion of Survey Findings" section, some of the survey respondents inappropriately nominated it as a KPI for access or discharge barriers. Because LOS is so commonly reported in patient flow publications, it is important to highlight the limitations of how it is analyzed and the alternatives. The hospital LOS is often reported as a mean, with or without SD. However, LOS distributions are typically not normally distributed, but skewed to the right, with a relatively small number of patients who have a much longer LOS.[8] The median and interquartile range are less sensitive to influence by extreme LOS outliers and should therefore be used when describing LOS.

Because hospitals are complex institutions,[28] a better approach to assessing systems activity than reporting LOS or the achievement of meeting fixed admissions or discharge targets is to consider the flow of patients through hospitals.[8,29] Operations research is a discipline that uses advanced analytic methods to help optimize decision making. It has only relatively recently been used in health care and has a clear role in optimizing patient flow.[30,31] Numerous publications provide further detail about this field,[29,32-36] and a considerable amount of work has been published using this methodology in aged care.[37-40] To our knowledge, however, operations research has not previously been reported in physical medicine and rehabilitation research. Analysis methods include discrete event simulation, closed queuing network research agendas, stochastic modeling, Markov modeling, Bayesian belief networks, and time series analyses of bed occupancy using "general additive models." The use of time series graphs, such as process behavior charts,[25] and other charting methods are also likely to be of value in understanding the behavior of systems and delays over time.

Recommendations regarding postacute patient flow research

Based on our findings, a number of recommendations for the development of research on postacute patient flow are suggested. Our definition and classification are proposed as a useful basis to facilitate formal study of barriers to discharge from postacute care. Although the nominated KPIs for access and discharge from postacute care had varying levels of endorsement from survey respondents, there was widespread support for the use of KPIs to improve rehabilitation patient flow. By using the definition and classification of discharge barriers prospectively to document and address barriers, in conjunction with appropriate KPIs, postacute patient flow and the efficiency of hospital resource utilization can potentially be improved.

The classification categories can be omitted if they do not occur, or some can be collapsed. For example, waiting for occupational therapy, competency assessment, or medical specialty could all come under a single category of awaiting internal specialty assessment.

We believe that these research recommendations should be used by clinicians and hospital managers with responsibility for patient flow in postacute inpatient settings to measure and improve barriers to patient admission and discharge. This applies particularly to longitudinal projects within the same setting and comparative studies across different impairment groups, postacute sectors, regions, and countries.

To improve the health care experiences for patients, we also suggest that future work in this field include patients' perspectives on the barriers.

Study limitations

There are some limitations to this project. The survey limitations include the response rates, the potential for responder bias, and being restricted to 1 country. We believe, however, that the survey results and classification of barriers are relevant to many other countries.

A classification system of barriers to admission into postacute care might also need to be developed. Our recent survey highlighted that the major causes of these barriers are likely to include the following: lack of beds; physical/environmental issues (eg, lack of single rooms for infection control); equipment issues (eg, lack of hoists, bariatric equipment); and staffing issues involving allied health or nursing.[5]

Our study has focused on barriers for admission into and discharge from inpatient rehabilitation. There are numerous inpatient rehabilitation team processes, and patient and systems factors that can also influence postacute patient flow, in addition to access and discharge barriers. These factors include the following: the intensity of rehabilitation therapy and modalities of treatment offered, including staffing levels, evidence-based practice, and equipment availability; work practices, organizational management, complexity and fragmentation of care,[41] team processes,[42] and goal setting[43]; the length of decision cycles and discharge coordination; patient variables such as cultural, language, personality, cognition, and health literacy; and the family availability and involvement in discharge planning. Addressing these factors, however, was beyond the scope of this article.

Conclusions

If a process is measured and relevant targets are set, then attempts to improve it will be more likely to succeed. The definitions, classification, and KPIs, together with the concepts for improving patient flow from the nonrehabilitation setting and our proposed recommendations, serve a useful basis for progressing further research in the area of patient flow in rehabilitation. Research is required to directly measure the occurrence and causes of barriers to transfer from the acute hospital into inpatient rehabilitation, and from this setting into the community. Hopefully, our proposals will stimulate interest among other researchers to address the dearth of information in this area and develop a more robust evidence base for improved patient flow through postacute care.

Supplier

a. SurveyMonkey, 285 Hamilton Ave, Ste 500, Palo Alto, CA 94301.

Keywords

Health services accessibility; Operations research; Outcome and process assessment (health care); Patient discharge; Rehabilitation

Corresponding author

Peter W. New, MBBS, M Clin Epi, FAFRM (RACP), Kingston Centre, Warrigal Rd, Cheltenham 3192, Victoria, Australia. *E-mail address:* peter.new@southernhealth.org.au.

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2.3 CHAPTER 2: Summary

This chapter has described the development of a definition and classification of barriers to discharge from inpatient rehabilitation. It also reported on the survey results of key experts and stakeholders in this field regarding the use and development of KPIs for sub-acute patient flow. The chapter also outlined important concepts for improving patient flow from the non-rehabilitation setting and highlighted important principles regarding patient flow measurement and length of stay in hospital.

The definition and classification of barriers to discharge from inpatient rehabilitation proposed in this chapter and KPIs for sub-acute patient flow can potentially be used in research and clinical systems improvement projects to measure and subsequently improve sub-acute patient flow. Chapter 4 uses these KPIs to measure process barriers in the patient journey from acute hospital admission through to transfer into rehabilitation. In chapter 5 the definition and classification of discharge barriers are further used in a prospective study.

3 CHAPTER THREE: PERCEPTIONS OF ADMISSION AND DISCHARGE BARRIERS IN SUBACUTE CARE

"Far better an approximate answer to the right question, which is often vague, than an exact answer to the wrong question, which can always be made precise."

John Tukey: The future of data analysis. Annals of Mathematical Statistics. 1962;33:13

3.1 Declaration B: Chapter 3

PART B: Declaration for Thesis Chapter

Monash University

Declaration for Thesis Chapter 3

New PW, Olver J, Cameron P A, Stoelwinder J U. Key stakeholders' perception of barriers to admission and discharge from inpatient subacute care in Australia MJA. 2011; 195: 538-541

Declaration by candidate

In the case of the above publication, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
I conceived the project, designed the survey, arranged the data collection, performed the analysis, and drafted the manuscript.	85%

The following co-authors contributed to the work.

	Name	Nature of contribution
1	John Olver	Provided constructive suggestions on revisions to the manuscript.
2	Peter Cameron	Provided constructive suggestions on revisions to the manuscript.
3	Johannes Stoelwinder	Provided constructive suggestions on revisions to the manuscript.

Candidate's Signature [redacted] **Date** 14/8/13

Declaration by co-authors

The undersigned hereby certify that:

(1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.
(2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
(3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
(4) there are no other authors of the publication according to these criteria;
(5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
(6) the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s) Department Rehabilitation, Kingston Centre, Warrigal Rd, Cheltenham 3192

Signature 1 [redacted] 5/9/13

Signature 2 [redacted] 14/3/13

Signature [redacted] 14/3/13

3.2 CHAPTER 3: Introduction

Little is known about the extent of problems concerning barriers for acute hospital patients waiting for admission into sub-acute care, or barriers for sub-acute patients waiting for discharge who no longer need this setting of care. Knowing the magnitude and cause of these problems is important in order to prioritise resources for addressing these problems and to help focus further research efforts.

This chapter describes a web-based survey of key stakeholders (n=101) in subacute patient flow. The survey was conducted to obtain the perception of Australian stakeholders regarding the degree to which they believe there are barriers to admission of these patients from acute hospital into subacute hospitals and barriers to discharge from subacute hospital, along with the perceived causes for these delays, which addresses the third aim of this thesis. A copy of the survey questions is found in appendix 6.

Research

Inpatient subacute care in Australia: perceptions of admission and discharge barriers

Peter W New
MB BS, MClinEpi, FAFRM(RACP), Head of Rehabilitation;[1] PhD Candidate;[2] Principal Researcher[3]

Peter A Cameron
MB BS, MD, FACEM, Director, Centre of Research Excellence in Patient Safety[2]

John H Olver
MB BS, MD, FAFRM(RACP), Director, Rehabilitation[3]

Johannes U Stoelwinder
MB BS, MD, FRACMA, Chair, Health Services Management[2]

1 Rehabilitation and Aged Care Services, Medical Program, Southern Health, Melbourne, VIC
2 Department of Epidemiology and Preventive Medicine, Monash University, Melbourne, VIC.
3 Epworth HealthCare, Monash University, Melbourne, VIC.

Peter.New@Southernhealth.org.au

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Abstract

Objective: To determine perceptions of barriers to admission to subacute care from acute hospital care, and barriers to subsequent discharge from subacute care.

Design, participants and setting: Web-based survey of key stakeholders using Likert scales and closed questions. Prompts were emailed repeatedly to potential participants in Australia between 15 May and 24 July 2009. Participants were physicians working in inpatient rehabilitation medicine and aged care units, as well as senior hospital managers with responsibility for patient flow.

Main outcome measures: Perceived admission and discharge barriers in subacute care.

Results: Half of the 101 respondents reported barriers to admission to subacute hospitals as moderate, severe or extreme, and 81% reported a similar grading of severity for barriers to discharge. There was no relationship between these perceptions and whether respondents worked only in the public hospital system (barriers to access: $\chi^2 = 0.02$ [df = 1; $P = 1.0$]; and barriers to discharge: $\chi^2 = 0.0$ [df = 1; $P = 1.0$]). The most commonly reported barriers to admission were: availability of beds (61% of respondents); physical, environmental and equipment inadequacies (62% of respondents); and allied health or nursing staff issues (55% of respondents). The most commonly reported barriers to discharge included: waiting for a more appropriate setting of care (76% of respondents) and funding for home modifications, equipment or carers (55% of respondents). There was no relationship between respondents' position and their reporting of various admission ($\chi^2 = 6.2$; df = 8; $P = 0.6$) or discharge barriers ($\chi^2 = 13.8$; df = 12; $P = 0.3$).

Conclusion: There is a strong perception among key stakeholders in subacute care that there are major barriers to patient admission and discharge. Redistributing proposed funding for inpatient subacute beds to measures for overcoming these barriers is likely to improve patient flow though the whole hospital system.

There is increasing concern in Australia about the long waiting times for patients attending emergency departments or requiring elective surgery.[1,2] The National Hospital and Health Reform Commission has recommended a substantial increase in the number of inpatient beds for subacute care (eg, rehabilitation medicine and aged care), to meet projected demands.[3] However, if, as in other sectors of the health service, there are problems with barriers to admission to subacute care or discharge from subacute care, it may be more efficient to divert some of this funding for extra beds into programs to overcome these barriers.

Few studies have focused on patient flow in the subacute sector. Difficulties for patients accessing subacute care have been identified in one acute care hospital,[4] and barriers to discharge from subacute care have been explored in a viewpoint article.[5] However, it is not known to what extent access or discharge problems occur more generally, or whether they differ across the various components of subacute care. Are there differences between the public and private sectors, or between the rehabilitation and aged care streams? Do hospital executives or those in senior management with responsibility for patient flow share the views of clinicians on access and discharge problems? Answering these questions is important for developing a shared vision for system improvements.

As little is known about the problems of subacute patient flow, a survey was designed to determine the perceptions of key stakeholders in subacute care. Opinions were sought from: (i) specialist doctors working in subacute inpatient units; and (ii) senior hospital managers with responsibility for patient flow in subacute care.

Methods

Survey development

The survey was developed by one of us (PWN) based on clinical experience and a literature review. Principles of good survey design were followed in developing and distributing the survey.[6] A web-based survey (SurveyMonkey, Palo Alto, Calif, USA) was piloted and refined to optimise the clarity, readability and focus of the questions, and to achieve a target completion time of about 10 minutes. The survey period commenced on 15 May 2009 and concluded on 24 July 2009.

Respondents were asked about their position and training, as well as their demographic characteristics. Their views about admission and discharge barriers for inpatients needing subacute care were canvassed using Likert scales and closed questions (limited choice, multiple choice, and checklists), as well as a few open questions allowing free-text answers (a copy of the survey is available from PWN).

Survey participants and recruitment

The survey targeted physicians working in rehabilitation medicine and in aged care; and senior hospital management personnel with responsibility for patient flow from acute care to inpatient subacute care and from inpatient subacute care to the community.

Although palliative care and psychiatry are also components of subacute care,[7] physicians in these areas were not included as their patient-flow issues are somewhat different. Also excluded were physicians working in paediatric rehabilitation medicine, and psychogeriatric and dementia units. Finally, physicians not working in inpatient units were also excluded from the survey.

The professional organisations representing rehabilitation medicine (Australasian Faculty of Rehabilitation Medicine) and aged care (Australian and New Zealand Society of Geriatric Medicine) were contacted for information about how many of their members would be eligible to complete the survey. Unfortunately, nei-

1 Characteristics of respondents and perceptions of problems of access to subacute care and barriers to discharge from subacute care

	Aged care physicians	Rehabilitation physicians	Hospital managers	*P*
No. (%), response rate	41 (41%), 43%	39 (39%), 24%	21 (21%), unknown	
Years since Fellowship, or in management position, median (IQR)	9 (2–19)	9 (4–15)	10 (5–15)	Kruskal–Wallis H = 0.3; *P* = 0.9
No. of inpatient beds responsible for, median (IQR)	16 (12–23)	21 (15–30)	119 (42–300)	Kruskal–Wallis H = 24.0; *P* = 0.001
Problems with access to subacute inpatient beds:*				
In your unit				χ^2 = 1.5; df = 4; *P* = 0.9
Extreme	0	3%	na	
Severe	2%	3%	na	
Moderate	37%	35%	na	
Minor	49%	43%	na	
No problem	12%	16%	na	
In your hospital or organisation				χ^2 = 5.1; df = 8; *P* = 0.7
Extreme	2%	3%	5%	
Severe	5%	3%	5%	
Moderate	42%	49%	43%	
Minor	44%	31%	38%	
No problem	7%	15%	10%	
In the health system in general				χ^2 = 6.8; df = 8; *P* = 0.6
Extreme	0	3%	5%	
Severe	20%	13%	24%	
Moderate	68%	67%	67%	
Minor	12%	13%	45%	
No problem	0	5%	0	
Problems with barriers to discharge from subacute inpatient beds:*				
From your unit				χ^2 = 13.4; df = 4; *P* = 0.006
Extreme	0	8%	na	
Severe	8%	29%	na	
Moderate	51%	50%	na	
Minor	33%	11%	na	
No problem	8%	3%	na	
From your hospital or organisation				χ^2 = 14.8; df = 8; *P* = 0.04
Extreme	0	0	5%	
Severe	21%	50%	20%	
Moderate	56%	40%	50%	
Minor	21%	8%	25%	
No problem	3%	3%	0	
From the health system in general				χ^2 = 8.3; df = 8; *P* = 0.3
Extreme	3%	3%	10%	
Severe	21%	42%	25%	
Moderate	72%	53%	60%	
Minor	3%	3%	5%	
No problem	3%	0	0	

IQR = interquartile range. na = not applicable (hospital managers not involved in individual unit access/discharge issues). * *P* values indicate differences between respondents in perception of access or discharge barriers. ◆

ther organisation had this information, nor were they aware of other sources of this information. However, they were able to provide an estimate based on the knowledge of senior members. Likewise, neither of the two organisations representing hospital management (Australian Healthcare and Hospitals Association, Australian Private Hospitals Association) could provide information about how many of their members were eligible to participate.

Survey distribution

An outline of the survey rationale and the URL link was repeatedly emailed (fortnightly to monthly) to potential participants by the organisations that agreed to participate in this process (those listed in the previous paragraph as well as the Royal Australasian College of Physicians). As this was an exploratory study of this topic, there was no predetermined sample size.

Analysis

Descriptive analysis was performed comparing the responses of the three participant groups regarding the extent to which barriers were perceived. We assessed (a) whether there was an influence on responses according to the number of years since specialisation (physicians working in rehabilitation medicine or aged care) or the number of years involved in patient flow (hospital management); and (b) whether the respondents worked exclusively in the public hospital system. To facilitate analysis, responses were collapsed into those reporting "extreme", "severe" or "moderate" problems, and those reporting only "minor" or "no problem".

Categorical responses were analysed using the χ^2 test, with the Fisher exact correction used throughout because the numbers were small. Data not normally distributed (eg, number of years since completing specialist training or working in patient-flow management) were analysed using the Kruskal–Wallis H test. *P* values of less than 0.05 were deemed statistically significant.

Ethics approval

Approval for the project was obtained from the Monash University Human

2 Barriers to subacute care admission and discharge commonly reported by respondents*

Barriers to admission to subacute care	Reported by:†
Number of available beds	61%
Physical/environmental issues (eg, lack of single rooms)	59%
Staffing issues — allied health	45%
Staffing issues — nursing staff	39%
Equipment issues (eg, lack of hoists, bariatric equipment)	32%
Barriers to discharge from subacute care	
Locating suitable accommodation	68%
Patients non-weight-bearing after lower-limb fracture and no longer benefiting from inpatient therapy	63%
Waiting for high-level care	63%
Funding for home modifications	46%
Lack of suitable ambulatory therapy options	45%
Funding for necessary equipment	39%
Carer funding or recruitment, including support packages	37%

* The items above are taken directly from the survey. † More than one response could be given, so totals do not add up to 100%. ◆

Research Ethics Committee and the Southern Health Human Research Ethics Committee.

Results

One hundred and one surveys met the inclusion criteria (another 13 had substantial amounts of missing information and were excluded). The proportion of respondents from the states and territories approximated that of the Australian population. The average (SD) age of respondents was 45 (11) years (range, 28–77 years), and there was a higher proportion of female respondents (62, 61%). Sixty-eight worked in the public sector, 16 in the private sector, and 17 in both the public and private sectors.

Perception of access and discharge barriers

Respondents' perceptions of problems accessing subacute beds and being discharged from subacute care are shown in Box 1. On average, 40% of clinicians (both rehabilitation medicine and aged care physicians) indicated that there were moderate, severe or extreme access problems for patients waiting for admission to their units, and 50% of all respondents indicated similar difficulty for their hospital as a whole.

There was no relationship between the number of years since completing specialisation and perception of unit access problems (Kruskal–Wallis $H = 3.6$; $P = 0.06$), and neither was the response influenced by whether the participating physicians worked in the public versus the private sector or in both sectors (barriers to unit access: $\chi^2 = 1.5$ [df = 1; $P = 0.3$]; and barriers to hospital access: $\chi^2 = 0.02$ [df = 1; $P = 1.0$]). However, respondents who had spent less time working in their field were significantly more likely (Kruskal–Wallis $H = 6.1$; $P = 0.01$) to perceive a moderate or worse problem with patients' access to subacute beds for their hospital.

More respondents perceived barriers to discharge from subacute care than perceived barriers to admission, with an average of 73% of clinicians indicating that there were moderate, severe or extreme problems with discharging patients from their units, and 81% of all respondents perceived a similar grading of severity for barriers to discharging patients from the hospital in which they worked. There was no relationship between the number of years since specialisation and the perception of the severity of discharge barriers for hospital units (Kruskal–Wallis $H = 1.2$; $P = 0.3$); neither was there any influence on this perception according to sector setting (barriers to unit discharge: $\chi^2 = 0.2$ [df = 1; $P = 0.8$]; and barriers to hospital discharge: $\chi^2 = 0.0$ [df = 1; $P = 1.0$]). Respondents who had spent less time working in their field were much more likely (Kruskal–Wallis $H = 4.2$; $P = 0.04$) to perceive a moderate or worse problem with discharging patients from subacute beds in their hospital.

Causes of access and discharge barriers

The most commonly perceived causes of barriers to admission to and discharge from subacute beds are listed in Box 2. Overall, the most commonly perceived barriers to admitting patients to subacute care included bed availability (61% of respondents); physical, environmental or equipment inadequacies (62% of respondents); and allied health or nursing staffing issues (55% of respondents). The most commonly perceived barriers to patient discharge included waiting for a more appropriate setting of care (76% of respondents) and inadequate funding for home modifications, necessary equipment, or carers (55% of respondents). There was no relationship between respondents' position and their reporting of various admission ($\chi^2 = 6.2$; df = 8; $P = 0.6$) or discharge barriers ($\chi^2 = 13.8$; df = 12; $P = 0.3$).

Two respondents reported that access to subacute beds was restricted by limited weekend admissions, and each of the following problems were reported by one respondent: lack of understanding of the processes involved (did not specify what processes) in acute hospitals; clinician shortage (did not specify which clinicians); inadequate numbers of rehabilitation medicine and nursing staff to triage referred patients; discharge planning issues; and poor financial reimbursement of hospitals for treating patients in the subacute sector.

Additional reasons nominated by respondents as barriers to discharge from subacute care included: delays in appointing a guardian ($n = 8$); difficulties in discharging patients aged under 65 years to high-level care ($n = 7$); family negotiations around discharge planning decisions ($n = 5$); waiting for the aged care assessment service processes to be completed ($n = 2$); waiting for home modifications to be completed ($n = 2$); and waiting for low-level care beds ($n = 2$).

Discussion

All respondent groups, but especially rehabilitation physicians, reported barriers to discharge of inpatients after subacute care. Fewer respondents, but still a concerning proportion, reported barriers to admission of acute hospital patients to subacute care. The perceived severity of access problems did not vary between respondent groups, and the commonly reported causes of admission and discharge barriers were consistent across the respondent groups.

There are few studies available that can be compared with ours. One in the United Kingdom highlighted problems with neurosurgical patients unable to access rehabilitation.[8] A New South Wales based study found that most acute-care hospital patients referred for rehabilitation or aged care were assessed within 2 days, and most needing admission were transferred to a subacute bed within 2 days.[9]

Another reported that most patients referred for rehabilitation no longer met formal criteria for acute care at the time of referral, indicating that they should have been referred sooner.[4] Many of the barriers perceived by respondents in our study have been highlighted previously.[5]

It is not possible to determine why respondents who had worked for a shorter time in their field were more likely to report access or discharge barriers as moderate or worse. Reasons could include younger respondents being less likely to tolerate barriers than older colleagues. Of interest was the similarity in perception of admission or discharge barriers between respondents working in the public sector and those working in the private sector or in both sectors. For rehabilitation patients this may be partially explained by selection bias resulting in patients in the private sector tending to be less disabled.[10]

The finding that rehabilitation medicine physicians are much more likely to report difficulties with barriers to discharge is not surprising. Most reasons for this relate to insufficient options for care and support after discharge for severely disabled patients. These have been highlighted previously.[5] The barriers to discharge also reflect the inadequate distribution and coordination of subacute services for older patients and insufficient nursing home beds.[11]

Improving the design and coordination of programs managed by the federal and state departments covering ageing, health, disability and social services would go a long way towards overcoming the barriers identified in our study. Unfortunately, this solution has not been included in the proposed health reforms.[3] The results of our survey strongly suggest that consideration should be given to directing some of the proposed increase in funding for subacute inpatient beds[3] to strategies that address subacute care admission and discharge barriers. It is quite likely that this approach would be more efficient and cost-effective than providing and staffing all the proposed inpatient beds. It is also vital that the hospital networks play an active role in overcoming barriers to patient flow through the subacute sector.

Limitations of our survey include the possibility of responder bias. Moreover, it was not possible to determine the potential number of hospital management staff with responsibility for patient flow, and therefore no response rate could be determined for this group. We were only able to estimate the number of potential eligible participants from rehabilitation medicine and aged care. Nevertheless, it is believed that our results are generally reflective of the key stakeholder groups.

The implications of our study for health managers and policymakers are that they should consider patient flow inefficiencies through the whole hospital system and not focus just on the emergency department and acute hospitals. Efficiency of the health system cannot be optimised unless subacute care is better integrated into the acute hospital system.[5] Research is required to measure the occurrence and causes of barriers to patient flow in subacute care, especially barriers to discharge. A prerequisite for this research should include a framework and a suite of suitable measures that could allow the barriers to be identified and targeted for improvement. In turn, this should improve the flow of patients through the entire hospital system.

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3.3 Chapter 3: Summary

Most respondents, but particularly rehabilitation physicians, reported barriers to the discharge of patients after subacute hospital care. The nominated causes of discharge barrier matched those developed in the classification presented in chapter 2. Fewer respondents, but still a concerning proportion, reported barriers to the transfer of acute hospital patients into subacute care.

In chapters 4 and 5 the results of studies that specifically measure the extent of the problem with the flow of rehabilitation patients from acute hospital into rehabilitation and discharge barriers from inpatient rehabilitation are presented.

4 CHAPTER FOUR: REDUCING THE LENGTH OF STAY FOR ACUTE HOSPITAL PATIENTS NEEDING ADMISSION INTO INPATIENT REHABILITATION

"When the facts change, I change my mind. What do you do, Sir?"

John Maynard Keynes, 1st Baron Keynes of Tilton (1883 – 1946)

4.1 Declaration B: Chapter 4

PART B: Declaration for Thesis Chapter

Monash University

Declaration for Thesis Chapter 4

New PW, Andrianopoulos N, Cameron PA, Olver JH, Stoelwinder JU. Reducing the length of stay for acute hospital patients needing admission into inpatient rehabilitation: a multicentre study of process barriers. Intern Med J. 2013;43:1005-1011

Declaration by candidate

In the case of Chapter 4, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
The candidate conceived the project, performed most of the data collection and directly supervised the additional data collection, performed the initial analysis and wrote the first draft of the manuscript.	75%

The following co-authors contributed to the work. If co-authors are students at Monash University, the extent of their contribution in percentage terms must be stated:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Nick Andrianopoulos	Provided advice regarding aspects of data analysis and constructive suggestions on revisions to the manuscript.	
Peter Cameron	Provided constructive suggestions on revisions to the manuscript.	
John Olver	Provided constructive suggestions on revisions to the manuscript.	
Johannes Stoelwinder*	Provided constructive suggestions on revisions to the manuscript.	

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the candidate's and co-authors' contributions to this work*.

Candidate's Signature [redacted] **Date** 30/9/13

***Main Supervisor's Signature** [redacted] **Date** 30/9/13.

4.2 Chapter 4: Introduction

This chapter describes a retrospective study of the time taken for key processes in the patient journey (n=360) from acute hospital admission through to transfer to inpatient rehabilitation admission in order to identify opportunities for improvement.

The rational for this study was based on the results presented in chapter 3. These results included the finding that among key stakeholders a high proportion of respondents had the perception that there were moderate, severe or extreme access problems for patients waiting for transfer from acute hospital into subacute care. The study methodology used in this chapter included some of the KPIs presented in chapter 2. This chapter addresses the fourth aim of this thesis, to conduct a retrospective study of the process barriers for acute hospital patients who are subsequently admitted to inpatient rehabilitation.

INTERNAL MEDICINE JOURNAL

Reducing the length of stay for acute hospital patients needing admission into inpatient rehabilitation: a multicentre study of process barriers

P. W. New,[1,2,3] N. Andrianopoulos,[1] P. A. Cameron,[1] J. H Olver[3] and J. U. Stoelwinder[1]

[1]Department of Epidemiology and Preventive Medicine, Monash University, [2]Rehabilitation and Aged Services, Department of Medicine, Monash Health and [3]Epworth-Monash Rehabilitation Medicine Unit, Monash University, Melbourne, Victoria, Australia

Key words
rehabilitation, health service accessibility, patient discharge, delivery of healthcare, outcome and process assessment (healthcare).

Correspondence
Peter New, Kingston Centre, Warrigal Road, Cheltenham, Vic. 3192, Australia.
Email: peter.new@monashhealth.org

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Abstract

Background: Patient flow is a major problem in hospitals. Delays in accessing inpatient rehabilitation have not been well studied.

Aims: Measure the time taken for key processes in the patient journey from acute hospital admission through to inpatient rehabilitation admission in order to identify opportunities for improvement.

Methods: Retrospective open cohort study. All patients admitted over 8- and 10-month periods during 2008 into two inpatient rehabilitation units in Melbourne, Australia. Main outcome measures were the duration of the following key processes: acute hospital admission until referral for rehabilitation, referral until assessment by the rehabilitation service, assessment until deemed ready for transfer to rehabilitation, ready for transfer until rehabilitation admission.

Results: Three hundred and sixty patients were in the study sample (females = 186; 51.7%); mean age = 58.4 (standard deviation = 15.0) years. There was a median of 7 (interquartile range [IQR] 4–13) days from acute hospital admission till referral for rehabilitation, a median of 1 (IQR 0–1) day from referral till assessment, a median of 0 (IQR 0–2) days from assessment till deemed ready for transfer and a median of 1 (IQR 0–3) day from ready till admission into rehabilitation. Overall, patients spent 12.0% (804/6682) of their acute hospital admission waiting for a rehabilitation bed.

Conclusions: There are opportunities to improve the efficiency of key processes in the acute hospital journey for patients subsequently admitted to inpatient rehabilitation; in particular, reducing the time from acute hospital admission till referral for rehabilitation and from being deemed ready for transfer to rehabilitation till admission.

Introduction

Rehabilitation is a vital component of the hospital system that is being challenged by increasing demand for services.[1] This demand will intensify with population ageing and consequent chronic disease and disability.[2,3] The occurrence of discharge barriers in the hospital care pathway has an adverse impact on bed availability.[4,5]

There has been little study of barriers to patient flow for patients requiring rehabilitation; in particular, study of barriers for acute hospital patients waiting for inpatient rehabilitation or barriers to discharge from rehabilitation.[6–8] This is despite reports indicating major problems in this area.[9–13]

The primary objective of the present study was to measure the time taken for key processes in the patient journey from acute hospital admission through to inpatient rehabilitation admission in order to identify opportunities for improvement. As an exploratory analysis, secondary objectives were to identify whether clinical or demographic factors contributed to three key outcomes. These were: (i) the period from acute hospital admission until referral for rehabilitation; (ii) the delay in admission into rehabilitation after being deemed ready for transfer and (iii) to determine if the time waiting for a rehabilitation bed after being deemed ready for transfer was associated with either the length

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of stay (LOS) in rehabilitation or dependency at discharge from rehabilitation.

Methods

Study design and setting

We conducted a retrospective open cohort study of consecutive patients admitted for inpatient rehabilitation in two acute ('fast stream') rehabilitation wards (Kingston Centre – a standalone subacute facility and Dandenong Hospital – co-located with an acute hospital campus) in Monash Health, the largest public hospital Network in Victoria, Australia. These wards provided the only interdisciplinary inpatient rehabilitation for patients with moderate–severe disability who could not be discharged directly to their home from the four acute hospitals in Monash Health at the time the study was conducted. There is a network of community rehabilitation centres and domiciliary rehabilitation available to help patients avoid inpatient rehabilitation who do not need this setting of care and who have adequate home environment and social supports. There was a total of 48 inpatient beds across the two wards that cared for a range of neurological (e.g. acquired brain injury, such as stroke, subarachnoid haemorrhage and traumatic brain injury), orthopaedic (e.g. arthroplasty and lower limb fractures, typically from falls – very rarely from motor vehicle accidents) and deconditioning-related impairments. Further details regarding the model of care and specifics of the rehabilitation services provided are available from the first author.

The typical journey for patients involved them being referred by the treating acute hospital unit to the rehabilitation assessment service. The patient would then be assessed by a either a rehabilitation assessment nurse, an advanced trainee in rehabilitation medicine or a consultant physician in rehabilitation medicine (depending on complexity of issues and staff availability). Patients referred from hospitals in other health networks were typically assessed by the rehabilitation assessment service based at that hospital and/or by the Network Head of Rehabilitation (first author). After necessary acute treatment and the patient deemed ready for transfer they would be put on the waiting list for admission. A centralised subacute access unit coordinated the admission of patients to optimise patient transfer into the most appropriate available bed. The rehabilitation assessment service and subacute access unit operated only on weekdays. Patients admitted to Kingston Centre after 1 January 2008 were included, while at Dandenong Hospital patients admitted after 1 March 2008 were included (starting dates were different because of study logistics).

Participants

All patients admitted into rehabilitation from study commencement until 31 October 2008 were included. Patients were excluded if they were an elective admission from the community or were discharged from rehabilitation on the day of admission because we wanted to focus on patients admitted to acute hospital and transferred to inpatient rehabilitation. The patients discharged on the day of admission (and who did not return to rehabilitation) were deemed to have not needed an inpatient rehabilitation programme as this duration would be too short for any meaningful programme to impact on functioning. Patients in this study have been described in a recent report on barriers to discharge from inpatient rehabilitation.[8]

Data collection

To calculate the duration of sequential discrete processes that each patient passes through from acute hospital admission until transfer to rehabilitation, the dates of the following were collected: acute hospital admission; referral for rehabilitation; assessment completed by rehabilitation assessment service; deemed ready for transfer to rehabilitation by rehabilitation assessment service; admitted to rehabilitation and discharged from rehabilitation. These processes and the intervening time periods (in days) are based on previous research in this area[10] and respondents to our survey on patient flow.[14]

Information was also recorded regarding patients' principal impairment necessitating rehabilitation; age at rehabilitation admission; gender; referral source (Monash Health or another health network) and the severity of self-care, continence and mobility dependency on admission to rehabilitation and discharge measured using the Modified Barthel Index (MBI)[15] (range: 0–100, 0 = total incapacity and 100 = independent).

Data were collected retrospectively from patients' medical files and databases used by the rehabilitation assessment service at Monash Health and the subacute bed access unit.

Statistical methods and analysis

Continuous variables were described using mean and standard deviation (SD) or median and interquartile range (IQR) as appropriate. Comparisons were made using the Student's *t*-test or Kruskal–Wallis rank test as appropriate. Categorical variables were compared using Pearson's chi-square test.

The time waiting for a rehabilitation bed after being deemed ready for transfer from acute hospital was

selected as one of the dependent variables for regression analysis. This was based on recommendations from our survey.[14] We did not use the interval between referral for rehabilitation and assessment, as also recommended by survey respondents, because in our experience the interval is typically very short, which was the case here (see below). Instead, based on our expectation that the longest of the other key processes would be the time from acute hospital admission until referral for rehabilitation – subsequenltly borne out in our findings – was selected as the dependent variable for another regression analysis. This time period offered a greater potential for improvement.

Stepwise multiple linear regression (backwards inclusion) was used to determine factors associated with the following four dependent variables: (i) the log-transformed time between acute hospital admission and referral for rehabilitation; (ii) the log-transformed time between deemed ready for transfer to rehabilitation and admission; (iii) the log-transformed rehabilitation LOS and iv) dependency (MBI) at discharge from rehabilitation. Log-transformation was used to facilitate parametric analysis. Patients' age, gender and impairment were considered as covariates for all four models. The MBI on admission to rehabilitation (as an indicator of dependency and burden of care at transfer from acute hospital), and the acute network where the patient was treated (Monash Health or other) were additionally included as covariates in the second model. The log-transformed time between deemed ready for rehabilitation and rehabilitation admission was included as a covariate in the third and fourth models. Admission MBI was also included as a covariate in the fourth model.

P values of less than 0.05 were deemed statistically significant. The project was approved by the Monash Health and Monash University Human Research Ethics Committees. Stata version 11 (StataCorp, College Station, Texas, USA) was used for statistical analysis.

Results

Three hundred and seventy-two patients were admitted during the study period; however, 12 were excluded (elective admissions from community = 10, discharged day of admission = 2), leaving 360 patients ranging in age from 16 to 93 years. We analysed the age of patients on admission, duration of the four key processes from acute hospital admission until transfer into rehabilitation and the total acute hospital LOS by the following: patients' impairment, the acute hospital network prior to rehabilitation admission and gender (Table 1). This was because of the perceived potential influence on the process

Table 1 Frequency of key impairment groups and duration of key processes in the patient journey from acute hospital to rehabilitation admission

	n (%)	Age (years) Mean (SD)	Median (IQR) days from acute hospital admission to referral for rehabilitation†	Median (IQR) days from referral for rehabilitation till assessment‡	Median (IQR) days from assessment for rehabilitation until ready for transfer§	Median (IQR) days from ready for transfer to rehabilitation until admission¶	Median (IQR) acute hospital LOS¶
Impairment							
Stroke/SAH/TBI	64 (17.8%)	55.2 (14.4)	7 (5–13)	1 (0–1)	0 (0–3)	1 (1–3)	12.5 (6–23.5)
Other neurological	47 (13.0%)	49.2 (16.0)	9 (5–14)	1 (1–2)	0 (0–3)	1 (0–5)	14 (7–24)
Lower limb arthroplasty	55 (15.3%)	64.2 (9.8)	4 (2–7)	0 (0–1)	0 (0–1)	1 (0–2)	7 (6–9)
Lower limb fracture	60 (16.7%)	58.8 (15.6)	5 (3–10)	1 (0–1)	0 (0–1)	1 (0–3)	9.5 (6–14.5)
Muscular-skeletal – other	45 (12.5%)	57.0 (14.8)	6.5 (3.5–10.5)	1 (0–2)	0 (0–3)	1 (1–3)	13 (7–21)
Cardiac, pulmonary, reconditioning	64 (17.8%)	64.7 (12.6)	10 (6.5–16)	1 (0–2)	0 (0–3)	1 (0–2)	15 (10–22.5)
Other impairment	25 (6.9%)	56.7 (16.8)	8 (6.5–15)	1 (0–1)	0 (0–1)	1 (0–3)	13 (9–17)
Network							
Monash Health	334 (92.8%)	58.4 (15.0)	7 (4–12.5)	1 (0–1)	0 (0–2)	1 (0–3)	11.5 (7–17)
Other network	26 (7.2%)	58.9 (14.3)	8.5 (5–33)	1 (0–2)	0 (0–2)	2 (1–5)	12 (9–46)
Gender							
male	174 (48.3%)	58.8 (14.4)	7 (4–12)	1 (0–1)	1 (0–2)	1 (0–3)	12 (7–18)
female	186 (51.7%)	58.0 (15.4)	7 (4–13)	1 (0–1)	1 (0–1)	1 (0–3)	11 (7–19)
Total	360 (100%)	58.4 (15.0)	7 (4–13)	1 (0–1)	0 (0–2)	1 (0–3)	12 (7–19)

*Impairment F = 1.2, *P* = 0.2; Network t = 0.2, *P* = 0.8; Gender t = 0.5, *P* = 0.6 †Impairment χ^2 = 44.5, *P* = 0.0001, missing *n* = 14; Network χ^2 = 6.3, *P* = 0.01; Gender χ^2 = 0.001, *P* = 1.0; ‡Impairment χ^2 = 12.1, *P* = 0.06, missing *n* = 14; Network χ^2 = 1.8, *P* = 0.2; Gender χ^2 = 1.2, *P* = 0.3; §Impairment χ^2 = 4.5, *P* = 0.6, missing *n* = 14; Network χ^2 = 0.01, *P* = 0.9; Gender χ^2 = 5.9, *P* = 0.02; ||Impairment χ^2 = 7.0, *P* = 0.3; Network χ^2 = 7.0, *P* = 0.008; Gender Kruskal–Wallis χ^2 = 0.006, *P* = 0.9; ¶Impairment χ^2 = 41.9, *P* = 0.0001; Network χ^2 = 5.9, *P* = 0.02; Gender χ^2 = 0.4, *P* = 0.5. IQR, interquartile range; LOS, length of stay; SAH, subarachnoid haemorrhage SD, standard deviation; TBI, traumatic brain injury.

Table 2 Proportion of patients achieving the key processes within specified time-frames

Time interval	Proportion referred for rehabilitation following acute hospital admission	Proportion assessed following referral for rehabilitation	Proportion deemed ready for transfer to rehabilitation after rehabilitation assessment completed	Proportion transferred from acute hospital to rehabilitation after deemed ready
Same day	2.6%	37.9%	62.7%	27.8%
1 day	6.1%	76.6%	74.3%	58.3%
2 days	10.7%	86.1%	79.2%	70.6%
3 days	18.2%	90.5%	81.8%	80.3%
1 week	53.2%	97.1%	93.6%	95.3%
2 weeks	80.9%	99.7%	98.3%	99.2%
3 weeks	88.7%	100%	99.4%	99.4%

durations from these variables. The LOS in rehabilitation (median 23, IQR 15–48.5 days), MBI on admission (median 34, IQR 17–47) and discharge (median 93, IQR 69–100) by impairment group have been reported previously.[8] There was no significant difference in the proportion of patients with the various impairments from Monash Health hospitals compared to those admitted from other networks (P = 0.7). Because it has been reported that patients can wait longer for admission to standalone facilities than co-located rehabilitation units,[16] we also tested if there was a difference in the waiting time for transfer to rehabilitation between the two. The standalone unit had a significantly shorter (χ^2 = 5.1, P = 0.02) waiting time (median 1, IQR 0–3) compared to the co-located unit (median 1, IQR 1–4).

The proportion of patients achieving the key processes within specified time frames is shown in Table 2. Eighty patients (22.2%) were assessed by the rehabilitation assessment service and also deemed ready for transfer to rehabilitation on the day of referral, 184 (51.1%) were assessed and deemed ready within 1 day of referral and 222 patients (61.7%) within 2 days. Half the patients spent 10.2% of their acute hospital admission waiting for a rehabilitation bed, and a quarter of patients spent 24.4% of their acute admission waiting for a rehabilitation bed. Overall, patients spent 12.0% (804/6682 days) of their acute hospital LOS waiting for a rehabilitation bed.

The results of the multiple linear regressions to determine the influence of variables on: (i) the time between acute hospital admission and referral for rehabilitation; (ii) time between deemed ready for rehabilitation and transfer into rehabilitation; (iii) rehabilitation LOS and iv) MBI at discharge from rehabilitation are shown in Table 3. Younger age and cardiac, pulmonary or reconditioning impairments were associated with a longer duration between acute hospital admission and referral for rehabilitation. Younger age and other hospital network patients waited longer for admission to rehabilitation after been deemed ready for transfer. The LOS in rehabilitation and disability at discharge from rehabilitation was not influenced by the delay between deemed ready for rehabilitation and subsequent transfer.

Discussion

Patients were typically seen promptly for assessment following referral for rehabilitation and most were ready for transfer to rehabilitation on the day of assessment. The longest processes were between acute hospital admission and referral for assessment and waiting for transfer to rehabilitation after being deemed ready for admission.

Our findings highlight opportunities for improvement in patient flow for acute hospital inpatients with rehabilitation needs. These include the need for acute hospital staff to commence the discharge planning for patients' potentially needing rehabilitation much sooner and the earlier involvement of rehabilitation in the management of patients in acute hospital. These strategies should be designed to shorten the time between admission into acute hospital and rehabilitation referral. A case has been made for a change to the model of care typically provided by rehabilitation physicians in acute hospitals, from a triage or gatekeeper model to a 'pull' model involving shared care between rehabilitation and acute hospital staff or an 'inreach' team from rehabilitation working in an acute hospital.[11,17] These models involve the early assessment of rehabilitation needs (even while patients are not fully stable) by a multidisciplinary rehabilitation team advising acute hospital staff so that patients receive appropriate prevention of deconditioning and other disability-related complications; therapy commensurate with what patients can tolerate; earlier commencement of discharge planning and re-directing patients to ambulatory rehabilitation programmes where available and appropriate. This would have the potential to deliver

Table 3 Multiple linear backward selection stepwise regression coefficient, 95%CI and *P* value of factors associated with (1) admission to referral time, (2) ready for rehabilitation to transfer time, (3) rehabilitation LOS and (4) MBI at discharge*

	Regression coefficient (95%CI)	*P*
Log-duration between acute hospital admission and referral for rehabilitation†		
Age	–0.01 (–0.2 – –0.006)	$t = -3.7$, $P < 0.001$
Cardiac, pulmonary or reconditioning	0.4 (0.2–0.7)	$t = 3.2$, $P = 002$
Fracture	–0.3 (–0.5 – –0.2)	$t = -2.2$, $P = 0.03$
Arthroplasty	–0.4 (–0.7 – –0.1)	$t = -2.9$, $P = 0.004$
Constant	2.8 (2.4–3.2)	$t = 14.6$, $P < 0.001$
Log-duration between deemed ready for rehabilitation and transfer into rehabilitation‡		
Age	–0.01 (–0.02 – –0.003)	$t = -2.9$, $P = 0.005$
Monash Health Network	–0.4 (–0.7 – –0.02)	$t = -2.01$, $P = 0.04$
Constant	1.7 (1.1–2.2)	$t = 6.2$, $P < 0.001$
Log-LOS in rehabilitation§		
Log-duration between deemed ready for rehabilitation and transfer into rehabilitation	0.1 (–0.01–0.2)	$t = 1.8$, $P = 0.08$
ABI	0.4 (0.1–0.6)	$t = 2.6$, $P = 0.009$
Age	–0.01 (–0.02 – –0.005)	$t = -3.4$, $P = 0.001$
MBI admission to rehabilitation	–0.01 (–0.02 – –0.008)	$t = -5.9$, $P < 0.001$
Constant	4.6 (4.1–5.1)	$t = 18.8$, $P < 0.001$
MBI at rehabilitation discharge‖		
Log-duration between deemed ready for rehabilitation and transfer into rehabilitation	–0.8 (–4.3–2.6)	$t = -0.5$, $P = 0.6$
MBI admission to rehabilitation	0.7 (0.6–0.8)	$t = 13.5$, $P < 0.001$
Age	0.2 (0.03–0.4)	$t = 2.2$, $P = 0.03$
Constant	31.8 (18.6–45.0)	$t = 4.9$, $P < 0.001$

*There were 14 cases with missing values excluded from the analysis. †Adjusted $R^2 = 0.11$, $P < 0.001$. ‡Adjusted $R^2 = 0.04$, $P = 0.003$. §Adjusted $R^2 = 0.22$, $P < 0.001$. ‖Adjusted $R^2 = 0.42$, $P < 0.001$. ABI, acquired brain injury (stroke, subarachnoid haemorrhage, traumatic brain injury); CI, confidence interval; LOS, length of stay; MBI, modified Barthels index.

major improvements in patient flow from acute hospital to rehabilitation, reduce preventable complications that result in patient harm and increase acute and rehabilitation LOS[11,17], and would be amenable to formal testing in a clinical trial.

Furthermore, there is also the potential to improve patient flow for certain groups of acute hospital patients needing inpatient rehabilitation (or subacute care) by way of a more streamlined approach to admission, such as a criterion-based transfer system. In this model, patients meeting certain predetermined criteria would be placed on the waiting list for transfer to subcute care without needing to be assessed by rehabilitation, but could be readily transferred back to acute hospital should complications arise. This model could also be evaluated in a formal clinical trial.

The key finding that a high proportion of patients was ready for rehabilitation transfer after completion of the rehabilitation assessment suggests an important potential implication for improving efficiency in patient flow. Patients could potentially be transferred to rehabilitation if they were referred earlier in their acute hospital stay. The speed by which the referral was attended to by the rehabilitation service was not a major barrier in the present study. In the experience of the authors who are rehabilitation physicians (PWN, JHO), the delay between referral for rehabilitation and assessment has been reported anecdotally by senior acute hospital clinical staff and management to be excessive. Our findings and those of Poulos suggest otherwise.[7,10]

The covariates in the regression models generally did not account for much of the variation in the dependent variables. However, this was an exploratory study which was not powered adequately for this purpose. In the best explained models, the LOS in rehabilitation and dependency at discharge did not include the covariate duration between deemed ready for rehabilitation and transfer into rehabilitation.

It is important to emphasise that simply transferring all patients who do not need acute care to any subacute bed (i.e. either a rehabilitation or aged-care bed, irrespective of whether this is appropriate) would only create inefficiencies in subacute care. Patients should ideally be transferred in a timely manner directly to the most appropriate subacute bed for their needs ('right patient, right ward, right time, first time, every time'). The shorter waiting time for transfer to rehabilitation for the standalone unit is contrary to previous findings [16], but the difference here is of uncertain clinical significance.

The results of this study indicate that further work is required to refine the list of potential key performance indicators (KPI) for access to rehabilitation and

benchmarks previously described.[14] Rather than the delay between referral for rehabilitation and assessment, a more appropriate KPI suggested by our findings could be the percentage of acute hospital LOS patients spent waiting for transfer to rehabilitation after being deemed ready. It is important to emphasise that KPI on their own will not improve patient flow, but by focusing clinical and management attention to addressing barriers, this has the potential to improve poor processes.

Our findings also underscore that strategies to reduce the barriers to discharge for rehabilitation inpatients would also reduce waiting of acute hospital patients for these beds.[8]

Another Australian study has also reported the waiting time for acute hospital patients assessed as ready for rehabilitation to be admitted – 67% were admitted within 1 day and 77% within 2 days,[18] which was slightly better than our results. A study in Canada reported a relationship between shorter delays for transfer to rehabilitation and a shorter rehabilitation LOS.[19] Our study using regression analysis to adjust for confounding variables did not find such a relationship. Our findings regarding the waiting for transfer to rehabilitation after being deemed ready reinforce the previous reports of this as a major problem,[7, 9–13]

It has been proposed that an ideal occupancy in acute hospitals is 85% – as a balance between unoccupied beds and optimising patient flow.[20,21] There have been no studies into what is the ideal occupancy in subacute care. The assumption in Monash Health, and as far as we know in other rehabilitation and aged-care units around Australia, is that 100% occupancy is appropriate. If there were, however, rehabilitation and aged-care beds that could be opened and closed as required ('flex-beds'), then this would be a cheaper and more clinically appropriate option than keeping patients unnecessarily in acute hospitals. It is hypothesised that this would have a marked positive influence on patient flow through the hospital system.

Limitations and generalisability

Our findings should be treated with some caution. Patients were sampled retrospectively from two rehabilitation units in the same network. There is also the potential that there may have been changes in hospital processes since the study was conducted that could result in different delay findings currently. We acknowledge that our results are not generalisable to private rehabilitation hospitals or to sub-speciality rehabilitation (e.g. spinal cord injury, amputee). Private rehabilitation hospitals are more restrictive about who they admit – tending to have less disabled patients and a shorter LOS compared to the public system.[22] Our study sample was younger than the patients typically admitted to other rehabilitation units,[22] in part because of the focus on patients who were higher functioning pre-morbidly and the existence of aged-care wards at the two sites for those patients more appropriate for a slower stream or geriatric rehabilitation programme. Similar findings by Poulos[7,10] regarding waiting times for the key processes suggest that our results may be generalisable to other public rehabilitation units in Australia. Recent studies highlighting inefficiencies in the Australian rehabilitation system outline the reasons for this.[11,13] We believe that there may also be generalisability of our results to international settings, in particular, Canada[12] and Europe,[9] where there are public-funded hospital systems. It is important to emphasise that the principle of measuring key processes in the patient journey as a component of patient flow improvement is vital,[14] and that this approach is transferrable to many jurisdictions. It is important to acknowledge that the concept of 'ready for discharge' is not a fixed construct. A patient can be deemed ready by the rehabilitation assessment service, the acute hospital referring unit, or a utilisation review tool – a discussion of these different approaches has been presented elsewhere.[7]Another limitation is that we did not study the processes for those acute hospital patients referred for rehabilitation, but whom were able to be discharged directly into the community or transferred to other settings.

Conclusion

Further study of process barriers for admission into inpatient rehabilitation is required. Studies with a greater number of participants and a broader range of variables would allow adequate power for the assessment of major contributors to the process barriers and reasons for differences between impairment groups.

Policy-makers and health managers should consider allocating more resources to process improvement projects that optimise patient flow through the whole hospital system instead of focusing on the emergency department and acute hospitals. Hospital efficiency cannot be optimised unless rehabilitation is better integrated into the hospital system.

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4.3 Chapter 4: Summary

Patients were typically seen promptly for assessment following referral for rehabilitation and most were ready for transfer to rehabilitation on the day of assessment. The longest processes were between acute hospital admission and referral for assessment, and waiting for transfer to rehabilitation after being deemed ready for admission.

Our findings highlight opportunities for improvement in patient flow for acute hospital inpatients with rehabilitation needs. The key finding that a high proportion of patients were ready for transfer to rehabilitation after completion of the rehabilitation assessment suggests that addressing this problem would increase efficiency in patient flow. The results presented here are used in chapter 6 to develop the model of rehabilitation patient LOS and inform the development of the hypothetical scenarios.

5 CHAPTER FIVE: BARRIERS TO DISCHARGE FROM INPATIENT REHABILITATION

"We are continually faced with great opportunities which are brilliantly disguised as unsolvable problems"

Margaret Mead (1901 – 1978)

5.1 Declaration B: Chapter 5

PART B: Suggested Declaration for Thesis Chapter

Monash University

Declaration for Thesis Chapter 5

New PW, Jolley DJ, Cameron PA, Olver JH, Stoelwinder JU. A prospective multicentre study of barriers to discharge from inpatient rehabilitation. Med J Aust. 2013;198:104-108

Declaration by candidate

In the case of the above publication, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
I conceived the project, supervised and coordinated the data collection, performed the initial analysis and wrote the first draft of the manuscript.	80%

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

	Name	Nature of contribution
1	Damien Jolley	Provided advice regarding aspects of data analysis and constructive suggestions on revisions to the manuscript.
2	Peter Cameron	Provided constructive suggestions on revisions to the manuscript.
3	John Olver	Provided constructive suggestions on revisions to the manuscript.
4	Johannes Stoelwinder	Provided constructive suggestions on revisions to the manuscript.

Candidate's Signature [redacted] **Date** 10/6/13

Declaration by co-authors

The undersigned hereby certify that:

(1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.
(2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
(3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
(4) there are no other authors of the publication according to these criteria;
(5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
(6) the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location(s) Department Rehabilitation, Kingston Centre, Warrigal Rd, Cheltenham 3192

Signature [redacted] ed by John McNeil [redacted] 12/6/2013

Signature 2 [redacted] 12/6/2013

Signature 3 [redacted] 10/6/2013

Signature 4 [redacted]

5.2 Chapter 5: Introduction

This chapter describes a prospective study (n=360) of the prevalence and reasons for barriers to discharge from inpatient rehabilitation. The study measured the resulting additional days in hospital and also sought to determine whether the occurrence of a discharge barrier or the extra unnecessary days in hospital were predicted by key demographic or clinical variables.

The rational for this study was based on the results presented in chapter 3. These included the finding that among key stakeholders a very high proportion had the perception that there were moderate, severe or extreme problems with discharge barriers for patients in rehabilitation. The study methodology used here included the definition of discharge barrier and the classification system for these developed in chapter 2, and was also informed by some of the KPIs presented in chapter 2. This chapter deals with the fifth aim of this thesis, study the causes of barriers to discharge from inpatient rehabilitation and their impact on the duration of hospital LOS.

Research

A prospective multicentre study of barriers to discharge from inpatient rehabilitation

Peter W New
MB BS, MClinEpi, FAFRM(RACP), PhD Candidate,[1] Rehabilitation Medicine Physician,[2] and Principal Researcher[3]

Damien J Jolley
MSc(Epidemiol), MSc, A Stat, Associate Professor and Senior Biostatistician, Centre of Research Excellence in Patient Safety[1]

Peter A Cameron
MB BS, MD, FACEM, Professor, and Head of Critical Care Research Division[1]

John H Olver
MB BS, MD, FAFRM(RACP), Professor, Director and Rehabilitation Medicine Physician[3]

Johannes U Stoelwinder
MB BS, MD, FRACMA, Chair of Health Services Management[1]

1 Department of Epidemiology and Preventive Medicine, Monash University, Melbourne, VIC.
2 Southern Health, Melbourne, VIC.
3 Epworth-Monash Rehabilitation Medicine Unit, Monash University, Melbourne, VIC.

Peter.new@southernhealth.org.au

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Abstract

Objectives: To assess the prevalence of and reasons for barriers to discharge from inpatient rehabilitation, to measure the resulting additional days in hospital, and to determine if these were predicted by key demographic or clinical variables.

Design, setting and participants: Prospective open cohort study of 360 patients admitted into two inpatient rehabilitation units in Melbourne over an 8-month and a 10-month period in 2008.

Main outcome measures: Occurrence of discharge barriers, their causes and the duration of unnecessary hospitalisation.

Results: There were 360 patients in the study sample, 186 were female (51.7%), and mean age was 58.4 years. Fifty-nine (16.4%) patients had a discharge barrier. The most frequent causes of discharge barriers were patients being non-weight bearing after lower limb fracture, family deliberations about discharge planning, waiting for home modifications and waiting for accommodation. Patients with acquired brain damage and lower limb fracture were the impairment groups most likely to experience a discharge barrier. Over the study period, 21.0% (3152/14 976) of all bed-days were occupied by patients deemed to have a discharge barrier. Regression analysis showed that age, sex, impairment group and dependency level on admission all influenced the occurrence of a discharge barrier. Although regression analysis showed that dependency on admission and age group were significant predictors of additional days in hospital resulting from discharge barriers ($P = 0.006$), these variables explained only 11% of the additional bed-days.

Conclusion: Barriers to discharge from inpatient rehabilitation are common and substantial, and they represent an important opportunity for improvement.

The occurrence of "exit block" from acute hospital to rehabilitation has been noted, but there has been little formal study of discharge barriers in rehabilitation.[1-3] Discharge barriers in rehabilitation have an adverse impact "upstream", with flow-on effects that limit acute hospital bed availability. A recent study highlighted rehabilitation discharge barriers as a major concern among clinicians and hospital managers in Australia.[3] Identifying and addressing these would be an important opportunity for improving hospital efficiency.

The objectives of this study were: 1) to measure the proportion of rehabilitation patients with a discharge barrier, 2) to record the causes of discharge barriers, and their duration, and 3) to determine whether any demographic or clinical variables predicted the discharge barriers or the number of additional days in hospital.

Methods

Study design and setting

We conducted a prospective open cohort study of consecutive patients admitted for inpatient rehabilitation into two acute "fast stream" rehabilitation units (South 4, Kingston Centre, and South West 2, Dandenong Hospital) in Southern Health, the largest public hospital network in Victoria. At Kingston Centre, the study commenced on 1 January 2008, while at Dandenong Hospital, the study commenced on 1 March 2008 (the starting dates were different because of the logistics involved in running the study).

The two units had a total of 48 inpatient beds for managing a range of neurological conditions (eg, acquired brain injury such as stroke, subarachnoid haemorrhage and traumatic brain injury, and other conditions), orthopaedic conditions (eg, arthroplasty and lower limb fractures, typically from falls — very rarely from motor vehicle accidents) and deconditioning after severe and acute illnesses, including cardiac and pulmonary conditions.

The rehabilitation units provide therapy (typically 2–3 hours a day) for patients with moderate to severe disability who cannot be discharged directly to their home from acute hospital care, and who require an interdisciplinary inpatient rehabilitation program. Patients are admitted for rehabilitation after any necessary acute medical or surgical treatments are completed, and when they are deemed stable by both the acute hospital staff and the rehabilitation assessment service.

Participants

We included all patients admitted from the two project commencement dates to 31 October 2008. Patients who remained in hospital beyond 31 October 2008 were monitored until discharge. Any patients who were transferred back to an acute hospital for elective or emergency treatment during the course of their rehabilitation and who were subsequently readmitted back into rehabilitation were considered as continuing their initial admission, rather than starting a separate admission. Patients were excluded if their admission was elective from the community or if they were discharged on the day of admission.

Discharge decisions were made with the involvement of the patient and their family. The treating team strived for the shortest length of stay (LOS) that would allow patients to be discharged to the least restrictive environment (always aiming for the previous accommodation) with the necessary care, equipment and home modifications for a safe discharge.

Variables

We recorded the following data for each patient: principal impairment necessitating rehabilitation, date of birth, date of admission, sex, rehabilitation LOS (excluding any days transferred back to acute hospital), and the patient's level of dependency

1 Classification of the causes of discharge barriers*† in a sample of 360 rehabilitation inpatients, proportion of patients affected by each type of discharge barrier and associated additional unnecessary days in hospital‡

Causes of discharge barriers†	Patients with discharge barrier	Additional unnecessary days in hospital	Median (IQR) additional unnecessary days in hospital
Non-weight-bearing: Patient non-weight-bearing after lower limb fracture(s). No longer needing inpatient rehabilitation therapy because of lack of benefit in improving function in mobility and transfers. Team recommends maintenance therapy until able to increase weight-bearing; however, no alternative setting of care available, and patient unable to return to the community.	20 (5.6%)	1390 (44.1%)	43.5 (34.5–75.5)
Family: Negotiations and discussions with family members regarding discharge planning issues that delay discharge processes. In particular, but not limited to, whether family will provide care for the patient or whether the patient will be discharged to a care facility.	13 (3.6%)	409 (13.0%)	24 (13–31)
Accommodation: Patient has no available suitable accommodation options.	12 (3.3%)	287 (9.1%)	16.5 (10.5–37)
Home modifications: Patient waiting for home modifications that are essential to ensure safe access and care at home after discharge. Includes funding and completion of modifications.	9 (2.5%)	713 (22.6%)	34 (16–132)
Long-term and supported care or services and equipment assessment/approval: Patient referred to a service or organisation for confirmation of appropriateness and necessity of supported care (nursing home or hostel) or long-term services or equipment. Includes waiting for the assessment; determination of level of care or range of services and equipment; related paperwork; and where relevant, confirmation that no option available for alternative care, where this process is required.⚡	7 (1.9%)	78 (2.5%)	12 (6–15)
Ambulatory rehabilitation: Patient waiting for assessment and/or availability of ambulatory rehabilitation services and no longer needing intensity of inpatient rehabilitation, but the team feels patient is not able to be discharged until ambulatory rehabilitation is confirmed and available.			
Southern Health network	7 (1.9%)	53 (1.7%)	7 (5–10)
Other health networks	1 (0.3%)	4 (0.1%)	4 (na)
Carer funding: Patient waiting for funding for carers to ensure safe care after discharge.	6 (1.7%)	479 (15.2%)	93 (6–135)
Carer recruiting and training: Waiting for recruiting and training of carers to ensure safe care after discharge.	5 (1.4%)	118 (3.7%)	15 (12–30)
Equipment: Delay waiting for necessary equipment to be available, after specific equipment needs have been identified and prescribed, that is essential to ensure safe care after discharge. Includes funding and supply of equipment.	4 (1.1%)	240 (7.6%)	45 (10–110)
Specialist review: Patient requires medical or surgical review to determine critical changes in his/her management deemed necessary to delay discharge planning process.	4 (1.1%)	46 (1.5%)	9 (1–22)
Alternative setting of care: Waiting for high-level (nursing home) or low-level (hostel, supported residential service) residential care accommodation to be available.			
High-level care accommodation	3 (0.8%)	108 (3.4%)	26 (10–72)
Low-level care accommodation	2 (0.6%)	34 (1.1%)	17 (16–18)
Occupational therapy home assessment: Patient no longer needs inpatient rehabilitation, but home visit not yet conducted and believed to be necessary before discharge to confirm and optimise safe access and internal environment.	2 (0.6%)	21 (0.7%)	10.5 (7–14)
Guardian/power of attorney appointment: Application made for determining power of attorney or guardian for making a decision that is blocking discharge planning, and patient not competent and no nominated person existing. Also includes subsequent delay in decisions being made by nominated guardian regarding discharge planning.⚲	2 (0.6%)	62 (2.0%)	31 (14–48)
Competency assessment: Patient requires neuropsychology assessment for competency in decision making before proceeding with discharge options.	1 (0.3%)	10 (0.3%)	10 (na)
Other causes	1 (0.3%)	13 (0.4%)	13 (na)

IQR = interquartile range. na = not applicable.
* A discharge barrier is considered to occur when the treating team believes that there are no longer any additional goals of therapy or treatment that require inpatient rehabilitation, and yet the patient is unable to be discharged. In applying this definition the following assumptions are made: 1) the patient's activity limitations, body functions and structures dysfunction have been addressed to an adequate degree, including safety considerations, such that it is no longer necessary to continue rehabilitation in an inpatient setting, and 2) environmental barriers and facilitators for discharge have been optimised within the limit of readily available resources.[5] † Definitions reproduced exactly as in New et al.[5] ‡ The totals for patients with a discharge barrier and additional days in hospital are greater than 100% in this table because of multiple barriers existing simultaneously for some patients. ⚡ Includes Aged Care Assessment Service. ⚲ Includes application made to the Victorian Civil and Administrative Tribunal. ◆

in self-care, continence and mobility at the time of admission and discharge using the Modified Barthel Index (MBI).[4] The MBI provides a scale from 0 to 100, with 0 = total incapacity and 100 = independent. The main outcome variables were the occurrence of a discharge barrier, its cause(s), and the number of additional unnecessary days in hospital resulting from the discharge barrier (from the onset of the barrier until resolution). When multiple discharge barriers occurred simultaneously, any overlapping days were eliminated from the regression analysis and total unnecessary days in hospital were reported. The definition of a discharge barrier and classification of causes (Box 1) were based on our recently published work.[5]

Data sources

The occurrence of a discharge barrier, the cause(s), and date of onset or resolution were noted during the twice-weekly ward rounds and confirmed at weekly team meetings. Data analysis was performed using Stata 11 for Windows (StataCorp).

Statistical methods

For variables that were normally distributed (eg, age), the mean and standard deviation were calculated. For continuous variables that were not normally distributed (eg, LOS), the median and interquartile range (IQR) were reported. The relationship between the occurrence of a discharge barrier and categorical variables was calculated using the χ^2 test.

2 Key impairment groups, patient age, level of dependency and proportion of patients with a discharge barrier in a sample of 360 rehabilitation inpatients

Key impairment group	Patients	Mean age* (SD)	Median MBI dependency score on admission† (IQR)	Median MBI dependency score on discharge‡ (IQR)	Patients with a discharge barrier§ (%) 95% CI	Odds ratio of discharge barrier¶ (95% CI)	χ^2	*P*	Median length of stay** (IQR)	Mean additional unnecessary days in hospital†† (IQR)
Stroke, SAH or TBI‡‡	64 (17.8%)	55.2 (14.4)	17 (1–36)	75.5 (25–100)	12 (20.3%) 11.0%–32.8%	1	—	—	41 (16–100)	33 (27–93)
Other neurological	47(13.0%)	49.2 (16.0)	28 (16–45)	89 (57–99)	5 (8.5%) 2.8%–18.7%	0.5 (0.2–1.5)	1.7	0.2	30 (19–50)	14 (7–28)
Lower limb arthroplasty	55(15.3%)	64.2 (9.8)	38 (26–49)	94 (82–99)	3 (5.1%) 1.1%–14.1%	0.2 (0.06–0.9)	4.9	0.03	17 (13–21)	14 (4–34)
Lower limb fracture	60 (16.7%)	58.8 (15.6)	35 (19.5–49)	91.5 (70–99)	18 (30.5%) 19.2%–43.9%	1.8 (0.8–4.2)	2.0	0.2	28.5 (17.5–54)	42 (16–70)
Other musculo-skeletal	45 (12.5%)	57.0 (14.8)	39 (20–47)	94 (79–100)	7 (11.9%) 4.9%–22.9%	0.8 (0.3–2.2)	0.2	0.6	22 (14–31)	39 (8–73)
Cardiac or pulmonary debility	64 (17.8%)	64.0 (13.2)	36 (23–48)	97 (72.5–100)	8 (13.6%) 6.0%–25.0%	0.6 (0.2–1.6)	1.1	0.3	20 (15–33)	23 (8.5–65.5
Other	25 (6.9%)	58.0 (16.6)	34 (13–45)	99.5 (89–100)	6 (10.2%) 3.8%–20.8%	1.5 (0.5–4.7)	0.5	0.5	27 (21–52)	19 (15–27)
Total	360 (100%)	58.4 (15.0)	34 (17–47)	93 (69–100)	59 (100%)	—	—	—	23 (15–48.5)	34 (14–58.5)

IQR = interquartile range. MBI = Modified Barthel Index. na = not applicable. SAH = subarachnoid haemorrhage. TBI = traumatic brain injury.
* $F = 1.2$; $P = 0.2$. † $\chi^2 = 30.8$; $P < 0.001$. ‡ $\chi^2 = 14.0$; $P = 0.03$. § $\chi^2 = 17.0$; $P = 0.009$. ¶ Test of homogeneity $\chi^2 = 17.0$; $P = 0.01$. ** $\chi^2 = 34.0$; $P < 0.001$. †† $\chi^2 = 4.7$; $P = 0.6$. ‡‡ Reference category. ◆

The relationship between normally distributed outcomes was calculated using the Student *t* test, or the Kruskal–Wallis test for data that were not normally distributed.

We calculated odds ratios for the occurrence of a discharge barrier for the different impairment groups. The influence of patients' age at the time of admission, sex, impairment and the admission MBI on the occurrence of a discharge barrier and the total number of unnecessary days in hospital was assessed using multivariable logistic and linear regressions (backwards inclusion), respectively. The duration of unnecessary hospitalisation was log-transformed to facilitate parametric analysis. Age was categorised into three groups (< 50 years, 50–64 years and ⩾ 65 years) corresponding to different age-based criteria for access to programs or services available to patients on discharge.

P values of less than 0.05 were deemed statistically significant. The project was approved by the Southern Health Human Research Ethics Committee and Monash University Human Research Ethics Committee.

Results

There were 372 patients admitted during the study period, but 12 were excluded (10 had elective admissions from the community and two were discharged on the day of admission), leaving 360 patients in the analysis. There were 186 females (51.7%) and 174 males (48.3%), ranging in age from 16 years to 93 years.

Overall, 59 (16.4%; 95% CI, 12.7%–20.6%) patients had a discharge barrier. There was no apparent difference between the participating units and the occurrence of discharge barriers ($\chi^2 = 1.5$, $P = 0.2$). Box 2 shows the proportion of patients in different impairment groups, their ages, their LOS, their MBI on admission and discharge, and the proportion with a discharge barrier. The impairment groups most likely to have a discharge barrier were patients with stroke, subarachnoid haemorrhage or traumatic brain injury, and those with lower limb fractures. Among patients with a discharge barrier, 35 had one barrier, 15 had two barriers and nine patients had three or more barriers.

Over the study period 21.0% (3152/14 976) of all bed-days were occupied by patients who were deemed to be clinically ready for discharge from rehabilitation but had a discharge barrier. Twenty-five per cent of patients with a discharge barrier spent more than an additional 2 months in rehabilitation, and nine patients had more than 100 additional unnecessary days of hospitalisation (maximum 322 days). The median LOS (58 days; IQR, 32–131) for patients with a discharge barrier was significantly greater ($H = 47$; $P < 0.001$) than that of patients who did not have a discharge barrier (median LOS, 21 days; IQR, 14–34).

The causes of discharge barriers and the resulting additional days in hospital are shown in Box 1. The most common causes of a discharge barrier were patients being non-weight bearing after lower limb fracture, family deliberations about discharge planning, waiting for home modifications and waiting for accommodation. The reasons accounting for the greatest number of additional hospital days were patients being non-weight bearing, home modifications, carer funding, family negotiations, accommodation and equipment necessary for discharge.

Multivariable logistic regression analysis showed that younger patients (< 50 years) had significantly greater odds of a discharge barrier than the older group (⩾ 65 years). Males had significantly greater odds of a discharge barrier than females. Those with lower limb fracture had higher odds compared with those who had a stroke, subarachnoid haemorrhage or traumatic brain injury, and the odds were reduced significantly with lesser dependency on admission (Box 3). Linear regression assessing the variables predicting the number of additional days in hospital showed that being in the younger age group and having greater dependency on admission

3 Multivariable logistic regression for the occurrence of a discharge barrier in a sample of 360 rehabilitation inpatients

Barrier	Odds ratio (95% CI)	*z*	*P*
Age group			
< 50 years	1.0*	– 1.5	0.1
51–64 years	0.57 (0.28–1.19)	– 3.0	0.003
⩾ 65 years	0.30 (0.13–0.66)		
Sex			
Male	1.0*	– 2.8	0.006
Female	0.41 (0.21–0.77)		
Impairment			
Stroke, SAH or TBI	1.0*	– 0.9	0.4
Other neurological	0.60 (0.18–1.95)	– 0.6	0.5
Lower limb arthroplasty	0.64 (0.16–2.59)	2.6	0.008
Lower limb fracture	3.65 (1.40–9.54)	0.4	0.7
Musculoskeletal — other	1.25 (0.41–3.84)	0.4	0.7
Cardiac or pulmonary debility	1.23 (0.42–3.55)	1.6	0.1
Other	2.72 (0.79–9.44)		
Modified Barthels Index on admission	0.97 (0.95–0.99)	– 3.4	0.001

SAH = subarachnoid haemorrhage. TBI = traumatic brain injury.
* Reference group. ◆

4 Approaches to consider when developing strategies to resolve discharge barriers for rehabilitation patients

- Identifying locus of control over the barrier: internal (rehabilitation team or hospital organisation) or external (other hospital networks, state or federal government)?
- Assessing preventability of the barrier: preventable, potentially preventable or non-preventable
- Setting priorities in resolving barriers: identifying barriers with the most common causes, those with the greatest contribution to unnecessary hospitalisation, those that are easiest to resolve. ◆

were significant predictors ($P < 0.001$), but these explained only 11% of the additional days.

Discussion

We have shown that many rehabilitation patients are in hospital unnecessarily. Patients aged less than 65 years, males, those with lower limb fractures who are non-weight bearing, or those with a brain impairment were more likely to have a discharge barrier. The number of unnecessary bed-days "blocked" by these patients is substantial and represents a significant waste of health care resources. However, a model predicting the number of unnecessary days explained only a small proportion of the total additional unnecessary days in hospital.

We believe the reason that younger patients are more likely to have a discharge barrier is because older patients have more access to services and care options in the community (eg, the Transition Care Program and high-level care). More investigation is needed into why males are more likely to experience a discharge barrier, but this could be related to lack of social supports or other factors.

Efficient patient flow is a major challenge confronting the hospital system,[6] which will become more pressing with population ageing and increasing chronic disease and disability.[7-8] Most attention to date has been focused on the emergency department[9-11] or acute hospitals.[12-13] No previous studies of discharge barriers in rehabilitation have been identified. In acute hospital general medical patients, the proportion of unnecessary bed-days in the United States[13] and Australia[12] has been found to be 14%, which is similar to our results. Others have noted that access to disability-related equipment often does not meet the needs of patients,[14] as we found here, but the impact of this on rehabilitation LOS has not previously been measured.

When patients are in hospital longer than required for medical reasons, there are a number of potential adverse outcomes. Patients or their families can develop adverse emotional reactions. Further, the additional hospitalisation places the patient at risk of iatrogenic complications, including medication errors, nosocomial infections and falls. It has been reported that each additional day in hospital increases the risk of a documented adverse event by 6%.[15]

Rehabilitation is often seen as separate from the acute hospital system.[2] Although it has been acknowledged that access to rehabilitation is vital for efficient hospital patient flow,[2,16] a coordinated and holistic view of bed access and patient flow across the whole hospital spectrum has not been present in health care planning and systems change processes to date.

What are the potential solutions for reducing discharge barriers?

Discharge barriers are complex phenomena, and there are multiple potential approaches to resolving them. Although not all discharge barriers are preventable, many are. Approaches to consider when resolving discharge barriers are shown in Box 4.

Suboptimal implementation of federal–state funding agreements and policies, as well as state-based funding and policies involving aged care, disability, welfare and housing contribute to discharge barriers. At the local level, senior hospital clinical or executive staff can help by resolving internal organisational barriers where this is beyond the ability of the patient's treating team, and by bringing external barriers to the attention of the relevant organisation or government department.

Establishing and communicating the patient's estimated date of discharge and expected destination within a week of admission is one strategy that can potentially help prevent barriers arising from family negotiations. Family negotiations around discharge could also be improved through staff training and increased access to social work and psychological resources. Different models of inpatient rehabilitation could be developed with the involvement of relevant government departments in planning and designing appropriately resourced and flexible models of supportive accommodation, which may be either transitional or permanent. For example, patients

who are non-weight bearing after lower limb fracture could be provided with lower-cost interim care, where they can also receive maintenance therapy until they are able to start bearing weight, while patients with disabilities who are in hospital should be provided with improved access to suitable permanent accommodation. Making the Transition Care Program[17] accessible to patients aged less than 65 years would be one potential solution. Improved and timely access to resources for home modification, equipment and carers would go a long way towards resolving discharge barriers. The proposed National Disability Insurance Scheme could solve some of these problems by providing greater and timelier funding than is currently available.[18]

Limitations and generalisability

The findings of this study should be treated with some caution because patients were sampled for a limited period in two hospitals. However, there were no differences in discharge barriers between the units, suggesting that these problems are unlikely to have resulted from issues within a particular unit. In addition, periodic audits of the occurrence and causes of discharge barriers performed since this project was completed have shown that the problems with discharge barriers remain. Also, it could be argued that there was subjectivity involved in identifying when a discharge barrier occurred and in measuring its duration. This was minimised by having senior rehabilitation team members make consensus decisions about the occurrence and duration of a barrier using an agreed definition of a discharge barrier and categories of causes (Box 1).[5]

We acknowledge that our findings would not be generalisable to private rehabilitation hospitals. Private rehabilitation units are able to be more selective about the patients they admit — tending to have less disabled patients and a shorter LOS compared with rehabilitation units in the public system.[19] We believe, however, that our results are likely to be generalisable to other public rehabilitation units in Australia. Recent articles in the Journal highlight resource limitations that cause problems with rehabilitation patient discharge as an Australia-wide problem.[2-3] We believe that our results may also be generalisable to international settings. In particular, our findings may be relevant to Canada and Europe, where there are publicly funded hospital systems and challenges with access to adequate social supports and discharge resources, and to other countries with a capped funding scheme (as opposed to fee-per-service funding models of hospital care).

Implications for future practice and research

More in-depth study of discharge barriers in inpatient rehabilitation is required, including in specialty settings (eg, rehabilitation for patients who are amputees or for patients with a spinal cord injury). Studies with increased numbers of participants and a broader range of measurements would allow adequate power to assess the patterns of different barriers in specific impairment groups, the predictors of specific discharge barriers and the interaction between barriers.

Policymakers and health managers should consider putting more resources into resolving inefficiencies in patient flow through the whole hospital system, not just focusing on the emergency department and acute hospitals. Hospital efficiency cannot be optimised unless rehabilitation is better integrated into the improvement process. Our findings strongly suggest that consideration should be given to directing some of the recently proposed health reform funding for rehabilitation beds[20] into programs and strategies to address rehabilitation discharge barriers. It is possible that this would be more cost-effective than building and staffing all the proposed rehabilitation inpatient beds.

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5.3 Chapter 5: Summary

This chapter has shown that many patients in rehabilitation hospitals are there unnecessarily and this results in a large number of extra days in hospital.

Efficient patient flow is a major challenge confronting the hospital system, as outlined in chapter 1, and this will become more pressing with population ageing and increasing chronic disease and disability.

No previous study of discharge barriers in rehabilitation has been identified.

Discharge barriers are complex phenomena, and there are multiple potential approaches to reducing their impact.

Policymakers and health managers should consider allocating more resources into resolving inefficiencies in patient flow through the whole hospital system, not just focusing on the emergency department and acute hospitals. Hospital efficiency cannot be optimised unless rehabilitation is better integrated into the improvement of the total patient care process.

The results presented here are used in chapter 6 to develop a model of rehabilitation patient LOS and inform the development of the hypothetical scenarios.

6 CHAPTER SIX: COMPUTER SIMULATION OF IMPROVEMENTS IN THE HOSPITAL LENGTH OF STAY FOR REHABILITATION PATIENTS

"Prediction is very difficult, especially if it's about the future."

Neils Bohr (1885 – 1962)

6.1 Declaration B: Chapter 6

PART B: Suggested Declaration for Thesis Chapter

Monash University

Declaration for Thesis Chapter 6

New PW, Stockman K, Cameron PA, Olver JH, Stoelwinder JU. Computer simulation of improvements in the hospital length of stay for rehabilitation patients. J Rehabil Med 2015; 47: 403–411.

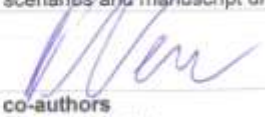
Declaration by candidate

In the case of Chapter 6, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
I conceived the project, developed the baseline for the computer model and played an active role in developing the computer model used to simulate patient length of stay. I performed the validation checks of the computer model and developed the hypothetical scenarios that were simulated. I performed the data analysis of the results of the simulations. I wrote the first draft of the manuscript and consolidated revisions into the final version	70%

The following co-authors contributed to the work.

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Keith Stockman	Developed the computer simulation model in conjunction with the candidate. Wrote computer code for the simulation. Provided constructive suggestions on the hypothetical scenarios and manuscript drafts.	NA
Peter Cameron	Provided constructive suggestions on the hypothetical scenarios and manuscript drafts	NA
John Olver	Provided constructive suggestions on the hypothetical scenarios and manuscript drafts	NA
Johannes Stoelwinder	Provided constructive suggestions on the hypothetical scenarios and manuscript drafts	NA

Candidate's Signature  **Date** 30/4/2015

Declaration by co-authors

The undersigned hereby certify that:

(1) the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.
(2) they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
(3) they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
(4) there are no other authors of the publication according to these criteria;
(5) potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
(6) the original data are stored at the following location(s) and will be held for at least five years from the date indicated below:

Location	Department Rehabilitation, Kingston Centre, Warrigal Rd, Cheltenham, 3192, VIC

Signature 1: KS	[redacted]	Date 1/5/15
Signature 2: PC		27/4/15
Signature 3: JO		01/5/15
Signature 3: JS		29/4/15.

6.2 Chapter 6: Introduction

This chapter describes the development of a computer model that that simulates rehabilitation patient flow. The model is used to calculate the impact on acute hospital and inpatient rehabilitation LOS from a number of hypothetical scenarios that simulate alternative care pathways. The scenarios incorporate the major process delays for transfer from acute hospital to rehabilitation, detailed in chapter 4, and the barriers to discharge from rehabilitation reported in chapter 5. The content of this chapter addresses the sixth, and final aim of this thesis, development a computer model that simulates rehabilitation patient flow and the use of this to simulate alternate care pathways that address barriers to patient flow.

The scenarios that are modelled and the potential reduction in hospital LOS will be useful to clinicians, hospital management, process improvement project leaders, governments and other funders involved in the development of alternative models of patient care, especially those concerned with timely quality care and optimising patient flow.

Computer simulation

Operations research is a specialised discipline that uses advanced analytic methods, such as mathematical and simulation modelling, statistical analysis, and mathematical optimization, to derive optimal solutions to complex decision-making problems. It has the potential to play an important role in health care, including optimizing patient flow. [109-113]

Simulation is a field that has enormous potential to help improve many aspects of health systems operation, and its full potential is yet to be explored. The scope of simulation in healthcare includes: clinical situations, such behaviour of diseases; operational; managerial and educational aspects. [114] In these areas, simulation can be used for

decision support, training, quality and process improvement, and to model the complexity of health care.

Computer simulation can be used to solve problems when it is not possible or practical to experiment using real objects. Scenarios can be replicated and parameters altered to assess the impact in ways that are not otherwise possible or practical due to constraints in time, finances, environment, training or equipment. [114]

There are a number of methodologies used in healthcare simulation modelling, including discrete event modelling, system dynamics, agent-based modelling (ABM) and hybrid methods. [114, 115] Health care system functioning can be described in terms of its quality, costs and access – simulation can then be used to assess the potential impact of systems changes that take into consideration these aspects in a virtual setting. Detailed explanations about simulation modelling in healthcare can be found elsewhere. [114-116]

The process of computer simulation model development assumes a degree of abstraction, where details felt to be less relevant are omitted – a model is always less complex than the original system. [114] Models of complex systems are intended to be an approximation and simplification of the actual system to assist in examining potential outcomes from alteration in the behaviour of the models' key components. Formulas that are useful for describing static relationships between variables are not appropriate for dynamic relationships in complex systems, which is where simulation modelling is appropriate. Models use a set of rules to describe how a system moves from one state to another.

The principles model development, which were followed in this project, include the following: a) formulate the problem, b) review collected information, c) establish assumptions, d) program the model, e) test if the model is valid, and f) refine the model.

Further details about the computer simulation design in general and the development of the model used in this project are given in the manuscript that forms the core of this chapter.

J Rehabil Med 2015; 47: 403–411

ORIGINAL REPORT

COMPUTER SIMULATION OF IMPROVEMENTS IN HOSPITAL LENGTH OF STAY FOR REHABILITATION PATIENTS*

Peter W. New, MBBS, MClinEpi, FAFRM (RACP)[1,2,3], Keith Stockman, BS, MBA[4], Peter A. Cameron, MBBS, MD, FACEM[1], John H. Olver, MBBS, MD, FAFRM(RACP)[3] and Johannes U. Stoelwinder, MD, MBBS, FRACMA, FACHE, FAFPHM[1]

From the [1]Department of Epidemiology and Preventive Medicine, Monash University, [2]Rehabilitation and Aged Care Services, Department of Medicine, Monash Health, [3]Epworth-Monash Rehabilitation Medicine Unit and [4]Operations Research and Projects, General Medicine Program, Monash Health, Victoria, Australia

Objective: **To estimate the potential improvement in acute and rehabilitation hospital length of stay for rehabilitation patients from hypothetical scenarios that address barriers to patient flow.**

Design: **Data about the duration of key processes for patients (n = 360) admitted to acute hospitals and subsequently transferred to inpatient rehabilitation in 2 wards in Melbourne, Australia were used to develop a computer simulation model.**

Subjects: **Simulated patients.**

Methods: **A computer model of length of stay was developed, validation checks performed and alternate care pathways simulated.**

Results: **Almost all scenarios resulted in significant changes in the length of stay compared with baseline. The effect size for the changes was typically small to medium. The duration of the rehabilitation discharge barriers showed significant changes in all hypothetical scenarios. The effect size was smaller when changes were made to a single barrier, but larger when multiple barriers were changed simultaneously.**

Conclusion: **Health system modelling can provide information regarding potential improvements in length of stay from addressing barriers to patient flow affecting rehabilitation patients. This can inform reforms to models of care and assist with cost benefit analyses.**

Key words: computer simulation; health services research; length of stay; rehabilitation; health services accessibility.

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Correspondence address: Peter New, Kingston Centre, Warrigal Road, Cheltenham 3192 Victoria, Australia. E-mail: peter.new@monashhealth.org

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INTRODUCTION

Addressing the challenge of increasing demand for hospital services is a global problem (1–4). It is vital that the flow of rehabilitation patients is considered as part of dealing with this challenge (5, 6). The whole healthcare system needs to be considered when optimizing patient flow because focusing on only 1 hospital setting, either acute or rehabilitation, will miss crucial bottlenecks. Relatively little attention, however, has been given to studying access barriers for acute hospital patients waiting for inpatient rehabilitation, or discharge barriers for rehabilitation inpatients after they are deemed to no longer require inpatient rehabilitation, despite reports indicating problems in these areas (6–13).

There are important reasons for addressing the lack of research on rehabilitation patient flow. These include the increased risk of iatrogenic complications arising from patients being in hospital unnecessarily (14); the poorer outcomes for patients who wait longer for rehabilitation (7, 15); the financial waste associated with the inefficient use of healthcare resources; and the flow-on effect of reduced access to beds in 1 setting impacting adversely on patient flow through the continuum of hospital care.

Computer simulation can be used to solve problems when it is not possible or practical to experiment using real subjects. Scenarios can be replicated and parameters altered to assess the impact in ways that are not otherwise possible or practical due to constraints in time, finances, environment, training or equipment (16). The process of developing a computer model for simulation assumes a degree of abstraction, where details felt to be less relevant are omitted. A computer model is always less complex than the original system (16). Simulation of patient flow through the hospital system can be used to illustrate the potential changes in length of stay (LOS) due to alterations in care processes (17, 18).

The aim of this project was to develop a computer simulation model of patients who are admitted to an acute hospital and subsequently transferred to inpatient rehabilitation. The objective was to use this model to estimate the potential changes

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in acute and rehabilitation hospital LOS from a number of hypothetical scenarios that simulate alternate care pathways for patients transferring from acute hospital to rehabilitation and from hypothetical changes to the barriers to discharge from rehabilitation. The information on potential LOS changes presented here will be useful to clinicians, hospital management, process improvement project leaders, governments and other funders involved in the development of alternative models of patient care, particularly those concerned with timely quality care and optimizing patient flow.

METHODS

Simulation design

A computer model was developed using established principles (19–21) to simulate the various stages of the patient journey from acute hospital admission to inpatient rehabilitation and subsequent discharge.

Agent-based modelling (ABM) was used for simulating patient flow (21–23). ABM uses state transitions, where agents (in this case patients) are represented in a state diagram at various stages of care (21), for example in an acute or rehabilitation hospital. Nested within the state diagram are various treatment or wait states (e.g. the period of active rehabilitation or waiting for home modifications to be completed before discharge can occur). The patients move from one state to the next in a stochastic process (http://statprob.com/encyclopedia/StochasticProcesses.html); that is, one whose behaviour is non-deterministic. In other words, the time patients spend in each state is not a fixed period that can be defined by an equation, but is a random process with indeterminacy. The duration patients spend in each state has a distinct probability distribution. The probability distribution of an event is the list of probabilities associated with each of its possible values. Fig. 1 shows the state diagram used in the model.

Compared with alternative computer modelling methods, such as discrete event or system dynamics (16, 20), ABM offers numerous advantages. We were not modelling queues for a single scenario, but multiple sequential processes, including nested states (i.e. states within states, such as the various process barriers that occur within acute hospital admission), which the other methods do not handle as easily. The capture of patient movement between transitions and waiting time in each state is also better suited to ABM than other modelling methods.

The model structure was based on our previous studies of process barriers for acute hospital patients admitted to rehabilitation (13) and barriers to discharge from rehabilitation (12). The definition of barrier to rehabilitation discharge used was that "a discharge barrier is considered to occur when the treating team believes that there are no longer any goals of therapy or treatment that require inpatient rehabilitation, and yet the patient is unable to be discharged" (24). In our previous studies data were collected on 360 consecutive patients admitted for inpatient rehabilitation into 2 wards in the largest public hospital Network in Victoria, Australia, which provides healthcare to more than 1 million people living in the southeast of Melbourne. Time in the model states was based on this previous data. The states in the model were as follows: between admission to acute hospital and referral for rehabilitation; between referral for rehabilitation and rehabilitation assessment completed; between assessment and patient deemed ready for transfer to rehabilitation; between ready for transfer from acute hospital to rehabilitation and admission into rehabilitation; between admission into rehabilitation and ready for discharge from rehabilitation; between ready for discharge from rehabilitation and actual discharge (Fig. 1). The states reflect sequential non-overlapping processes that each patient passes through in their journey from acute

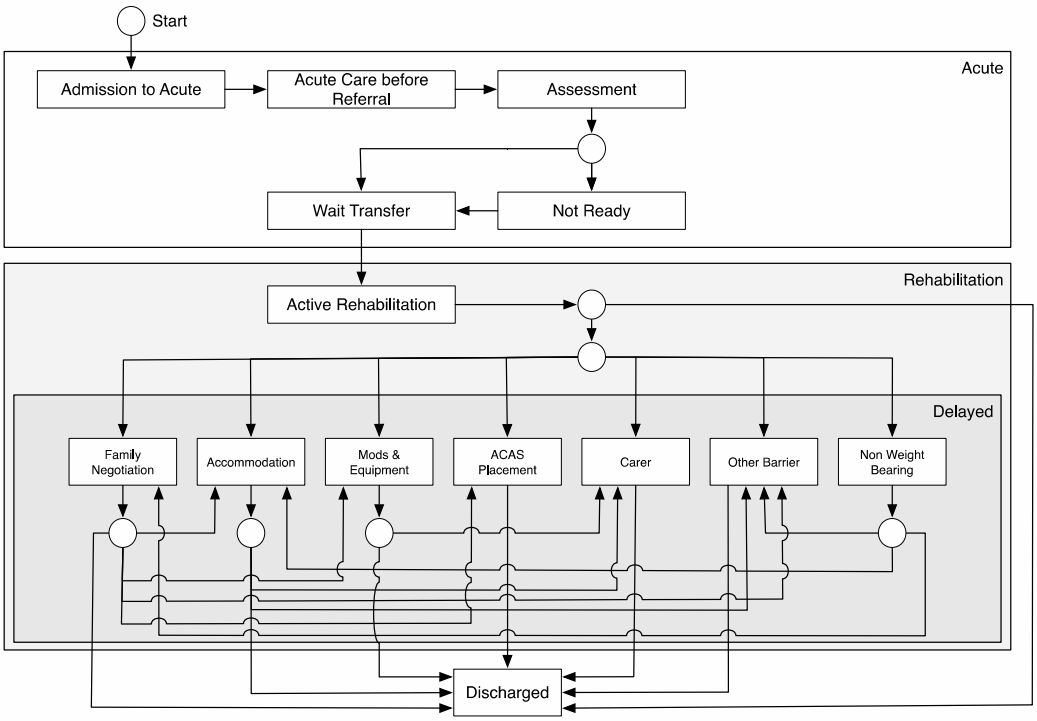

Fig. 1. State diagram used in the model indicating the acute hospital process barriers and rehabilitation discharge barriers.

hospital admission until discharge from inpatient rehabilitation. In an earlier study information was collected regarding the occurrence of any rehabilitation discharge barrier, the cause(s), and the number of additional days in hospital arising as a consequence (12). These barriers were also included in the simulation model (Fig. 1).

The duration of each state in our model was stochastically modelled using Pert probability distributions, which require only the minimum, modal and maximum values (20). This approach offers numerous advantages compared with alternative methods for generating probability distributions. A major practical advantage is the simplicity and intuitive nature for setting the parameters that determine the probability distribution. In addition, the Pert distribution is continuous but bounded on both sides. We confirmed that the probability distribution for the duration of the key processes between acute hospital admission and transfer to rehabilitation and duration of rehabilitation LOS and rehabilitation discharge barriers in our previous studies could be approximated using the Pert method. Our previously collected data were used as the basis for generating the parameters (minimum, mode and maximum) for each of the Pert distributions used in the baseline simulation model. In a few instances the data in our observed distribution were uniform, that is, there was no single modal value. In these instances the data were descretized by plotting a histogram that allowed a modal value to be obtained.

Our previously developed classification of discharge barriers has 15 categories (24) but in order to simplify the model we collapsed these into 7 barrier states. Non-weight bearing, family negotiations, and accommodation were used in the model as per the classification system. Those barriers with infrequent occurrences (occupational therapy home assessment, competency assessment, specialist review, waiting for ambulatory rehabilitation, guardian/power of attorney appointment) were collapsed into an "other" group. Categories of related problems were combined from the remaining barriers. Equipment and home modifications were merged in the model as these are both related to overcoming physical barriers and are either self-funded by patients or paid through insurance. Assessment and approval of long-term supported care was combined with the time waiting for an alternative setting of care (typically a nursing home). Carer funding was combined with carer recruitment and training (Fig. 1).

In our previous study of inpatient rehabilitation discharge barriers numerous patients had sequential barriers to discharge (12). We designed the model to simulate the occurrence of these sequential barriers in a way that mirrored those observed as closely as possible. In our study a small number of patients had multiple discharge barriers simultaneously. In the model patients could only be in 1 state at a time, which was dealt with in the model by allocating the overlapping time proportionally to each state (i.e. discharge barrier).

We did not directly include in the model the number of available beds as a resource for 2 reasons. Firstly, the data from our prior studies did not include information on non-rehabilitation patients admitted into rehabilitation beds or rehabilitation patients admitted into other beds (e.g. aged-care wards) (12, 13). Secondly, for the model to be generalizable, access was better represented as a time delay. It is important to note, however, that the problem of rehabilitation bed availability for acute hospital patients was included in the model by way of the time that patients spent waiting for a bed.

Several assumptions were made in designing the model. These were: that the data collected in our previous studies on time in the various processes and waits (model states) are generalizable to delays typically seen across the sector for this cohort of patients; that the pert distribution is a reasonable approximation of the real world distribution of time in the various processes and delays; and that the time in any model state is independent of the time in any prior state.

The computer model was designed with 100 patients (agents) in each simulation run, equivalent to approximately 10 weeks of admissions into the 2 wards. The model generated the following outputs:

Table I. *Hypothetical scenarios of changes to process barriers for the flow of patients through the hospital system*

- *"Major improvements"*: reduced the baseline maximum and modal pert values by approximately 15–25% for the acute hospital referral till assessment and waiting for transfer processes, and all rehabilitation discharge barriers.
- *"Major improvements plus"*: used the same parameters as the "major improvements" scenario, but in addition included a 10% improvement in the probability that patients were ready for transfer when assessed. This was based on the premise that earlier referral to rehabilitation during the acute hospital phase of care would result in functional and medicals benefit resulting in this improvement. In addition, a 10% reduction in the active rehabilitation LOS was modelled, based on the principal that efforts to improve team processes and discharge planning could achieve this without compromising patient care.
- *"Extreme improvements"*: reduced the baseline maximum and modal pert values by approximately 33% for the acute hospital referral till assessment and waiting for transfer processes, and all rehabilitation discharge barriers, except for non-weight bearing, which was modelled as in the "targeting non-weight bearing scenario". In addition, the "approval & waiting for nursing home" minimum waiting was reduced from 17 to 10 days.
- *"Targeting non-weight bearing"*: This only had changes made to the parameters for patients non-weight bearing as a result of a lower limb fracture who were unable to be discharged and not able to benefit from ongoing intensive therapy until they could partially weight-bear. This was the most common barrier to discharge from rehabilitation in our previous study and was responsible for the greatest number of unnecessary days in hospital (12). The same parameters for these processes used in the "extreme improvements" scenario were applied.
- Scenarios were also run that simulated changes to other individual key processes in the rehabilitation ("accommodation", "family negotiations", "modifications and equipment" and the rehabilitation LOS independent of any discharge barrier) and acute hospital (acute admission until referral for rehabilitation and waiting for a rehabilitation bed after deemed ready) using the same parameters for these processes used in the "extreme improvements" scenario. This allowed for a comparison of the impact of single process change compared with combined effect of multiple process changes.
- *"Extreme improvements plus"*: used the same parameters as the "extreme improvements" scenario, and in addition included a 25% improvement in the maximum and modal time from admission to acute hospital till referral, a 10% improvement compared with baseline in the probability that patients were ready for transfer when assessed (from 0.63 to 0.7), a reduction from 16.4% to 10% in the probability of a patient in rehabilitation had a discharge barrier and an approximate 20% reduction compared with baseline in the active rehabilitation LOS mode and maximum pert values.
- *"Deteriorated"*: This was based on the challenges arising from an ageing population and increased pressure on rehabilitation units from acute hospitals to accept patients sooner, but without increased resources or other systems changes to address rehabilitation discharge barriers. The scenario included a worsening from the baseline probabilities for occurrence of the following barriers: family negotiations, demand for nursing homes and hostel beds; access to alternative accommodation for people unable to return to their previous home; availability of carers; and inadequate resourcing for aids, equipment and home modifications (see Table II for specific parameter changes). We also increased the pert distribution mode and maximum by approximately 15% for these barriers. The acute hospital processes were not altered in this scenario.

LOS in acute hospital, time patients spent waiting in acute hospital after deemed ready for transfer to rehabilitation, LOS in rehabilitation, number of days in rehabilitation with a barrier to discharge, and the number of days in rehabilitation that had no barrier to discharge.

There are numerous approaches for determining the number of runs needed in computer simulations (21, 25, 26). An important principle is to ensure an adequate number of runs so that stable predictions and outputs are generated (26). It is also important to consider that although the effect size is important, the distribution of output variables is often more important, which are often not normal distributions (25). Furthermore, because of the fixed relationship between effect size, significance levels and the sample size (or number of runs), any relationship between simulation parameters and output can be "made significant" (25). With our project we initially predetermined the number of simulation runs by performing a power calculation and then confirming that acute and rehabilitation hospital LOS cumulative values for the median, average, 25th and 75th quartiles, standard deviation and standard error of the mean had stabilized by the specified number of runs. For the power calculation we set a 2-tailed alpha of 0.05, power of 99% and a medium Cohen's effect size (27) of 0.5 to give an estimate of 142 runs (26), which we rounded up to 150. This generated the equivalent of over 8 years of patient admissions into the 2 wards (15,000 patients) based on the number of admissions during the previous data collection (12, 13).

Validation and testing

Suggested frameworks for testing ABM were followed in confirming the validity of the model (19, 28, 29). Verification testing was conducted to confirm that the model behaved as expected, including using extreme and single numbers. Refinements were made after testing indicated that the "tail" of the probability distribution in some states was too skewed (i.e. the duration of states in the model was much longer than in the observed data). In these instances the extreme outliers from our data (typically less than 5% of participants) were excluded when generating the parameters for the Pert probability distributions. After making these changes the median duration of each state in the model was approximately the same as in our previously collected data.

Hypothetical scenarios

Twelve hypothetical scenarios were developed that simulated changes to the barriers for the flow of patients through the hospital system. The detail of what these scenarios entail and how they compare to the baseline is explained in Table I. Eleven scenarios had improvements and one had a worsening of parameters. The improvement scenarios were based on our clinical expertise with working in patient flow and health systems redesign, including proposals outlined in our previous

Table II. *Values for probability distributions of the model of rehabilitation patient flow and hypothetical alternatives scenarios*

Variable parameters	Baseline	Major improvements	Major improvements plus	Extreme improvements	Extreme improvements plus	Deteriorated
Acute hospital process barriers states						
Acute hospital admission till referral						
minimum, mode, maximum	0, 4, 35	0, 4, 35	0, 4, 35	0, 4, 35	0, 3, 28	0, 4, 35
Referral till assessment by rehabilitation team						
minimum, mode, maximum	0, 1, 4	0, 0.75, 3	0, 0.75, 3	0, 0.5, 2	0, 0.5, 2	0, 1, 4
Pr (ready transfer when assessed)	0.63	0.63	0.7	0.63	0.7	0.63
Not ready when assessed until ready for rehabilitation						
minimum, mode, maximum	1, 1, 14	1, 1, 14	1, 1, 14	1, 1, 14	1, 1, 14	1, 1, 14
Waiting for transfer to rehabilitation after ready						
minimum, mode, maximum	0, 1, 6	0, 0.75, 5	0, 0.75, 5	0, 0.5, 4	0, 0.5, 4	0, 1, 6
Inpatient rehabilitation to discharge barriers						
Pr (discharge barrier)	0.164	0.164	0.164	0.164	0.10	0.20
Rehabilitation LOS if no discharge barrier						
minimum, mode, maximum	2, 9, 105	2, 9, 105	2, 8, 95	2, 9, 105	2, 7, 84	2, 9, 105
Non-weight bearing						
Pr (non-weight bearing) discharge barrier	0.34	0.34	0.34	0.34	0.34	0.16
minimum, mode, maximum	14, 38, 100	14, 30, 80	14, 30, 80	7, 14, 21	7, 14, 21	14, 38, 100
Family negotiations						
Pr (family negotiations) discharge barrier	0.13	0.13	0.13	0.13	0.13	0.18
minimum, mode, maximum	2, 21, 60	2, 19, 50	2, 19, 50	2, 14, 40	2, 14, 40	2, 24, 69
Accommodation						
Pr (accommodation) discharge barrier	0.12	0.12	0.12	0.12	0.12	0.17
minimum, mode, maximum	5, 14, 60	5, 12, 50	5, 12, 50	5, 9, 40	5, 9, 40	5, 16, 69
Equipment and home modifications						
Pr (equipment and home modifications) discharge barrier	0.13	0.13	0.13	0.13	0.13	0.18
minimum, mode, maximum	3, 18, 180	3, 15, 145	3, 15, 145	3, 12, 120	3, 12, 120	3, 21, 207
Approval & waiting for nursing home						
Pr (approval & waiting for nursing home) discharge barrier	0.07	0.07	0.07	0.07	0.07	0.12
minimum, mode, maximum	17, 30, 86	17, 24, 70	17, 24, 70	10, 20, 57	10, 20, 57	17, 35, 99
Carer funding, recruitment and training						
Pr (carer) discharge barrier	0.1	0.1	0.1	0.1	0.1	0.15
minimum, mode, maximum	5, 28, 120	5, 22, 100	5, 22, 100	5, 19, 80	5, 19, 80	5, 32, 138
Other barriers						
Pr (other barriers) discharge barrier	0.11	0.11	0.11	0.11	0.11	0.04
minimum, mode, maximum	1, 8, 45	1, 7, 36	1, 7, 36	1, 5, 30	1, 5, 30	1, 8, 45

Pr: probability; LOS: length of stay.

publications (12, 13). Table II shows the stages of care that patients progress through (transition states), the values used for the parameters in the Pert distributions for the baseline model and the hypothetical scenarios, the probability of various barriers occurring, and the corresponding results from our previous studies. These values are the basis for generating the modelling parameters. The parameters for the Pert distributions for the hypothetical scenarios were based on the premise that it is feasible to develop programmes, strategies or alternative models of patient care that target the barriers identified to provide a more efficient care pathway. Practical examples of how these hypothetical scenarios could be operationalized by systems redesign programs that improve processes are presented in Table III.

There were a number of assumptions made in generating the above scenarios. When acute hospital patients were assessed earlier in the hypothetical scenarios the assumption was made that the probability they are ready for transfer was unchanged or improved. This is based on the assumption that the earlier involvement of rehabilitation professionals in the patient journey will improve the chance of a patient being ready for rehabilitation sooner (30); and that there was no change in the distribution values for the "not ready when assessed until ready for rehabilitation" waiting period.

Data analysis

The median and interquartile range (IQR) was calculated for the outcomes generated by the baseline model and for the hypothetical scenarios. The Wilcoxon Mann-Whitney test was used to compare the distribution of the baseline model population with the various hypothetical scenarios and the effect size for the differences was calculated using recommended methods for non-parametric analysis (31). The percentage of the acute and rehabilitation hospital LOS patients spend waiting for transfer into or discharge from rehabilitation have been proposed as key performance indicators of rehabilitation patient flow (24) and these were calculated from the data generated. The 2-sample test of proportions was used to compare the baseline model proportions with those in the hypothetical scenarios. *p*-values less than 0.05 were deemed statistically significant.

The Monash Health and Monash University Human Research and Ethics Committees approved the project. The simulation model and

Table III. *Practical examples of how hypothetical scenarios could be operationalized in clinical practice and changes programs*

Scenario	Practical suggestions for operationalization of hypothetical scenarios
Acute hospital process barriers	
Acute hospital admission till referral	Systematic approach to raising awareness of acute hospital teams to commence the discharge planning processes immediately after admission. This would also include processes to improve the recognition of patients potentially requiring rehabilitation, either inpatient or ambulatory, and the improvement of rehabilitation services in acute hospitals, including assessment and inreach programmes.
Referral till assessment by rehabilitation team	Improved rehabilitation assessment staffing and organization of assessment services in acute hospital.
Waiting for transfer to rehabilitation after ready	Improved rehabilitation bed access through the development of "flexible" bed numbers and addressing barriers to rehabilitation discharge. Additional funding for increased number of rehabilitation inpatient beds may also be cost-efficient.
Inpatient rehabilitation barriers	
Rehabilitation length of stay	Improve inpatient rehabilitation team and systems processes. These include the following: increase the intensity of rehabilitation therapy, implement evidence-based practice; improve work practices and organizational management, including dealing with complexity and fragmentation of care, team processes and goal setting; the length of decision cycles and discharge coordination.
Non-weight bearing	Development of alternate level of care that meets patient care and therapy needs at a lower cost than the intensity provided in rehabilitation units until patient able to able to start weight-bearing.
Family negotiations	Formal staff training on dealing with difficult families and uncertainty in discharge planning. Develop strategies to identify potentially challenging discharge planning situations earlier in the patients' hospital admission, including in acute hospital, and implement strategies to initiate discussions involving experienced staff with the patient and family sooner.
Accommodation	Involve government housing, social services and health departments as well as community-based non-governmental organizations providing accommodation in development of interim and long-term housing options specifically designated towards hospital patients who are unable at return home. Insurance and compensation companies may also have a role in this area.
Equipment and home modifications	Involve government disability and health departments in the development of improved access in terms of timeliness and scope of cover for providing these needs for hospitalized patients where they are necessary for discharge. Explore alternative models of funding and re-imbursement, including co-payment, deferred payment and low/zero interest loans to patients and their families to cover the costs. Develop a dedicated team of architects, draftsmen, and tradespeople to perform home modifications to for hospital patients in a timely way on a regional basis. Insurance and compensation companies may also have a role in this area.
Approval and waiting for nursing home	Develop systems and processes to improve the timeliness of the approval process required for services and care, including nursing home access. Allow for the earlier referral and approval for patients still in active rehabilitation for whom it is obvious that nursing home will be required.
Carer funding, recruitment and training	Involve government disability and health departments in the development of improved access in terms of timeliness and scope of cover for providing these needs for hospitalised patients where they are necessary for discharge. Explore alternative models of funding and re-imbursement, including co-payment, deferred payment and low/zero interest loans to patients and their families to cover the costs. Insurance and compensation companies may also have a role in this area.

Table IV. *Key outcomes from previous results, the model baseline and hypothetical alternatives scenarios*

Variable	Results from previous studies (12, 13)	Baseline model	Major improvements	Major improvements plus	Extreme improvements	Extreme improvements acute hospital admission to referral only	Extreme improvements waiting for transfer to rehabilitation only	Extreme improvements for rehabilitation length of stay only	Extreme improvements for non-weight bearing only	Extreme improvements for family negotiations only	Extreme improvements for accommodation only	Extreme improvements for home modifications and equipment only	Extreme improvements plus	Deteriorated
Acute hospital total LOS, days, median (IQR)	12 (7–19)	12 (8–17)[a]	11 (7–16)	11 (7–16)	10 (7–15)	10 (7–14)	11 (7–16)						8 (5–12)	
Acute hospital waiting for rehabilitation, days, median (IQR)	1 (0–3)	1 (1–2)[b]	1 (1–2)	1 (1–2)	1 (0.5–1.5)		1 (0.5–1.5)						1 (0.5–1)	
Rehabilitation hospital total LOS, days, median (IQR)	23 (15–49)	24 (13–41)[c]	24 (13–33)	22 (12–37)	23 (13–38)			23 (10–33)	23 (13–39)	24 (13–41)	24 (13–41)	24 (13–40)	17 (10–29)	25 (13–44)
Duration rehabilitation discharge barriers, days median (IQR)	34 (14–56)	37 (23–57)[d]	31 (20–46)	31 (19–45)	17 (13–29)			37 (22–56)	22 (14 –40)	35 (21–56)	36 (20–55)	36 (21–54)	17 (12–30)	40 (26–62)
Proportion of acute hospital LOS waiting for transfer to rehabilitation; %	12.0	13.1[e]	11.2	11.2	10.8		8.3						8.9	
Proportion of rehabilitation hospital LOS waiting for discharge; %	21.0	21.8[f]	19.7	18.1	13.0			25.3	16.5	20.6	20.7	20.4	10.4	28.6

[a]Wilcoxon Mann-Whitney test, difference compared with baseline: major improvements $p < 0.0001$, $Z = 9.5$, $r = 0.05$; major improvements plus $p < 0.0001$, $Z = 14.2$, $r = 0.18$, extreme improvements $p < 0.0001$, $Z = 21.2$, $r = 0.12$; extreme improvements acute hospital admission to referral only $p < 0.0001$, $Z = 27.8$, $r = 0.16$; extreme improvements waiting for transfer to rehabilitation only $p < 0.0001$, $Z = 10.2$, $r = 0.06$; extreme improvements plus $p < 0.0001$, $Z = 52.2$, $r = 0.30$.

[b]Wilcoxon Mann-Whitney test, difference compared with baseline: major improvements $p < 0.0001$, $Z = 27.5$, $r = 0.16$; extreme improvements $p < 0.0001$, $Z = 58.2$, $r = 0.34$; extreme improvements waiting for transfer to rehabilitation only $p < 0.0001$, $Z = 58.8$, $r = 0.34$.

[c]Wilcoxon Mann-Whitney test, difference compared with baseline: major improvements $p < 0.0001$, $Z = 10.5$, $r = 0.06$; major improvements plus $p < 0.0001$, $Z = 36.8$, $r = 0.21$, extreme improvements $p < 0.0001$, $Z = 26.6$, $r = 0.15$; extreme improvements for rehabilitation length of stay only $p < 0.0001$, $Z = 53.5$, $r = 0.31$; extreme improvements for non-weight bearing only $p < 0.0001$, $Z = 10.5$, $r = 0.06$; extreme improvements for family negotiations only $p = 0.003$, $Z = 3.0$, $r = 0.02$; extreme improvements for accommodation only $p = 0.8$. $Z = 0.1$, $r < 0.01$; extreme improvements for home modifications and equipment only $p < 0.0001$, $Z = 6.9$, $r = 0.04$; extreme improvements plus $p < 0.0001$, $Z = 81.2$, $r = 0.47$; deteriorated $p < 0.0001$, $Z = 23.9$, $r = 0.14$.

[d]Wilcoxon Mann-Whitney test, difference compared with baseline: major improvements $p < 0.0001$, $Z = 15.9$, $r = 0.09$; major improvements plus $p < 0.0001$, $Z = 39.4$, $r = 0.23$, extreme improvements $p < 0.0001$, $Z = 34.8$, $r = 0.20$; extreme improvements for rehabilitation length of stay only $p < 0.0001$, $Z = 23.2$, $r = 0.13$; extreme improvements for non-weight bearing only $p < 0.0001$; $Z = 38.5$, $r = 0.22$; Extreme improvements for family negotiations only $p < 0.0001$, $Z = 4.7$, $r = 0.03$; extreme improvements for accommodation only $p < 0.0001$, $Z = 14.8$, $r = 0.09$; extreme improvements for home modifications and equipment only $p < 0.0001$; extreme improvements plus $p < 0.0001$, $Z = 41.6$, $r = 0.24$; deteriorated $p < 0.0001$, $Z = 41.5$, $r = 0.24$.

[e]Two-sample test of proportions compared with baseline model: 2-sample test of proportions compared with baseline model: major improvements, major improvements plus, extreme improvements, extreme improvements waiting for transfer to rehabilitation only and extreme improvements plus all $p < 0.0001$.

[f]Two-sample test of proportions compared with baseline model: major improvements, major improvements plus, extreme improvements, extreme improvements for rehabilitation length of stay only, extreme improvements for non-weight bearing only, extreme improvements plus, and deteriorated all $p < 0.0001$; extreme improvements for family negotiations only and extreme improvements for accommodation only $p = 0.02$; extreme improvements for home modifications and equipment only $p = 0.003$.

LOS: length of stay; IQR: interquartile range.

hypothetical scenarios were run using the agent mode of Anylogic 6.9 (Anylogic 2007, XJ Technologies, Office 410, 49 Nepokorennykh pr. 195220, St. Petersburg, Russian Federation). Stata version 12 (StataCorp, College Station, TX, USA) was used for statistical analysis.

RESULTS

The outputs of the computer simulation of the baseline model and hypothetical scenarios, with corresponding comparisons to the results from our previous studies used for generating the model (12, 13), are presented in Table IV. This includes the results for the LOS in acute and rehabilitation hospitals and the key wait states (waiting for transfer from acute hospital to rehabilitation and the duration of discharge barriers) as well as the proportion of acute LOS waiting for transfer to rehabilitation and the proportion of rehabilitation LOS with a discharge barrier. The "extreme" series of hypothetical improvement scenarios show the results for only the parameter mentioned in the column or for those influenced by the parameter altered.

Almost all hypothetical scenarios resulted in significant changes in the LOS or duration in the various states, compared with the baseline. The effect size for the changes was typically small to medium (Cohen's suggested guidelines: $r = 0.1$, small; $r = 0.3$, medium, and $r = 0.5$, large) (27).

The acute hospital LOS and the waiting time in acute hospital for transfer to rehabilitation values had significant reductions compared with baseline for all hypothetical scenarios. The rehabilitation LOS had significant reductions for all scenarios except for "extreme improvements for accommodation only". The duration of the rehabilitation discharge barriers had significant changes for all hypothetical scenarios. The effect size was much smaller when changes were made to a single barrier. Correspondingly, the effect size was larger when multiple barriers were changed simultaneously.

The proportion of acute hospital LOS waiting for transfer to rehabilitation improved for all hypothetical scenarios. The proportion of rehabilitation LOS waiting for discharge improved for all scenarios except for "rehabilitation LOS independent of any discharge barrier". The reason for the deterioration in this outcome for this scenario was because no changes occurred to discharge barriers, but the efficiency of the rehabilitation process was improved, giving a higher proportion of unnecessary time in hospital.

DISCUSSION

This paper describes the development of a computer model that simulates the hospital processes for rehabilitation patients moving through the acute and rehabilitation hospital system, which generates outputs that include the LOS in these 2 settings. We used this model to estimate the potential LOS improvements from hypothetical care pathways that address the important process delays for patients. These scenarios are contrasted with the baseline state and a worsening scenario.

Although almost all of the scenario changes were statistically significant, signifying differences in the distributions, the median values in many cases were not appreciably different (for example the extreme improvement scenarios with only a single parameter changed). These results reinforce the need for care among researchers and hospital administrators when planning and evaluating outcomes from process improvements targeting LOS. Because LOS is not normally distributed, but right skewed, descriptions of LOS should utilize measures of distribution as well as measures of central tendency, such as mean or median LOS (24, 32). Our simulations, involving cohorts of 15,000 patients illustrate that simply looking at LOS outcomes for a relatively small numbers of patients with such widely distributed LOS may give a false impression of the absence of significant change when there actually may be a significant effect present. The reverse could also occur.

The results of the hypothetical scenarios illustrate that it is important to address multiple barriers simultaneously as part of process improvement projects in order to maximize the improvement in hospital LOS and patient flow. Not surprisingly, scenarios that improved a single process had a much smaller effect size compared with those targeting multiple processes. It is important to emphasize that the model and simulations presented here are a tool to illustrate potential outcomes from hypothetical changes. It is not possible to use our findings to specify how resources should be allocated in order to address process barriers or what are the best combinations of barriers to address first. In each hospital this will need to be informed by the actual specific barriers that are responsible for the greatest delays and the cost and ease of addressing the barriers. Approaches to consider when developing strategies to address discharge and process barriers have been proposed (12).

Information generated by our model can potentially be used by clinicians, hospital management, government and other healthcare funders to guide the development of alternative models of care that improve patient flow, and subsequent patient outcomes, as well as hospital access for other patients and the overall efficiency of healthcare resource utilization. Our model could be combined with health system costs and estimates of the costs involved with funding the hypothetical scenarios to generate cost-benefit analyses.

Implications of this project are that the potential of modelling in rehabilitation for facilitating improvements in health service research and redesigning models of care and service delivery needs to be recognized and acted upon by a greater number of people involved in these activities. Furthermore, it can be seen that addressing both acute hospital and rehabilitation process barriers enhances the potential improvement in patient flow.

This project was limited by the use of data for designing the model from 2 inpatient rehabilitation units in Melbourne, Australia, collected in 2008–2009 and the use of a single modelling method. The process barriers in acute hospital and barriers to discharge from rehabilitation used in the model are based on results from our previous studies. These barriers were also reported as common in a survey of other rehabilitation units in Australia (11) as well as in 10 spinal rehabilitation units in different countries (33). We therefore assert that the principals underpinning our model and simulation are generalizable to

other settings, both in Australia and internationally, although the exact duration of the delays will no doubt vary from 1 setting to another. Although the specific durations of the process and discharge barriers will vary in other settings, the critical issue is that the underlying principals are the same and that the potential of computer modelling to facilitate heath system improvements is generalizable.

We have listed the assumptions made for the baseline model and hypothetical scenarios. It is important to emphasize that even if more time and effort was spent on developing a more complex model, this would not necessarily improve the validity of the model in a cost-effective way, as any model only needs to be as detailed and complex to perform the objectives for which it was designed (19). Furthermore, it is important to note that the outcomes from the real-world health systems and simulations are non-stationary (distributions of successive observations vary with time) and that they are auto-correlated (outcomes from processes are correlated with each other).

The model developed in this study used a single-method and single-paradigm approach. Alternative mixed-modelling methods using multi-paradigms, additional states, and developed using a wider range of stakeholders would enable a more complex model to be developed that could allow a wider range of scenarios to be considered.

The major strength of the model developed in this study is that it has the potential to use a more comprehensive range of data collected prospectively and combined with process improvement programs to address barriers to patient flow. In this way it would be possible to test hypothetical improvements in a simulation and then assess these against achievements in a series of "plan-do-study-act" activities. By doing this the simulation model can be developed and integrated to run in parallel to routine clinical care as a part of continuous improvement processes. Collecting data dynamically and using this to refine simulation models, while at the same time informing system changes to optimize patient flow, has potential to improve health system efficiency enormously (16).

In conclusion, health system modelling is useful in providing the likely magnitude and direction of potential improvements in LOS by addressing barriers affecting rehabilitation patient flow. Information from modelling can be used to guide reforms directed at improving patient flow in hospital and associated cost benefit analyses.

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6.3 Chapter 6: Summary

This chapter has described the development of a computer model that simulates the hospital processes for rehabilitation patients moving through the acute and rehabilitation hospital system which generates outputs that include the LOS in these two settings. The model was used to estimate the potential LOS improvements from hypothetical care pathways that address the important process delays for patients. These scenarios are contrasted with the baseline state and a worsening scenario.

The results of the hypothetical scenarios illustrate that it is important to address multiple barriers simultaneously as part of process improvement projects in order to maximize the improvement in hospital LOS and patient flow.

Information generated by the model can potentially be used by clinicians, hospital management, government and other health care funders to guide the development of alternative models of care that improve patient flow, and subsequent patient outcomes, as well as hospital access for other patients and the overall efficiency of health care resource utilization. The model could be combined with health system costs and estimates of the costs involved with funding the hypothetical scenarios to generate cost-benefit analyses.

7 CHAPTER SEVEN: CONCLUSION

"Now this is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning."

Sir Winston Churchill, November 1942

7.1 Chapter 7: Introduction

The aim of this chapter is to highlight the key findings and outputs from the program of research conducted for this thesis, examine how the findings have influenced the field, discuss the limitations, explore the implications of the findings and outline potential future directions of research on this topic.

This thesis used a range of research methodologies to study patient flow through inpatient rehabilitation. There was a specific focus on barriers to the flow of patients from acute hospital through to inpatient rehabilitation and subsequent barriers to discharge. It makes new contributions to the field and provides a foundation upon which further research can explore problems with rehabilitation patient flow and investigate solutions.

7.2 Key findings and outputs of thesis

The thesis outputs included a definition of barrier to discharge from inpatient rehabilitation and a classification system of the major causes of barriers to discharge (aim one). [117] These were developed in an iterative, multi-disciplinary process. To facilitate research in this area the thesis also developed recommendations for KPIs for rehabilitation patient flow which were based on an Australia-wide survey of key stakeholders (aim two). [117] The above were both detailed in chapter two.

In chapter three an Australia-wide survey of key stakeholders in sub-acute patient flow highlighted that many had the perception that there are major problems with barriers to the timely transfer of acute hospital patients into sub-acute care and barriers to discharge from sub-acute care, with the problems facing rehabilitation believed to be worse than those for aged-care (aim three). [118]

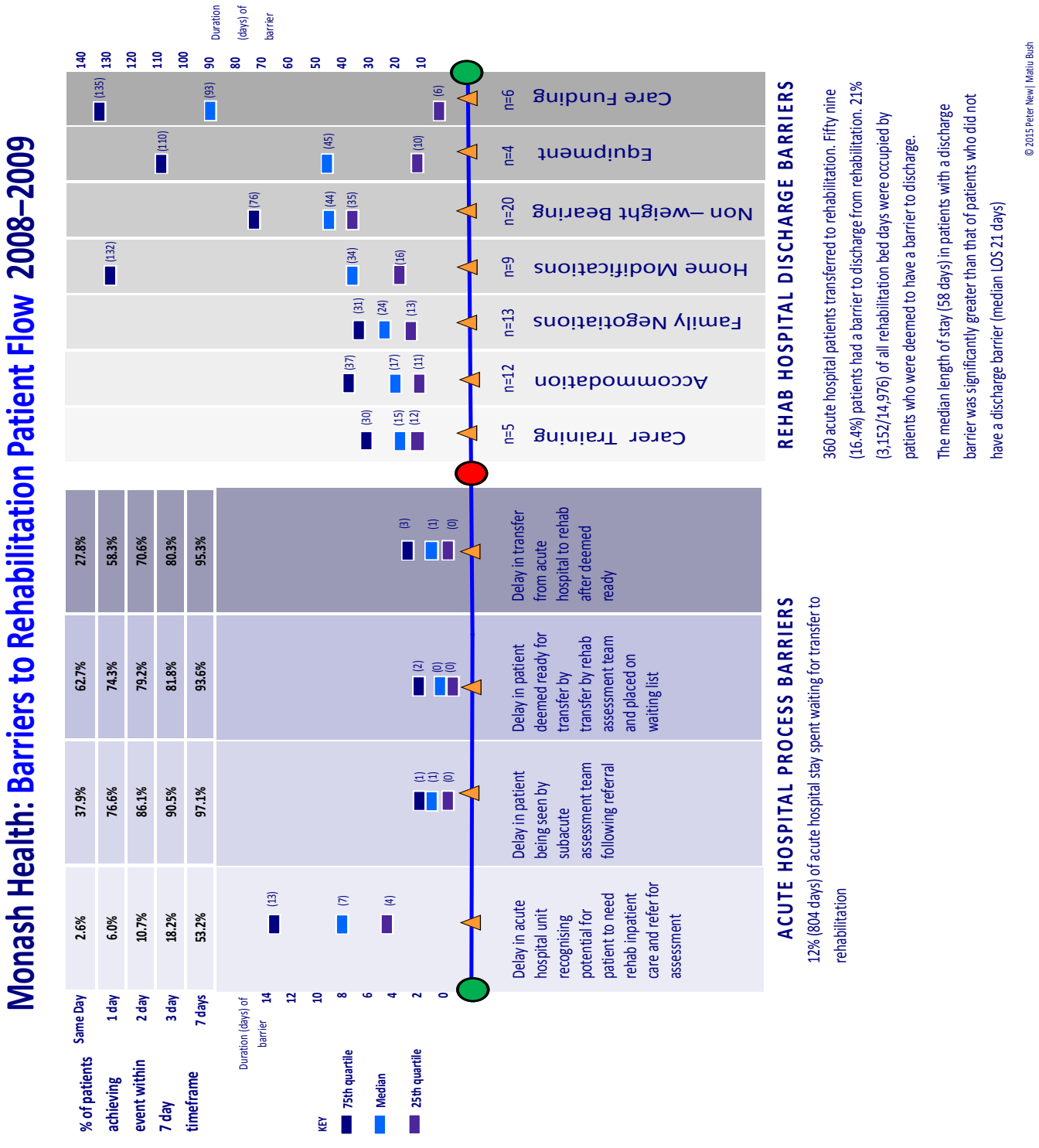
The key processes in the acute hospital patient journey for rehabilitation patients were reported in a retrospective cohort study in chapter four (aim four). [119] This work used some of the KPIs reported in chapter two. The main process delays for acute hospital patients needing inpatient rehabilitation were the time from acute hospital admission until referral for rehabilitation and the waiting for a rehabilitation bed after the patient had been deemed ready for transfer. A notable proportion of the acute hospital admission was spent waiting for a rehabilitation bed.

Using the definition of discharge barrier and classification of the causes (presented in chapter two) a prospective cohort study was detailed in chapter five which reported on the frequency of discharge barriers and the main causes (aim five). [120] Over a fifth of rehabilitation bed-days had a barrier to discharge.

Figure 2 summarises the key process barriers for rehabilitation patients in acute hospitals, the main discharge barriers from rehabilitation, as well as the key results from the studies presented in chapters 4 and 5.

Chapter six describes the development of a computer model that simulates the acute and rehabilitation hospital LOS for rehabilitation patients (aim 6). [121] The model utilised the rehabilitation discharge barriers classification and KPIs developed in chapter 2 and was informed by the findings presented in chapters four and five. The computer model of LOS was then used to simulate the changes in the acute and rehabilitation LOS and the major waiting periods that patients faced during their hospital admission from a number of hypothetical scenarios that simulated alternative care pathways.

Figure 2. Illustration of rehabilitation patient flow at Monash Health - the key process barriers in acute hospital for rehabilitation patients and the main discharge barriers from rehabilitation.



7.3 How my research has influenced the field?

Although the findings presented in this thesis have only recently been published they have already had an influence on the field. This is reflected in a number of ways, as detailed below. In summary, the findings have been used by others interested in rehabilitation patient flow research and quality improvement projects, the publications have been cited in other manuscripts, as well as being the subject of a 'letter to the editor' (Appendix 4.2). [122]

The research outputs from this thesis have been used by a number of clinicians, researchers and project officers to inform and assist in local projects on rehabilitation and aged-care patient flow. In particular, the outputs that have been used by others are the KPIs for patient flow, the definition and classification of discharge barriers and the survey of key stakeholders. The use of these to further progress research into patient flow is an important step in advancing this field and illustrates the influence that the program of research contained in this thesis has had. In addition, other clinicians and researchers have contacted the PhD candidate for discussion and advice regarding different aspects of studying barriers to rehabilitation patient flow and indicated that they are considering projects that will utilise the thesis outputs. Examples of uses of thesis outputs in other settings include the following:

- The current version of the AROC dataset (version 4; http://ahsri.uow.edu.au/content/groups/public/@web/@chsd/@aroc/documents/doc/uow126283.pdf) that is used to collect data from almost all public and private inpatient rehabilitation hospitals in Australia [85] was revised and finalised during the time that this thesis was carried out. The revised dataset included for the first time items on process barriers for admission into rehabilitation and barriers to discharge from inpatient rehabilitation. The candidate, amongst many others, provided feedback to AROC regarding suggested changes to be included in the revision. Work from this thesis was included in feedback provided, specifically including the definition and classification of discharge barriers as well as the survey of key stakeholders publications. This added to the information available to AROC from which they developed the revised dataset that included the new items on barriers to rehabilitation patient flow (Personal communication, Frances Simmonds, Director Australasian Rehabilitation Outcomes Centre).
- Caulfield Hospital (Alfred Health, Victoria) conducted a point-prevalence survey at in February 2013 across 6 sub-acute inpatient wards (3 rehabilitation and 3 Geriatric Evaluation and Management)

using the classification and definition of discharge barriers, and further use was planned (Personal Communication Ms Shai Bynon, Manager, Clinical Innovations & Interdisciplinary Projects).

- Brighton Rehabilitation Hospital (Brighton, Queensland) used the definition of discharge barriers and classification in a prospective study conducted over 4 months during 2014 as part of a process improvement/research project (Personal communication Raj Singh, Senior physiotherapist).
- McKellar Centre (Barwon Health, Geelong, Victoria) used the definition and classification of discharge barriers in a prospective study of patients admitted into five sub-acute wards (two Geriatric Evaluation and Management wards and three rehabilitation wards: neuro-rehabilitation, Acquired Brain Injury-trauma and orthopaedic) during 2014 (neuro-rehabilitation ward for 12 months, the other wards for 6 months). This project was conducted as part of a process improvement project/research project, with funding provided by the Victorian Health Department (Personal communication, Dr Michael Bennett, Senior Staff Specialist in Rehabilitation Medicine, McKellar Centre).
- A survey of the perception of the severity and causes of barriers to discharge of acute and rehabilitation hospital patients was conducted using the questions I developed for my survey at a NSW hospital and subsequently presented as a poster at the Australasian Faculty of Rehabilitation Medicine annual scientific meeting. (Personal communication, Dr Elizabeth Thompson, Rehabilitation Physician, South Eastern Sydney Local Health District)
- Ms Heather Flett (Rick Hansen Institute, Vancouver, BC, Canada) used the discharge barrier classification in a presentation “Reasons for extending length of stay in inpatient spinal cord rehabilitation”, International Spinal Cord Society Annual Scientific Meeting, 5/9/2012, London UK (requested via email in previous correspondence prior to publication).
- Brain Injury Rehabilitation Unit, Hampstead Rehabilitation Centre (Adelaide, South Australia) indicated an intention to use the definition and classification of discharge barriers in a prospective study in 2015 (Personal communication, Ms Alexandra Totani, Clinical Service Coordinator).

The papers published as part of this thesis have already been cited by a number of authors in their articles. As of June 2015, the publications have been cited as follows:

- Defining barriers to discharge from inpatient rehabilitation[117]: 8 citations
- Key stakeholders’ perception of barriers to admission and discharge[118]: 8 citations

- Reducing the length of stay for acute hospital patients needing admission into inpatient rehabilitation[119] : 4 citations
- A prospective multicentre study of barriers to discharge from inpatient rehabilitation[120]: 8 citations

7.4 Key Strengths and Limitations

The strengths and limitations of each publication included in this thesis are discussed in the relevant sections of each manuscript. This section presents the broader strengths and limitations of this thesis.

A key strength of the research presented in this thesis is that it addresses key knowledge gaps in the field that were identified by the literature review presented in the introduction chapter. In particular, the development of a definition and classification of barriers to discharge from rehabilitation as well as KPIs for barriers to rehabilitation patient flow. In addition, no studies had been identified that specifically measured the nature and magnitude of barriers to rehabilitation flow, from either acute hospital into rehabilitation or from inpatient rehabilitation, or the impact of these barriers to rehabilitation flow on hospital LOS.

7.4.1 Limitations

There are a number of limitations to the work presented in this thesis that need to be acknowledged. The development of the definition and classification of rehabilitation discharge barriers involved a selection of senior clinicians working at two sub-acute hospitals in Victoria. Although a few experts from other States in Australia were asked to provide constructive feedback, it is uncertain how generalizable the definition and classification is to other States in Australia or to other countries. However, direct contact with clinicians in other States who have used these or are planning on using these, as mentioned above, as well as informal discussion with colleagues at conferences where this work has been presented (detailed in the 'Associated publications and presentations' section), have indicated to the candidate that there is broad agreement with the KPIs, definition and classification of rehabilitation discharge barrier.

It is also relevant to highlight, as mentioned in the relevant discussion sections of the publications in chapter 4 and 5, the data collected on process barriers for acute hospital patients admitted to rehabilitation was collected retrospectively and the data on this and barriers to discharge were collected from two

rehabilitation wards in the same Network. There is no doubt that different results would be obtained from other rehabilitation hospitals, and that private rehabilitation hospitals would be expected to have very different findings. It would also be expected that there would also be differences for different speciality stream of rehabilitation patients, for example those with spinal cord damage (see Appendix 3), acquired brain injury or limb amputation. There may also be differences between major metropolitan rehabilitation units compared with regional units, although any differences will in part also be a reflection of differences in specialisation. Another limitation is that the data used in this thesis was collected during 2008 and 2009. It is not know to what extent the findings presented here have changed in the intervening period.

This thesis focused on process barriers to patient flow from acute hospital to inpatient rehabilitation and barriers to discharge from inpatient rehabilitation. The need for this focus meant that a number of important areas were not included in the program of research that are relevant to a complete understanding of this complex area. Although the causes of barriers to discharge from inpatient rehabilitation were studied in detail, the causes for the delay in transfer of patients from acute hospital into rehabilitation after they were deemed ready were not studied, nor was there any attempt to study the situation where patients were deemed ready and appropriate for rehabilitation but were instead transferred to an aged-care bed (as can occur). In addition, patients in acute hospital who were discharged to an ambulatory rehabilitation program, whether as the initial recommendation or as a result of a delay in been transferred to inpatient rehabilitation, were not also included in this thesis. There most certainly would be barriers for these patients accessing appropriate rehabilitation services in a timely manner that could be improved.

It is vital to also point out that the research program of this thesis did not consider opportunities for improving patient flow during the process of inpatient rehabilitation. During the course of working on this thesis the PhD candidate has been involved with 2 major process improvement projects that focused on improving the inpatient rehabilitation processes to reduce LOS without compromising patient care or key patient-centred outcomes, such as disability at discharge or discharge into the community, at two health Networks in Melbourne he has clinical appointments (Alfred Health and Monash Health). Although the results of these projects have unfortunately not been published in peer-reviewed journals (the candidate is planning a manuscript on one of these projects), internal evaluation has shown reductions in the rehabilitation LOS of approximately 15-20% across both organisations. It is believed that these process

improvements can be generalised to other settings and that further reductions in the rehabilitation LOS can be achieved without compromising patient outcomes.

7.5 Implications of findings and suggestions for future research

The implications of findings and suggestions for future research from each study that are included in this thesis are discussed in the relevant manuscripts. This section outlines the most important broader implications and suggestions.

This thesis has identified problems with rehabilitation patient flow in Monash Health, the largest health Network in Victoria. Based on the survey of key stakeholders for subacute patient flow in Australia presented in chapter 3, [118] and recent survey of spinal rehabilitation units from 10 countries (Appendix 3.1)[4] it is strongly believed that problems with rehabilitation patient flow are not unique to Monash Health but are generalizable to many other settings, both in Australia as well as in other countries. It is important that greater effort is spent on measuring barriers to rehabilitation patient flow in order to identify opportunities for improvement. Future research projects on rehabilitation patient flow are needed to study these problems in a range of settings, both in Australia and other countries, and involving some of the more challenging specialty streams of rehabilitation. It is hoped that the addition of variables concerning barriers to rehabilitation patient flow in the Australasian Rehabilitation Outcomes Centre dataset will facilitate future research projects.

With population aging in coming decades the population aged over 65 years is predicted to double by the year 2051. [10] When this thesis commenced the Australasian Rehabilitation Outcomes Centre annual report for the preceding year, 2008, reported just over 60,000 inpatient episodes of care for adults. [85] The most recent Australasian Rehabilitation Outcomes Centre data available (for the year 2013) reported over 100,000 inpatient episodes. [86] This is more than double the rate of increase in acute hospital admissions. [17] An important implication of this thesis is that concerted efforts are needed to optimise the hospital LOS for patients so that it is as short as necessary in order to optimise patient flow. In particular, it is important not to neglect rehabilitation patients in this improvement process.

Addressing barriers to discharge is particularly complex. Doing this successfully in Australia will necessitate cooperation and agreements between the State and Federal Governments as well as between numerous departments within each level of government. In particular, improvements are needed between the Health Departments and those responsible for disability (for both younger aged people as well as those aged over 65 years) and housing. It is uncertain what impact the National Disability Insurance Scheme will have on barriers to discharge from inpatient rehabilitation, but there is certainly an opportunity for this scheme to have a positive benefit.

Suggestions for future research include whether the integration of dynamic monitoring of KPIs for patient flow into 'real-time' bed access can be used to improve patient flow. For example, by way of a 'sub-acute dashboard' that is accessible on hospital computers by senior clinicians and managers. A more ambitious research project would be to explore the potential for computer modeling to be used in conjunction with the prospective collection of data on barriers to rehabilitation patient flow and a comprehensive range of clinical, demographic, and social variables. These inputs could be utilized in process improvement programs to address barriers to patient flow. It would be possible to test hypothetical improvements in a simulation modelling and then assess these against achievements in a series of 'plan-do-study-act' activities. Collecting data dynamically and using this to refine simulation models while at the same time informing system changes to optimize patient flow may potentially improve health system efficiency enormously.

7.6 Summary of conclusion chapter

This chapter has reflected on the key outputs of the program of research completed as part of this thesis, the influence that these have had had on the field, the key strengths and limitations as well as implications and future directions of research regarding rehabilitation patient flow.

Similar to other components of the healthcare system rehabilitation has many potential barriers to optimal patient flow. In this thesis the major barriers to rehabilitation patient flow have identified, classified and described. In addition, potential solutions and areas for further research have been identified.

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9 APPENDICES

9.1 Appendix 1: Ethics approvals

[redacted]

Southern Health

246 Clayton Road
Clayton, Victoria 3168
Australia

Postal address:
Locked Bag 29
Clayton South, Victoria 3169
Australia

tel 03 9594 6666
fax 03 9594 6727

Research Directorate

Level 4, Main Block
246 Clayton Rd, Clayton, 3168

Tel (03) 9594 4611
Fax (03) 9594 6306

28 May 2008

Dr Peter New
Head Rehabilitation
Kingston Centre
Warrigal Road
Vic 3192

Dear Dr Peter New,

Re: Prospective Study of Discharge Barriers for Sub-Acute Inpatients at Southern Health

Thank you for your email dated 15 May 2008. It is our understanding that this project is a quality assurance exercise involving collection, use and disclosure of data in a de-identified format. As such, we advise that it does not raise any ethical concerns and does not fall within the category of a 'research' project within the *National Statement on Ethical Conduct In Human Research* (NHMRC, 2007). This project does not require submission to the Human Research Ethics Committee. In addition, this quality assurance activity can be described as an activity to monitor, improve and evaluate the quality of health services provided by Southern Health.

Should you have any queries please contact me.

Yours sincerely

[redacted]

DEBBIE DELL
Administrative Officer
Research Support Unit

Cc: Ms J Moorfoot, Quality Director

Southern Health

ABN 82 142 580 338

Dandenong Hospital
Kingston Centre
Cranbourne Integrated Care Centre

Monash Medical Centre
Casey Hospital

www.southernhealth.org.au

Community Health Services across the South East

Southern Health

246 Clayton Road
Clayton, Victoria 3168
Australia

Postal address:
Locked Bag 29
Clayton South, Victoria 3169
Australia

tel 03 9594 6666
fax 03 9594 6727

Research Directorate

Level 4, Main Block
246 Clayton Rd,
Clayton, 3168

Tel (03) 9594 4611
Fax (03) 9594 6306

20 October 2009

Dr Peter New
Head of Unit, Rehabilitation
Continuing Care Sector
Kingston Centre
Warrigal Road
Cheltenham VIC 3192

Dear Researcher,

Research Project Application No. 09283Q: A Web-based Survey of Perceived Barriers to Admission and Discharge from Inpatient Sub-Acute Care

Thank you for your email dated 15 October 2009. It is our understanding that this project is a quality assurance exercise involving collection, use and disclosure of data in a de-identified format. As such, we advise that it does not raise any ethical concerns and does not fall within the category of a 'research' project within the *National Statement on Ethical Conduct In Human Research* (NHMRC, 2007). This project does not require submission to the Human Research Ethics Committee. In addition, this quality assurance activity can be described as an activity to monitor, improve and evaluate the quality of health services provided by Southern Health.

Should you have any queries please contact me.

Yours sincerely

[redacted]
Administrative Officer
Research Support Unit

Cc: Ms Cindy Hawkins, Quality Director

Monash University Human Research Ethics Committee (MUHREC)
Research Office

20 May 2010

Dr Peter New
Head Rehabilitation
Kingston Centre
Warrigal Rd
Cheltenham 3192 VIC

Dear Dr New,

Re: Projects involving human participants

1. **Study of the waiting time for admission to specialist spinal cord injury rehabilitation inpatient rehabilitation program and subsequent causes and impact of barriers to discharge.**
2. **Prospective Study of Discharge Barriers for Sub-Acute Inpatients at Southern Health**
3. **A Web-Based Survey of Perceived Barriers to Admission and Discharge from Inpatient Sub-Acute Care**

Thank you for the email dated 30 April 2010 in which you provided details of the above projects. This is to acknowledge that the work was already conducted as a low risk or quality assurance activity and had received the appropriate ethical approval from the Alfred Hospital HREC (project 1) or the Southern Health Research Directorate (projects 2 & 3).

Please contact me if you have any queries.

Yours sincerely,

[redacted]

Dr Souheir Houssami
Executive Officer, MUHREC

Postal – Monash University, Vic 3800, Australia
Building 3E, Room 111, Clayton Campus, Wellington Road, Clayton
[redacted]
www.monash.edu/research/ethics/human/index/html
ABN 12 377 614 012 CRICOS Provider #00008C

9.2 Appendix 2: Background publication

VIEWPOINT

Functional improvement of the Australian health care system — can rehabilitation assist?

Peter W New and Christopher J Poulos

ABSTRACT

- Strategies for managing increasing health system demand have focused on the acute sector and chronic disease management in the community, with little attention on the role of rehabilitation.
- There were over 53 000 inpatient rehabilitation episodes in Australia in 2006. We argue that rehabilitation can improve patient flow and outcomes in acute care if engaged early.
- The effectiveness of rehabilitation can be enhanced by increasing the intensity of therapy and developing models of rehabilitation that provide alternatives to inpatient care.
- Factors that reduce the efficiency of rehabilitation services include the location of many services in small, stand-alone hospitals without acute support; the lack of options for managing younger people with acquired disability in the community; and deficiencies in government programs for the supply of aids, equipment and home modifications.
- Improving the organisation of rehabilitation services should improve access to acute and rehabilitation inpatient beds, improve patient outcomes and reduce costs.

MJA 2008; 189: 340–343

Management of demand for services in public hospitals is a key challenge for the health care system. The situation will intensify with the ageing of Australia's population and increases in the prevalence of chronic disease and disability. Strategies to date have focused on the acute care sector,[1,2] reducing hospital attendances, post-acute support, and management of chronic disease in the community. The rehabilitation sector is generally seen as separate from the acute care system,[3,4] and there is relatively little focus on patient flow into and through rehabilitation, or on the secondary and tertiary prevention strategies that optimal rehabilitation intervention can offer. We feel that the lack of focus on rehabilitation is detrimental to our health care system.

Twenty per cent of Australians have a disability, and more than 6% of the population has a profound or severe core-activity limitation.[5] With an increasing proportion of older people living alone,[6] the ability to keep living in the community is often more dependent on functional independence than on medical factors, suggesting a role for rehabilitation.

Rehabilitation has been defined as "a health strategy ... that aims to enable people with ... disability to achieve and maintain optimal functioning in interaction with the environment".[7] In the context of this article, rehabilitation refers to the provision of multidisciplinary, medically directed services that aim to improve the functioning of an individual after illness or injury and that are evidenced by comprehensive assessment of function and realistic and negotiated goals.[8]

Here, we provide an overview of public rehabilitation services in the two most populous Australian states, New South Wales and Victoria, but many of the issues raised are likely to apply to the rest of the country. We highlight preventable systems factors that contribute to access block "upstream" in the acute care sector and exit block "downstream" in rehabilitation, and present possible solutions. The issues identified relate to people of all ages with disabilities.

Current rehabilitation services in NSW and Victoria

Data on over 53 000 inpatient rehabilitation episodes in Australia for 2006 were recently reported.[9] Most of these (39 168 [77.5%]) were in NSW and Victoria (Frances Simmonds, Manager, Australasian Rehabilitation Outcomes Centre, personal communication). Patients were mostly aged over 70 years, but about a fifth were aged under 65 years. More episodes from private hospitals were reported, but patients treated in the public sector tended to be more disabled. Most patients returned to living in the community after discharge. Rehabilitation has been described as the "glue" between the acute care and community sectors.[10]

Victoria and NSW are generally well served in the availability of public rehabilitation beds and rehabilitation physicians (1 per 62 000 and 1 per 46 000 people, respectively, at June 2008 [Rebecca Forbes, Senior Executive Officer, Australasian Faculty of Rehabilitation Medicine, personal communication] and calculated using Australian Bureau of Statistics estimates). In Victoria, most public rehabilitation beds are in stand-alone facilities, while in NSW, co-location with acute care facilities occurs more frequently. The trend over recent decades has been to re-allocate the role of small hospitals to that of subacute care, including rehabilitation, in an effort to satisfy the political imperative of keeping these hospitals open, while acknowledging that the provision of acute care in small facilities is no longer appropriate.

Ambulatory rehabilitation is generally more widely available in Victoria than in NSW, with the former offering comprehensive outpatient public rehabilitation programs and the availability of home-based rehabilitation, typically for 2–6 weeks.

Problems with the current organisation and delivery of rehabilitation services

System issues, funding and workforce constraints, and conflict between federal and state responsibilities[11,12] all contribute to reducing the positive potential of rehabilitation in the acute care hospital and community sectors. Critical factors are outlined below.

Provision of hospital-based care

Functional decline in patients secondary to inactivity is ubiquitous in acute care hospitals, resulting in prolonged recovery times. Systems are generally not in place to minimise this. Preventable complications, such as pressure ulcers,[13] falls, malnutrition[14] and contractures also affect outcomes and increase length of stay.

In acute care hospitals, rehabilitation services are often not engaged early enough to help prevent functional decline and

complications. Delays in obtaining rehabilitation assessments in acute care are common, due to delays in referral or in availability or responsiveness of the rehabilitation team.[15] Under-resourcing of allied health staff in some acute care hospitals results in patients receiving minimal therapy and discharge planning once they have been identified for rehabilitation or other subacute care. This contributes to functional decline and increases subsequent length of stay in subacute care.

As private rehabilitation capacity has expanded to target patients with predominantly single-system impairments (eg, elective orthopaedic conditions and milder strokes), the nature of public hospital rehabilitation has moved towards the management of older patients with multiple morbidities and general debility, often requiring ongoing interaction with the acute care system.

We question the appropriateness of providing inpatient rehabilitation services that are isolated from the back-up of an acute care facility — for efficiency, safety and workforce reasons. Acute care patients in need of rehabilitation must wait till they are medically stable before they can be transferred to a stand-alone rehabilitation facility, creating a hiatus in their care (both acute care and rehabilitation). When acute care and rehabilitation hospitals are not collocated, the elective transfer of patients from acute care to rehabilitation often takes place later in the day — effectively wasting a day by the time the admission process is completed. Interruptions to rehabilitation then occur if patients are transferred back to acute facilities for medical review or investigations. In stand-alone facilities, on-site after-hours medical rostering in an environment of workforce shortage is problematic and costly.

For some patients (eg, those who are non-weight-bearing for prolonged periods after lower-limb fractures or those awaiting home modifications), there is a lack of alternative care settings. This results in inappropriate admissions to rehabilitation or longer stays there.

Community-based rehabilitation

In NSW, the provision of public hospital outpatient and domiciliary allied health has not kept pace with the demands of an ageing population. While the Medicare system has expanded to cover community allied health (ordered by a general practitioner for eligible patients), rehabilitation providers cannot access these services even though they are in an ideal position to prescribe and coordinate such care.

Inpatient rehabilitation exit block for younger people

Little has been done to provide sufficient high-level care for younger people with severe, persistent, acquired disabilities (eg, acquired brain injury or spinal cord injury or damage) who no longer require rehabilitation and are not covered by compensation. There is a lack of options under state programs to accommodate these people, and the restrictions imposed by the federal government on younger people accessing residential aged care compound the problem. Therefore, these patients often wait in rehabilitation for many months until a suitable community solution can be brokered, or for placement — often, in spite of the government restrictions, in a residential aged care facility, after all other options have been exhausted. In NSW, the new Lifetime Care and Support Scheme (http://www.lifetimecare.nsw.gov.au) is seen as a positive step, but this is only available for people with catastrophic injury as a result of a motor vehicle accident.

Physiotherapist working with a young rehabilitation patient. ◆

The lack of funding for paid carers and the bureaucratic processes that restrict and delay the provision of home-based care result in patients being generally limited to 5–7 hours per week of personal care assistance at home. This results in stress to the family providing care and significant out-of-pocket expense. Once determined appropriate, the wait for packages that can provide a greater number of hours of care can take months. In Victoria, the Disability Support Register provides younger patients with access to a package of services to avoid admission to residential aged care via the "my future my choice" program (http://www.dhs.vic.gov.au/disability/improving_supports/my_future_my_choice). However, access to such services can take 4 to 8 months to implement.

Provision of aids, equipment and home modifications

In both NSW and Victoria, the system for supplying aids, equipment or home modifications to patients not covered by compensation is inadequate. There are long waiting periods and variation in supply between jurisdictions.

While the acute care sector demands and often gets the immediate supply of costly equipment, supply of orthoses (to allow mobility, for example) or of preventive footwear (for at-risk

diabetic feet) can take up to a year. This is in contrast to the artificial limb schemes, which are administered under different funding programs and, in both states, are equitable and responsive and operate within a capped budget.

There are also delays in funding the home modifications required for a safe home environment. Patients can wait in hospital for months, even though the cost of modifications is much less than the prolonged hospitalisation. For example, in Victoria, a single one-off contribution of $4400 per patient is available. However, the cost of home access or bathroom modifications can reach $15 000–$20 000 each, while the estimated weekly cost of caring for a patient in hospital is about $3500.

Interface with aged care services

Improvements in aged care service provision have focused on care and support rather than on the minimisation and reversal of disability. The federal government's recently established Transition Care Program offers 8–12 weeks of support with limited therapy to improve the functioning of patients at risk of residential aged care facility admission.[16] However, this program is available only to patients aged over 65 years. It is also more akin to restorative care, with the expectation of slow gains over time with good supportive care and minimal therapy, than to intensive specialist rehabilitation. A recent article in the Journal highlighted concerns about the cost-effectiveness of this program compared with alternatives, including rehabilitation.[17]

Proposals to improve the organisation and delivery of rehabilitation services

There are a number of strategies that can improve service delivery, potentially improving patient flow and outcomes in both acute care and rehabilitation. Implementing these improvements will require cooperation between state and federal governments and greater flexibility by health departments and hospitals as to how rehabilitation services are organised.

Furthermore, a national rehabilitation strategy should be established, as recently proposed by the Australasian Faculty of Rehabilitation Medicine (http://afrm.racp.edu.au/index.cfm?objectid=0F7AE593-9D8B-CDD1-A2096977C34069AA). This would, among other things, improve national rehabilitation policy, planning, service provision, research and workforce development.

In addition to the changes suggested here, there are likely to be other ways in which the acute–subacute–community interface can be improved. The clinical redesign principles described in a recent supplement to the Journal provide a useful framework for progressing this process.[18] It is also important to have cooperation and collaboration between rehabilitation and aged care services, to avoid duplication of similar services and to limit delays caused by parallel assessment processes, while at the same time preserving the important differences that each of these fields of expertise offers.

Minimise preventable disability and complications

Rehabilitation can play a major role in minimising preventable disability and complications in hospitalised patients. There is a need for programs to increase activity levels to prevent unnecessary functional decline in patients in both acute and subacute care,[19,20] along with early referral to rehabilitation services for patients with significant disability who are likely to require multidisciplinary care. Commencing a multidisciplinary rehabilitation program at an early stage, even while still in acute care, can improve outcomes[21-23] and patient flow by reducing length of stay in rehabilitation or avoiding a rehabilitation admission entirely if adequate ambulatory care programs are available.

Use should be made of systems for the early identification[15] and referral of patients appropriate for rehabilitation.[24]

Relocate rehabilitation facilities

Health planners should consider the efficiency, patient safety and workforce benefits of relocating stand-alone inpatient rehabilitation facilities back to acute care hospital campuses.

Redesign rehabilitation

There is growing evidence suggesting that increasing the intensity of rehabilitation therapy may lead to improved efficiency and patient outcomes in some types of impairment. The best evidence exists for stroke,[25] but it is quite likely that patients with other impairments would also benefit from an increased intensity of therapy.[19,26]

Improve ambulatory rehabilitation care

Significant increases in community rehabilitation are required to minimise preventable disability as the population ages. State and federal governments need to work together to develop ways to make sufficient community allied health interventions available to rehabilitation services, given that the latter are ideally placed to select appropriate patients and monitor outcomes.

Improve systems for supply of aids, equipment and home modifications

Funding for aids, equipment and home modifications for people with disabilities of all ages needs to be streamlined and made more accessible and equitable. There are economic and quality-of-life benefits to be gained from rapid supply of these items. It is not unreasonable for patients to be supplied with orthoses and appliances in a timely fashion, in the order of 4–6 weeks.

Support younger people with severe disability

A range of suitable and accessible care options for younger[27] adults requiring high-level care is needed. Options include smaller group residential homes, adequate funding for home-based carers, and programs similar to the existing Transition Care Program, but with a greater intensity of allied health intervention, if required.

Develop a broader range of inpatient rehabilitation and other subacute care services

Inpatient rehabilitation and other subacute care would probably be more efficient and effective if they were stratified into "acute, intensive" rehabilitation and "less intensive, more supportive" care, based on patient need. This is in contrast to the usual situation in Australia (outside the specialised spinal and brain injury units) of a "one size fits all" approach to rehabilitation. Such models exist overseas, with individual patient factors determining the intensity of rehabilitation or subacute service provision required.[4]

While the new Transition Care Program[16] provides longer-term restorative-type care for older patients, there are strict admission criteria and approval processes. There are currently limited options

for other elderly or young patients with the same care needs, including those awaiting home modifications or who are non-weight-bearing after sustaining fractures.

Conclusion

To make the best use of the current wave of hospital and community health system reforms, a focus on the rehabilitation sector is essential. Recent government initiatives, while addressing some of the issues raised, have concentrated on the aged care domain and not on rehabilitation.[28,29] Addressing the issues outlined in this article will require a whole-of-government approach, as well as involvement of regional health authorities and local personnel. We feel that the effectiveness of the health care system would be considerably enhanced by these changes, which would help to increase access to inpatient beds (in both the acute and subacute sectors), improve patient outcomes and reduce costs.

Competing interests

None identified.

Author details

Peter W New, MB BS, MClinEpi, FAFRM(RACP), Head, Acute Rehabilitation,[1] Head, Spinal Rehabilitation Unit,[2] and Honorary Lecturer[3]

Christopher J Poulos, MB BS, MSc, FAFRM(RACP), Network Clinical Director (Medicine, ED, Cardiac Services, Neurosciences and Rehabilitation),[4] and Clinical Associate Professor[5]

1 Continuing Care Program, Southern Health, Melbourne, VIC.

2 Rehabilitation Services, Caulfield General Medical Centre, Bayside Health, Melbourne, VIC.

3 Department of Medicine and Department of Epidemiology and Preventive Medicine, Monash University, Melbourne, VIC.

4 Southern Hospital Network, South Eastern Sydney and Illawarra Area Health Service, Wollongong, NSW.

5 University of Wollongong, Wollongong, NSW.

Correspondence: Peter.New@Southernhealth.org.au

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9.3 Appendix 3: publications related to spinal rehabilitation patient flow

9.3.1 International spinal rehabilitation unit survey

Spinal Cord (2013) 51, 893–897

www.nature.com/sc

ORIGINAL ARTICLE

International survey of perceived barriers to admission and discharge from spinal cord injury rehabilitation units

PW New[1,2], G Scivoletto[3], É Smith[4], A Townson[5,6], A Gupta[7], RK Reeves[8], MWM Post[9], I Eriks-Hoogland[10], ZA Gill[11] and M Belci[12]

Study design: Survey.
Objectives: To describe and compare perceived barriers with patient flow in spinal rehabilitation units (SRUs).
Setting: International. Ten SRUs (Australia, Canada, India, Ireland, Italy, Netherlands, Pakistan, Switzerland, UK and USA) that admit both traumatic and non-traumatic spinal cord injury patients.
Methods: Survey completed between December 2010 and February 2013 on perception of barriers for admission into and discharge from SRUs. Opinion was sought from the participants regarding the utility of collecting data on the timeliness of access to SRUs and occurrence of discharge barriers for benchmarking and quality improvement purposes.
Results: The perceived barriers in accessing SRUs ranged from no access problem to a severe access problem (no access problems $n=3$; minor access problems $n=3$; moderate access problems $n=2$; severe access problem $n=1$ and extreme $n=1$). Most units ($n=9/10$) agreed that collecting data on timeliness of access to SRUs for acute hospital patients may help improve patient outcomes and health system processes by providing information for benchmarking and quality improvement purposes. All units reported perceived barriers to discharge from SRUs. Compared with admission barriers, a greater perception of barriers to discharge was reported (minor problem $n=3$; moderate problem $n=3$; severe problem $n=3$; and extreme $n=1$). All units agreed that collecting data on barriers to discharge from SRU may help improve patient outcomes and system processes.
Conclusions: Perceived barriers to patient flow in SRUs are reported in many countries. Projects to identify and minimise the occurrence and impact of admission and discharge barriers could increase access to rehabilitation and improve the rehabilitation outcomes for patients.
Spinal Cord (2013) **51,** 893–897; doi:10.1038/sc.2013.69; published online 30 July 2013

Keywords: spinal cord diseases; rehabilitation; health services accessibility; patient discharge; patient flow; bed block

INTRODUCTION

Spinal cord injury (SCI) medicine is a complex field, and delayed access to appropriate expertise at any point in the care continuum—pre-hospital, emergency, acute hospital, rehabilitation and community—can potentially compromise patient outcomes. Furthermore, an inability to transfer a patient from one phase of care in the management continuum to the next phase can result in inefficient resource utilisation. This problem can contribute to difficulty with other patients at different phases in the management continuum being unable to access their optimal setting of care.

Problems with patient flow in hospital systems have been well described in emergency departments[1–3] and acute-care hospitals.[4–6] Patient flow in rehabilitation has not been studied to the same degree, but in recent years, a number of reports have detailed problems in this area.[7–11] A recent survey of rehabilitation physicians in Australia highlighted problems with access to, and especially discharge from, rehabilitation units.[11] A few articles have previously highlighted problems for patients with non-traumatic SCI (NTSCI) not being able to access specialist spinal cord rehabilitation services as readily as patients with traumatic SCI (TSCI).[7,12–14] The occurrence of barriers for admission into spinal rehabilitation units (SRUs) for patients with recent onset of spinal cord damage or barriers to discharge from SRUs after the completion of necessary inpatient rehabilitation for patients with spinal cord damage from any cause are an issue that has received little attention in the literature.

We planned a survey of units participating in our research collaboration, the International Spinal Cord Rehabilitation (ISCoR) study group (previously known as the International Non-traumatic Spinal Cord Injury Study Group)[15] on the perception of senior staff, regarding barriers for admission of patients into their SRU from acute hospitals and subsequent barriers to discharge. It is important to emphasis that all participating units admit patients with spinal cord

[1]Spinal Rehabilitation Unit, Caulfield Hospital, Alfred Health, Melbourne, Victoria, Australia; [2]Epworth-Monash Rehabilitation Medicine Unit, Southern Medical School, Monash University, Melbourne, Victoria, Australia; [3]Spinal Cord Unit, IRCCS Fondazione S. Lucia, Rome, Italy; [4]National Rehabilitation and Mater Misericordiae University Hospitals, Dublin, Ireland; [5]GF Strong Rehabilitation Centre, Vancouver, British Columbia, Canada; [6]Division of Physical Medicine and Rehabilitation, Department of Medicine, University of British Columbia, Vancouver, Canada; [7]Neurological Rehabilitation Division, Department of Psychiatric & Neurological Rehabilitation, National Institute of Mental Health and Neurological Sciences, Bangalore, India; [8]Department of Physical Medicine and Rehabilitation, Mayo Clinic College of Medicine, Rochester, MN, USA; [9]Rudolf Magnus Institute of Neuroscience and Center of Excellence in Rehabilitation Medicine, University Medical Center Utrecht and De Hoogstraat, Utrecht, The Netherlands; [10]Swiss Paraplegic Research, Swiss Paraplegic Centre, Nottwil, Switzerland; [11]Spinal Rehabilitation Unit, Armed Forces Institute of Rehabilitation Medicine (AFIRM), Rawalpindi, Pakistan and [12]National Spinal Injuries Centre, Stoke Mandeville Hospital, Buckinghamshire Healthcare NHS Trust, Aylesbury, UK
Correspondence: Dr PW New, Spinal Rehabilitation Unit, Caulfield Hospital, Alfred Health, 260 Kooyong Road, Caulfield, Melbourne 3162, Victoria, Australia.
E-mail: p.new@cgmc.org.au
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damage from any cause, both NTSCI (median, interquartile range proportion 40%, 30–42%) and TSCI (median, interquartile range proportion 45%, 20–48),[15] and that the survey responses were based on consideration of both these patient groups in combination. The objective was to (a) measure the perception of barriers for admission into SRU and subsequent barriers to discharge; (b) to identify the types of perceived barriers; and (c) to provide further understanding of the context of the SRUs in the ISCoR Study Group that will be important for interpreting the results from subsequent phases of this project when patient outcomes, including length of stay in rehabilitation, are reported.

MATERIALS AND METHODS

Participants

The participating units were chosen by the Principal Investigator on the basis that they included a broad international representation of SRUs, including a mix of developed and developing countries. It was initially planned to include at least one unit from each continent. Despite our best efforts, no unit from South America or Africa was located that was able to participate and meet the inclusion criteria (which included admitting a minimum of 50 patients with NTSCI over 3 years for inclusion into the ISCoR study group).

The full inclusion and exclusion criteria, and the results dealing with the organisation of rehabilitation services and systems of care (funding sources, relationship with acute hospitals, catchment, referral process, the number of rehabilitation beds, proportion of patients with NTSCI and TSCI, determination of readiness to discharge, staffing ratios, provision of secondary non-core therapists and ancillary services, and relevant support programs) have been recently reported.[15] Subsequent to the acceptance of the above manuscript, a site from the United Kingdom joined our Study Group, which also met the inclusion criteria.

Survey

A survey of participating units was developed by the Principal Investigator (PWN) based on clinical expertise and literature review. The survey questions on barriers to access and discharge were modified from a similar survey conducted on rehabilitation and aged-care physicians and senior hospital managers in Australia.[11] The present paper is based on items concerning respondents' perceptions regarding admission and discharge barriers for SRU patients, irrespective of aetiology of spinal cord damage (that is, the survey questions did not distinguish between TSCI and NTSCI). The survey used Likert scale (no problem, mild, moderate, severe or extreme problems) and closed questions, as well as a few open questions, allowing free-text answers (copy of the survey available from PWN). The respondents were able to select as many relevant reasons for barriers to admission and discharge from a list, with the opportunity to also add their own reasons.

The survey was completed electronically by a representative from each of the participating SRUs between December 2010 and February 2013. Given the time period over which the survey was completed, all authors reconfirmed the responses pertaining to their SRU were still applicable in March and April 2013. No specific data analysis was planned. We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research. Approval for the project was obtained separately by the participating units from their respective institute's ethics committees, where required, and from the Alfred Health Human Research and Ethics Committee, Melbourne, Victoria, Australia.

Table 1 Reported barriers to admission from SRUs

	Australia	*Canada*	*Italy*	*Ireland*	*India*	*Netherland*	*Pakistan*	*Switzerland*	*UK*	*USA*
City, Hospital	Melbourne, Spinal Rehabilitation Unit, Caulfield Hospital	Vancouver GF Strong Rehabilitation Centre	Rome IRCCS Fondazione S. Lucia	Dublin National Rehabilitation Hospital	Bangalore National Institute of Mental Health and Neuro Sciences	Utrecht De Hoogstraat	Rawalpindi Armed Forces Institute of Rehabilitation Medicine	Nottwil, Swiss Paraplegic Center	Aylesbury, National Spinal Injuries Centre	Rochester, Minnesota Saint Marys Hospital
Admission barriers										
How accessible generally are SRU beds for acute SCI patients needing admission?	Extreme access problems	Minor access problems	Moderate access problems	Minor access problems	No access problems	No access problems	Moderate access problems	No access problems	Severe access problems	Minor access problems
Agree that it may help improve patient outcomes, and health system processes, to collect data on the timeliness of access to inpatient rehabilitation for acute hospital patients with SCI by using this information for benchmarking and quality improvement purposes.	Strongly agree	Agree	Agree	Strongly agree	Strongly agree	Agree	Unsure	Agree	Agree	Strongly agree
Currently, collect such information	Yes	Yes	No	Yes	No	No	No	No	Yes	Yes
If yes, what information?	Time from ready to admission	Time from ready to admission		Time from ready to admission					Time from referral to admission	Time from ready to admission
Reported difficulties contributing to access problems for SCI admission into SRU										
Number of available beds	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No
Physical/environmental issues, e.g., lack of single rooms	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes
Equipment issues, e.g., lack of hoists, bariatric	Yes	No	No	No	No	No	No	No	No	No
Staffing issues—nursing	Yes	No	Yes	No	No	No	No	No	Yes	No
Staffing issues—allied health	Yes	No	Yes	No	No	No	No	No	Yes	No
Other	No	No	No	No	No	No	Financial issues for civilians	No	No	No

Abbreviations: SCI, spinal cord injury; SRU, spinal rehabilitation unit.

Table 2 Reported barriers to discharge from SRUs

	Australia	*Canada*	*Italy*	*Ireland*	*India*	*Netherlands*	*Pakistan*	*Switzerland*	*UK*	*USA*
Discharge barriers										
How great a problem are barriers to discharge for SCI patients in SRU?	Extreme problem	Moderate problem	Severe problem	Severe problem	Moderate problem	Minor problem	Minor problem	Moderate problem	Severe problem	Minor problem
Agree that it may help improve patient outcomes, and health system processes, to collect data on barriers to discharge for SCI rehabilitation inpatients by using this information for benchmarking and quality improvement purposes.	Strongly agree	Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Agree	Agree	Strongly agree
Currently, collect such information	Yes	Yes	No	Yes	No	No	No	No	No	Yes
If yes, what information?	Date ready for discharge versus actual discharge date and causes of discharge barriers.	Date ready for discharge versus actual discharge date		Date ready for discharge versus actual discharge date and causes of discharge barriers.						Date ready for discharge versus actual discharge date and causes of discharge barriers.
Reported difficulties contributing to discharge barriers for SRU inpatients										
Waiting for high-level care/nursing home bed	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes
Locating suitable accommodation in community	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes
Carer funding	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Home modification funding	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No
Equipment funding	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes
Lack of suitable ambulatory therapy options	No	Yes	No	No	Yes	No	No	No	No	Yes
Other	No	No	No	No	No	No	No	No	No	No

Abbreviations: SCI, spinal cord injury; SRU, spinal rehabilitation unit.

RESULTS

Ten SRUs agreed to participate in this project and completed the survey (Australia, Canada, Italy, Ireland, India, Netherlands, Pakistan, Switzerland, United Kingdom and USA). The responses regarding perceived barriers to admission are shown in Table 1. There was a wide diversity in the perception of barriers to admission (no access problems $n=3$; minor access problems $n=3$; moderate access problems $n=2$; severe access problem $n=1$; and extreme $n=1$). Despite the range of responses, most units ($n=9/10$) agreed that collecting data on timeliness of access to the SRU for acute hospital patients with SCI may help improve patient outcomes and health system processes by providing information for benchmarking and quality improvement purposes. Five units collected this type of information at the time of survey completion (time from ready for transfer from acute hospital until admission into SRU). The most common nominated reasons for barriers to admission were physical/environmental issues ($n=7$) and the number of available beds ($n=5$).

The responses regarding perceived barriers to discharge from the SRU are shown in Table 2. Compared with admission barriers, there was a greater perception of barriers to discharge reported (minor problem $n=3$; moderate problem $n=3$; severe problem $n=3$; extreme $n=1$). All units agreed that collecting data on barriers to discharge for SRU patients may help improve patient outcomes and health system processes. Four units collected this type of information at the time of survey completion. The most common reasons nominated for barriers to discharge from SRUs were as follows: lack of funding for caregivers ($n=8$), lack of funding for home modifications ($n=7$), waiting for nursing home ($n=7$) or other accommodation ($n=7$) and lack of funding for necessary equipment ($n=6$).

DISCUSSION

Our results found that the perception of the degree of difficulty with barriers for transfer from acute hospital into SRUs varied between participating units. In contrast, there was a much more consistent perception of problems with barriers to discharge from SRUs. There was strong agreement that collecting data on both the timeliness of access to SRU and the barriers to discharge from SRU and using this information for benchmarking and quality improvement purposes may help improve patient outcomes and health system processes. Our findings highlight that problems with patient flow in SRUs are of international significance.

Our results are consistent with the survey results from Australian clinicians and health managers regarding perception of barriers to patient flow and the use of related process measures.[11] In that study, 87% of rehabilitation physicians believed that there were moderate, severe or extreme discharge barriers for inpatients in their unit compared with 41% who reported the same degree of problems with barriers to admission. Although 45% of respondents in that survey reported collecting data related to the timeliness of acute hospital patients, accessing rehabilitation beds for quality improvement purposes, 70% agreed that this information would be useful for

benchmarking and quality improvement purposes. Nineteen percent of respondents reported collecting data related to discharge barriers, but 71% agreed that this information would be useful. The reasons nominated as admission or discharge barriers from the Australian survey had many similarities with the reasons nominated by respondents in this report.

Our findings reinforce the assertions of others that there are problems with rehabilitation patient flow generally,[9–10] as well as patients with spinal cord damage.[7–8] Two previous reports have highlighted the problems with timely access to appropriate expertise in the SCI management continuum, particularly admission to SRU.[7–8] None of the units in our survey reported health policies limitations or constraints to either admission or discharge, as others have reported,[16–18] but this may be due to the number of units included and non-random participation in the survey. A survey from The Netherlands highlighted problems with the amount of time some patients spent arranging their home modifications or alternative accommodation, with a third of patients reporting that their discharge was delayed by a median of 15 weeks while this issue was resolved.[19] A recent study from the United States of America that classified the barriers to community integration for patients with SCI report that the two most common barriers were equipment issues and lack of environmental and home assistance, which coincides with the common reporting among our units of these as barriers to discharge.[20]

Problems with patient flow in rehabilitation can result in a number of potential adverse consequences, as well as wasting health-care resources that could be better utilised. When patients are in hospital for longer than necessary, for each additional day of hospitalisation, the risk of iatrogenic complications, such as medication errors, nosocomial infections and falls, increases by 6%.[21] Stroke[22] and trauma patients[23] are reported to have better outcomes when transferred to rehabilitation sooner, with a shorter rehabilitation length of stay and better functional outcomes at discharge.[22,23] Similar findings have also been reported in patients with spinal cord damage. Patients with a shorter acute hospital admission have been reported to have a shorter rehabilitation admission,[24,25] fewer pressure ulcers[24] and a more efficient functional improvement.[25,26]

A detailed discussion of the implications of each barrier reported would be quite lengthy; however, it is apparent that in order to adequately address the range of barriers reported, more resources may be required to meet the needs of NTSCI and TSCI patients. Some of these resources may be needed by the SRUs and others by community organisations, with the specific requirements varying between settings. These resources include physical and material goods, workforce, health and disability services, and the timely availability of accommodation options for disabled. The responsibility for implementing the required solutions would vary between SRUs, but would typically lie at either a regional, State or National level. Unfortunately, given the current global economic outlook, many countries would have difficulty in adequately addressing the need highlighted here in the short term.

The implications of our results are that health funders, managers, policymakers and senior clinicians need to address patient flow inefficiencies through the whole hospital system, and not just focus on the emergency department. Our results highlight the potential to improve the flow for patients with spinal cord damage through the hospital system. Further study of this problem will facilitate the wise use of scarce resources and the best achievable patient outcomes. The problems we highlight are an important opportunity for improvement of health-care and hospital systems. A detailed understanding of access and discharge barriers would allow resources to be optimally directed. An international study group will allow cross-cultural comparisons. Efficient patient transfer to the optimal level of care may be able to reduce the total cost of care and also the chance of iatrogenic complications, and help improve functional outcomes. It is quite likely that developing solutions to access and discharge barriers would result in a significant improvement in length of stay, in both acute and rehabilitation hospitals. It is important to note that addressing the barriers to discharge for patients who have completed rehabilitation and for those whose discharges have been delayed will consequently improve access for patients waiting for transfer into the SRU.

Research is needed to measure the occurrence and causes of barriers to patient flow for SCI patients across the management continuum. A necessary requirement for future studies includes key principles to guide this research—because this field has not been well studied to-date—including the development of trans-cultural definitions, classifications and key performance indicators of patient flow in rehabilitation that can facilitate patient flow barriers being identified and addressed.[27] Risk adjustment strategies will also be necessary to allow meaningful comparisons across centres. In order to improve the health-care experiences for patients, it is also suggested that future work in this field include patients' perspectives on admission and discharge barriers.

Study limitations

Limitations of our survey include the possibility of responder bias, which could have influenced answers in either direction, and the small number of participating units. We believe, however, based on discussion with colleagues in our respective countries and internationally in other SRUs, that our findings are generalisable to many other SRUs around the world, not just in the countries that participated in this survey. Furthermore, we believe that there are likely to be problems with patient flow in rehabilitation that affect other impairment groups besides those with spinal cord damage.

Other limitations are the range of factors considered in the survey questions. For example, there was no rating of the degree to which the nominated reasons for a barrier contributed to the access or discharge barriers or quantification of the rating of barrier severity. We did not record perceptions about lack of awareness of SRUs among acute hospital staff or the lack of availability of such units, and we did not attempt to measure actual duration of the barriers or their impact on length of stay. A future project plans to measure the occurrence, causes and duration of barriers to the flow of patients into and out of our units. There is also the possibility that the perceptions regarding the severity and causes of barriers to admission or discharge may have changed, either for better or worse, since the survey was conducted. Finally, we have not considered internal processes in acute hospital units or the SRU that can also impact on length of stay and contribute to admission or discharge barriers. Recent publications using the operations research methodology have highlighted the opportunities for improving these internal processes for patients with SCI.[28,29]

CONCLUSIONS

We have found that many SRUs have problems with timely access for acute hospital patients to their beds and most have problems with barriers to discharge. These problems contribute to hospital inefficiency and compromise patient outcomes. Further research is warranted to quantify the extent and impact of barriers to the flow of patients with spinal cord damage through the care continuum.

Systems improvement processes designed to minimise the barriers identified could result in benefits for individual patients and major improvements in the flow of patients through the entire hospital system.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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9.3.2 Barriers to admission into spinal rehabilitation unit

Spinal Cord (2014) 52, 472–476

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ORIGINAL ARTICLE

Reducing process barriers in acute hospital for spinal cord damage patients needing spinal rehabilitation unit admission

PW New[1,2]

Study design: Prospective open cohort case series.
Objectives: To identify opportunities for improvement by recording duration of key processes from acute hospital admission until spinal rehabilitation unit (SRU) admission.
Setting: SRU, Victoria, Australia.
Methods: Consecutive referrals of patients with recent spinal cord damage had prospective documentation of the key clinical and demographic characteristics and duration (days) of the following sequential discrete processes: acute hospital admission until referral to SRU, referral until SRU assessment, SRU assessment until ready for transfer to SRU and ready for transfer until SRU admission.
Results: A total of 347 patients were referred with median age (interquartile range (IQR)) of 65 (52–76) years. Most patients were male ($n=203$, 58.5%), had paraplegia ($n=267$, 77%) and an aetiology due to spinal cord myelopathy ($n=280$, 80.7%). There was a median of 12 days (IQR 6–20) from acute hospital admission until referral, a median of 1 day (IQR 0–2) from referral till assessment, a median of 0 (IQR 0–3.5) days from assessment till deemed ready and a median of 7 (IQR 2–20) days from deemed ready until transfer to SRU. Overall, patients spent 34.2% (4951/14 478 days) of their acute hospital length of stay waiting for a SRU bed.
Conclusions: There are opportunities to improve the efficiency of the acute hospital journey for patients referred to a SRU. The biggest opportunities exist for reducing the time from acute hospital admission till referral to SRU and the time from deemed ready for transfer to SRU till admission.
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INTRODUCTION

Problems with patient flow have been well described in emergency departments[1] and acute care hospitals[2,3] in many countries. It is likely that this challenge will intensify with population ageing[4] and the anticipated increase in chronic disease and disability. There has been relatively little attention given to barriers for acute hospital patients waiting for inpatient rehabilitation,[5–9] or the occurrence and causes of discharge barriers for rehabilitation patients remaining in hospital after they are deemed to no longer require inpatient rehabilitation for management of the activity limitations resulting from their impairment.[8,10] The occurrence of these barriers has an adverse impact 'upstream'—with flow-on affects reducing acute hospital bed availability and increasing the risk of adverse outcomes for patients, such as iatrogenic[11] or impairment-related complications.[5,12]

Spinal cord damage (SCD), either traumatic spinal cord injury (SCI) or non-traumatic spinal cord myelopathy (SCM) require optimal care from the onset in order to prevent secondary complications that can have a detrimental influence on long-term outcomes. A review of the evidence regarding setting of care for patients with SCD has highlighted that patients have improved outcomes with a specialized and systematic approach to their care, in comparison with less specialized and less coordinated models of care.[12] The benefits of a specialised and integrated system of care include reduced complications, length of stay (LOS) in hospital, costs and improved efficiency of rehabilitation in reducing disability.[12,13] There has been very little formal study of the process barriers for patients with SCD needing admission to a spinal rehabilitation unit (SRU), although a number of studies have highlighted this as a problem area[5,6,14,15] and this has recently been highlighted as an international problem.[16]

The primary objective of this study was to measure the time taken for the key processes in the patient journey for patients with SCD from acute hospital admission through to inpatient SRU admission in order to identify opportunities for improvement. In addition, as an exploratory analysis, secondary objectives were to test hypotheses regarding whether clinical or demographic factors contributed to three key outcomes: (1) the delay from acute hospital admission until referral to SRU, (2) the delay between being deemed ready for

[1]Spinal Rehabilitation Unit, Caulfield Hospital, Alfred Health, Melbourne, Victoria, Australia and [2]Epworth-Monash Rehabilitation Medicine Unit, Monash University, Melbourne, Victoria, Australia
Correspondence: Dr PW New, Spinal Rehabilitation Unit, Caulfield Hospital, Alfred Health, 260 Kooyong Road, Caulfield 3162, Victoria, Australia.
E-mail: p.new@cgmc.org.au
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transfer to SRU and subsequent admission SRU and (3) to determine whether the time waiting for a SRU bed after being deemed ready for transfer was associated with either an increased LOS in SRU, pelvic pressure ulcer or an increased dependency at discharge from rehabilitation.

MATERIALS AND METHODS

Setting

The SRU at the Caulfield Hospital, Victoria, Australia is a 12-bed adult inpatient unit. It is located in a public hospital and funded by the State. Patients with SCD are referred from both private and public hospitals from greater metropolitan Melbourne and elsewhere in the State. Many patients are admitted from the acute care tertiary hospital in the inner-south of metropolitan Melbourne that is part of the same Network as the SRU. As the other major SRU in Melbourne does not routinely admit patients with SCM, the SRU at Caulfield hospital admits mainly these patients; however, it has no specific aetiology bias in its' admission criteria.

The typical hospital journey for patients involves them being referred by the treating acute hospital unit to the SRU via a central access unit at Caulfield Hospital. The patient would then be assessed by either an advanced trainee in rehabilitation medicine or the unit head (the author—a physician in rehabilitation medicine who specialises in SCD). Patients referred from hospitals in other health networks were typically assessed by the rehabilitation assessment service based at that hospital and subsequently by the advanced trainee in rehabilitation medicine in the SRU, who would confer with the unit head. If the patient was deemed by the SRU to be appropriate and ready for admission, they would be put on a waiting list for admission with the central access unit, which coordinated the timing of admission as beds became available.

Study design

This was a prospective open cohort case series of consecutive referrals of patients with SCD to the SRU between 1 September 2006 and 31 July 2013.

Participants

All patients with a recent onset of SCD who were referred and accepted for admission into the SRU were included in the study. Patients with a chronic SCD readmitted to hospital for management of late-onset complications after a previous rehabilitation admission were excluded.

Outcome measures

Relevant dates were collected to calculate the duration (in days) of the sequential discrete processes that patients passed through from acute hospital admission until transfer into the SRU. If the onset of SCD occurred after the acute hospital admission—for example, in cases of SCM due to spinal cord infarction from aortic aneurysm surgery—then the date of onset of SCD was used instead of the date of acute hospital admission. The key processes recorded were as follows: acute hospital admission (or onset if after) until referral to SRU, referral until assessment by the SRU, assessment by SRU until deemed ready for transfer to rehabilitation and ready for transfer until SRU admission. These processes are based on previous research in this area.[17,18] If a patient was deemed ready for transfer to the SRU and became unwell—for example, due to medical complications—then the 'not ready' duration was excluded from calculating the duration waiting for transfer. Patients referred and accepted for admission into the SRU, but not subsequently admitted, had the date they were removed from the waiting list and the reason for this recorded.

In addition to the duration of the above processes, the following information was also recorded: referral source (same health network or another network); age on admission to acute hospital (years); gender; level of SCD (tetraplegia or paraplegia); and aetiology of SCD (traumatic SCI or non-traumatic SCM).

On admission to the SRU, the presence of any pelvic region pressure ulcers was noted. This complication was selected because wounds in this region have the greatest negative impact, compared with other locations, on participation in rehabilitation by limiting sitting in a wheelchair and bed-based tasks. At SRU admission and discharge, the American Spinal Injury Association Impairment Scale (AIS) grade of injury[19] and the Functional Independence Measure (FIM) were recorded.[20]

Data collection and storage

The data were recorded in a password-protected database prospectively by the advanced trainee in rehabilitation medicine or the unit head and were reviewed by the unit head weekly to confirm their accuracy.

Statistical analysis

Continuous variables were described using the median and interquartile range (IQR). Comparisons were made using the Kruskal–Wallis rank test. Although multiple analyses were planned, as this was a hypothesis generating study no correction was made for these. Analysis was performed to test for the influence of clinical (AIS grade and level), demographic (gender or age) and referral source on the key process in the patient journey from acute hospital to SRU.

On the basis of previous research[9,17] it was decided to use the time waiting for a SRU bed after being deemed ready for transfer from acute hospital and the time from acute hospital admission until referral to the SRU as dependent variables for regression analysis. Stepwise multiple linear regression (backwards inclusion) was used to determine factors associated with the following four dependent variables: (1) the log-transformed time between acute hospital admission and referral to the SRU, (2) the log-transformed time between deemed ready for transfer to the SRU and admission, (3) the log-transformed rehabilitation LOS and (4) physical disability at discharge from SRU measured using the motor subscale of the FIM. Log-transformation was used to facilitate parametric analysis. As some of the wait periods in acute hospital were zero days, when the log-transformation was made for all of these one was added to the raw score to avoid a result of infinity. Patients' age, gender, level, aetiology (SCI or SCM) and AIS on admission (dichotomised to AIS A, B or C versus D) were considered as covariates for all models. The FIM motor subscale on admission to SRU (as an indicator of disability and burden of care at transfer from acute hospital), the presence of a pelvic region pressure ulcer on SRU admission and the acute network where the patient was treated (same health network or another network) were additionally included as covariates in the second model. The log-transformed time between deemed ready for SRU and subsequent admission was included as a covariate in the third and fourth models. Admission FIM motor subscale was also included as a covariate in the fourth model.

All applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research. The project was approved by the Alfred Health Human Research Ethics Committee. P-values of <0.05 were deemed statistically significant. Stata version 12 (StataCorp, College Station, TX, USA) was used for statistical analysis.

RESULTS

There were 378 patients referred to the SRU during the study period; however, 31 were excluded because they had a prior SCD, leaving 347 patients ranging in age from 17 to 93 years included in the analysis. We analysed the age of patients on admission, duration of the four key processes from acute hospital admission until transfer into SRU and the total acute hospital LOS by the following: aetiology of SCD, level of SCD, AIS on admission, gender and the acute hospital Network before rehabilitation admission Table 1.

The proportion of patients achieving the key processes within specified time frames is shown in Table 2. Half the patients spent 28.6% of their acute hospital admission waiting for a rehabilitation bed and a quarter of patients spent 54.1% of their acute admission waiting for a SRU bed. Overall, SCD patients spent 34.2% (4951/14 478 days; IQR 8.3–51.4%) of their acute hospital LOS waiting for a SRU bed to become available.

Table 1 Duration of key processes in the patient journey from acute hospital to SRU admission according to key variables

	n (%)	*Age (years) median[a] (IQR)*	*Median (IQR) days from acute hospital admission to referral to SRU[b]*	*Median (IQR) days from referral to SRU till assessment[c]*	*Median (IQR) days from assessment for SRU admission until ready for transfer[d]*	*Median (IQR) days from ready for transfer to SRU until admission[e]*	*Median (IQR) acute hospital LOS[f]*
Aetiology							
Spinal cord myelopathy	280 (80.7)	66 (53–76)	12 (7–20)	1 (0–2.5)	0 (0–3)	8.5 (3–22)	31 (17–55)
Traumatic SCI	67 (19.3)	60 (45–75)	11 (4–18)	1 (1–2)	1 (0–6.5)	4 (1–11)	20 (13–45)
Level of injury							
Paraplegia	267 (77)	65 (51–76)	12 (7–20)	1 (0–2)	0 (0–2)	7 (2–21)	29 (16–52)
Tetraplegia	80 (23)	62.5 (52–74)	11.5 (5–21)	1 (0–2)	1 (0–7)	6 (1–20)	29 (15–54)
AIS grade[g]							
AIS A, B or C	189 (66.6)	65 (53–75)	13 (7–25)	1 (0–2)	0 (0–4)	7 (2–21)	31 (18–58)
AIS D	95 (33.4)	61 (47–74)	10 (5–15)	1 (0–2)	0 (0–3)	5 (1–13)	18 (13–36)
Gender							
Male	203 (58.5)	63 (51–75)	12.5 (6–20)	1 (0–2)	0 (0–4.5)	6 (1–18)	28 (15–53.5)
Female	144 (41.5)	66 (52–76)	11 (7–20)	1 (0–2)	0 (0–3)	10.5 (4–22.5)	30 (18–51)
Referral source							
Same network	137 (39.5)	61.5 (48.5–73)	11 (5–17)	1 (0–2)	1 (0–6)	2 (1–6)	18 (12–31.5)
Another network	210 (60.5)	66 (55–77)	13 (7–21)	1 (0–3)	1 (0–1)	16 (6–30)	36 (23–63)
Total	347 (100)	65 (52–76)	12 (6–20)	1 (0–2)	0 (0–3.5)	7 (2–20)	29 (16–52)

Abbreviations: AIS, American Spinal Injury Association Impairment Scale; IQR, interquartile range; LOS, length of stay; SCI, spinal cord injury; SRU, spinal rehabilitation unit.
[a]Age: aetiology $\chi^2=2.9$, $P=0.09$; level $\chi^2=0.4$, $P=0.5$; AIS $\chi^2=2$, $P=0.2$; gender $\chi^2=1.3$, $P=0.3$; referral source $\chi^2=4.8$, $P=0.03$.
[b]Acute hospital admission to referral to SRU: missing data $n=11$; aetiology $\chi^2=2.1$, $P=0.1$; level $\chi^2=0.6$, $P=0.4$; AIS $\chi^2=10.9$, $P=0.001$; gender $\chi^2=0.2$, $P=0.6$; referral source $\chi^2=4.5$, $P=0.03$.
[c]Referral to SRU till assessment: missing data $n=4$; aetiology $\chi^2=2.8$, $P=0.09$; level $\chi^2=1.9$, $P=0.2$; AIS $\chi^2=0.12$, $P=0.7$; gender $\chi^2=0.03$, $P=0.9$; referral source $\chi^2=1.4$, $P=0.2$
[d]Assessment for SRU admission until ready for transfer: missing data $n=14$; aetiology $\chi^2=2.6$, $P=0.1$; level $\chi^2=4$, $P=0.05$; AIS $\chi^2=0.7$, $P=0.4$; gender $\chi^2=0.6$, $P=0.4$; referral source $\chi^2=5.8$, $P=0.01$.
[e]Ready for transfer to SRU until admission: missing data $n=13$; aetiology $\chi^2=13.5$, $P=0.0002$; level $\chi^2=2.3$, $P=0.1$; AIS $\chi^2=8.1$, $P=0.004$; gender $\chi^2=7.8$, $P=0.005$; referral source $\chi^2=113.8$, $P=0.001$.
[f]Acute hospital LOS: aetiology $\chi^2=6.8$, $P=0.009$; level $\chi^2=0.001$, $P=1$; AIS $\chi^2=18.5$, $P=0.0001$; gender $\chi^2=0.5$, $P=0.5$; referral source $\chi^2=49.5$, $P=0.0001$.
[g]Missing data $n=63$, patients referred but not admitted.

Of the 347 patients referred and accepted for admission into the SRU, most ($n=283$, 81.6%) were subsequently admitted. However, 31 patients (8.9%) were admitted to a non-specialist rehabilitation unit because of the long delay waiting for a bed into the SRU, 10 patients (2.9%) changed their mind after being accepted and decided that they did not want to come to the SRU, 6 patients were transferred to palliative care, 6 patients (1.7%) died and 11 (3.2%) were removed from the waiting list for other reasons.

The results of the multiple linear regressions to determine the influence of variables on (1) the delay between acute hospital admission and referral to the SRU, (2) delay between deemed ready for rehabilitation and transfer into the SRU, (3) LOS in the SRU and (4) motor subscale of the FIM at discharge from SRU are shown in Table 3.

Patients with a more complete grade of injury tended to have a longer duration between acute hospital admission and referral to SRU. A longer delay from when deemed ready for transfer to SRU and subsequent admission into SRU was found for patients who were more physically disabled (lower motor FIM), had a pelvic region pressure ulcer on admission to the SRU, were female or were referred from another network to the SRU. The LOS in the SRU tended to be longer for patients who were more disabled on admission and was not influenced by the duration of the wait from being deemed ready for SRU until transfer. Patients who were less disabled at discharge from SRU tended to be less disabled on admission, have a longer LOS in rehabilitation, wait shorter from being deemed ready for transfer to SRU after being deemed ready, have a traumatic SCI and were younger.

DISCUSSION

There was typically a short delay between referral and assessment by the SRU, and most SCD patients were ready for transfer to rehabilitation on the day of assessment. The longest delays were for the period between the acute hospital admission/onset of SCD and the referral for assessment by the SRU and the wait for transfer to SRU after being deemed ready for admission.

These findings highlight the important opportunities for improving the acute hospital processes for patients with SCD in our region. There is a need to educate acute hospital staff about the importance of commencing the discharge-planning process for patients with SCD much sooner. Earlier referral to a SRU has the potential to reduce unnecessary time in acute hospital and prevent complications related to SCD. No explanation is available as to why the patients with complete SCD would tend to wait longer for referral, and it is important to note that this covariate only explained a small amount of the variance in the regression analysis.

Table 2 Proportion of patients achieving the key processes within specified time frames

Time interval	*Cumulative proportion referred for SRU following acute hospital admission or onset SCD (%)*	*Cumulative proportion assessed following referral for rehabilitation (%)*	*Cumulative proportion deemed ready for transfer to SRU after rehabilitation assessment completed (%)*	*Cumulative proportion transferred from acute to SRU after being deemed ready (%)*
Same day	0	38.3	57.5	7.5
1 Day	0.6	62.9	70.5	21.6
2 Days	4.2	77.8	72.3	27.9
3 Days	9.3	84.5	75.0	31.2
1 Week	30.2	96.5	83.4	53.5
2 Weeks	62.1	99.7	91.9	66.4
3 Weeks	77.0	100	94.3	75.7
4 Weeks	82.4		95.8	84.1
5 Weeks	88.4		97.0	89.2

Abbreviations: SCD, spinal cord damage; SRU, spinal rehabilitation unit.

Table 3 Multiple regression analyses

	Regression coefficient (95% CI)	P
Log-duration between acute hospital admission and referral to SRU[a]		
AIS admission grade ABC	0.3 (0.1–0.6)	$t=-3.2$, $P=0.001$
Constant	2.3 (2.2–2.5)	$t=27.2$, $P<0.001$
Log-duration between being deemed ready for SRU and transfer into SRU[b]		
Admission motor FIM	−0.01 (−0.02 to −0.004)	$t=-3$, $P=0.003$
Pelvic pressure ulcer admission SRU	0.4 (0.2–0.8)	$t=-2.8$, $P=0.005$
Females	0.2 (0.09–0.4)	$t=2.7$, $P=0.007$
Another network referral	−1.4 (−1.6 to −1.2)	$t=11.7$, $P<0.001$
Constant	2.8 (2.5–3.1)	$t=18.3$, $P<0.001$
Log-LOS in SRU[c]		
Log-duration between being deemed ready for SRU admission and transfer into SRU	0.08 (0.02–0.2)	$t=2.5$, $P=0.01$
FIM admission to rehabilitation	−0.03 (−0.03 to −0.02)	$t=-9.5$, $P<0.001$
Constant	4.7 (4.5–5)	$t=37.4$, $P<0.001$
FIM motor subscale at SRU discharge[d]		
FIM motor admission to SRU	1.1 (0.9–1.3)	$t=-12.9$, $P<0.001$
Log SRU LOS	6.2 (3–9.3)	$t=3.8$, $P<0.001$
Log-duration between deemed ready for SRU and transfer into SRU	−2.6 (−4.4 to −0.7)	$t=2.8$, $P=0.006$
Age	−0.15 (−0.3 to −0.01)	$t=2.2$, $P=0.03$
Traumatic SCI	6.1 (0.7–11.6)	$t=2.2$, $P=0.03$
Constant	8.95 (−11.10 to 29.01)	$t=0.9$, $P=0.4$

Abbreviations: AIS, American Spinal Injury Association Impairment Scale; CI, confidence interval; FIM, Functional Independence Measure; LOS, length of stay; SCI, spinal cord injury; SRU, spinal rehabilitation unit.
[a]Adjusted $R^2=0.03$, $P=0.001$.
[b]Adjusted $R^2=0.36$, $P<0.001$.
[c]Adjusted $R^2=0.28$, $P<0.001$.
[d]Adjusted $R^2=0.48$, $P<0.001$.

A major effort is needed to reduce the unnecessary time that patients with SCD spend in acute hospital waiting for a bed in a SRU, particularly for patients from other health networks to the one associated with the SRU. This would also probably help to reduce the not insignificant proportion of patients accepted to the SRU but subsequently admitted to non-specialist general rehabilitation units because of the long delay they spent waiting for a SRU bed. Patients in our study who waited longer for a SRU bed after being deemed ready tended to have a lower motor FIM score on admission, be more likely to have a pressure ulcer and were female. No explanation is available as to why female patients waited longer for admission into the SRU. It is not possible to determine whether the increased pressure ulcers and disability in patients who waited longer for a SRU bed was a result of the delay or the cause. Patients experiencing a longer delay for a SRU bed tended to have greater disability at rehabilitation discharge, after adjusting for the disability on admission. The LOS in SRU was prolonged for patients who were more disabled on admission and those who waited longer for a SRU bed after being deemed ready for transfer, possibly because of greater deconditioning or increased complications, again emphasising the importance of developing strategies to reduce this wait.

A study of general rehabilitation patients admitted into two units in a different health network in Melbourne recently reported that the proportion of acute hospital LOS spent waiting for a rehabilitation bed was 12%.[9] The waiting time for the key processes for the SCD patients in this study was much longer compared with the general rehabilitation patients, especially for the delay between acute hospital admission and referral and being deemed ready for rehabilitation and transfer.

There are a number of studies in the literature that are relevant for comparison with our findings. There are a few reports in the literature of delays for patients with SCD accessing SRU. Different authors use different cutoffs in duration for defining delays in processes, whereas in the present study the durations are reported as medians, IQR and proportion of patients achieving process within certain time frames. In one study from the United Kingdom over a 5-year period, the average time from traumatic SCI to referral was 5.5 days and from referral to admission was 10.7 days.[6] As was found here, others have also reported an association between the delay in admission to SRU and the occurrence of pressure ulcers,[14] increased LOS in SRU[6,14,21] and greater disability at discharge from SRU.[15,21]

A strength of this study is that it uses validated measures of the key processes in the acute hospital to SRU journey to identify opportunities for improvement.[9,17] Although others have highlighted the delays that patients with SCD can face in accessing SRU,[5,6,14–16] none have reported the duration of each sequential process.

The results of this study cannot be generalised to other SRUs because of the variability in systems and organisation of care for patients with SCD.[22] It is important to emphasise, however, that unless processes are measured, they cannot be improved, and that there appears to be support internationally among those working in SRUs to record these processes for benchmarking and quality improvement processes.[16]

Limitations of this study include that data were only collected from one SRU and there is inevitably referral bias associated with any centre. Our SRU has a bias towards patients with SCM. It was not possible to explore the reasons for delay in admission to SRU or referral.

In conclusion, the implications of this study are that future study of process barriers for admission into SRUs should include the reasons for delay and involve a number of different sites. Health-care managers and clinicians should allocate resources to process improvement projects that optimise the acute hospital LOS for patients with SCD in order to reduce complications, preventable disability and improve the efficiency of the hospital system by facilitating earlier referral and transfer to specialised SRU.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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9.3.3 Discharge barriers from spinal rehabilitation unit

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ORIGINAL ARTICLE

Prospective study of barriers to discharge from a spinal cord injury rehabilitation unit

PW New[1,2]

Study design: Prospective open cohort case series of consecutive patients admitted with spinal cord damage to a spinal rehabilitation unit (SRU) between 1 January 2008 and 31 July 2013.
Objectives: Measure the prevalence of barriers to discharge, their reasons and resulting additional unnecessary days in hospital.
Setting: SRU, Victoria, Australia.
Methods: Consecutive SRU admissions had prospective documentation of key clinical and demographic characteristics, the occurrence of any discharge barrier, the cause(s) and duration of unnecessary hospitalisation.
Results: There were 235 patients in the study; 138 (58.7%) were male and the median age was 63 years. Eighty-six (36.6%) patients had a discharge barrier. The most common reasons for a discharge barrier were: waiting for approval for long-term and supported care or services, residential care, home modifications, family deliberations regarding discharge planning and the provision of equipment necessary for discharge. The reasons accounting for the greatest number of additional hospital days were: home modifications, residential care, equipment necessary for discharge, waiting for approval for long-term and supported care or services and accommodation for people unable to return to their previous residence without readily available alternatives. Over the study period 17.5% (3176/18 184) of all bed-days were occupied by patients deemed to be clinically ready for discharge from the SRU but who had a discharge barrier.
Conclusions: Barriers to discharge from rehabilitation for patients with spinal cord damage are common, substantial, and represent an important opportunity for health systems improvement.
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INTRODUCTION

Problems with patient-flow in hospital systems have been well described in emergency departments[1–3] and acute care hospitals,[4–6] and the challenge of managing the increase in demand for hospital services is recognised as a major issue worldwide. It is anticipated that as a result of fiscal constraints in health-care funding and population ageing[7] resulting in an associated increase in chronic disease and disability, the challenge of managing the demand for hospital services will become even more arduous in the coming decades.

Although rehabilitation is an important component of the hospital system, there has been relatively little study of the barriers for acute hospital patients waiting for an inpatient rehabilitation bed,[8–10] or the occurrence and causes of discharge barriers for patients remaining in hospital after they are deemed to no longer require inpatient rehabilitation for management of the activity limitations resulting from their impairment.[10,11] I have previously reported findings from a survey of rehabilitation physicians in Australia in which 87% reported that barriers to discharge were an extreme, severe or moderate problem.[10] In a prospective study of patients in two general rehabilitation wards I found that 16.4% of patients had a discharge barrier, which accounted for 21.0% of bed-days over the study period.[11] A few studies have also highlighted that admission and discharge barriers are a problem affecting patients with spinal cord damage (SCD)[12–15] but none of these studies have classified the causes or quantified the impact of discharge barriers on patients with SCD.

The objectives of this study were to measure the proportion of patients admitted to a spinal rehabilitation unit (SRU) who developed a discharge barrier, the cause(s) and duration of any discharge barrier, and to determine whether any demographic or clinical variables predicted the occurrence of a discharge barrier or the number of additional days in hospital. These outcomes will help identify opportunities for improvement in the length of stay (LOS) for patients with SCD. The hypothesis is that patients with discharge barriers will have a longer LOS in SRU.

METHODS

Setting

The SRU at Caulfield Hospital, Victoria, Australia is a 12-bed adult inpatient unit. It is located in a public hospital and funded by the State. Patients are referred from both private and public hospitals, mainly from greater metropolitan Melbourne, but also from elsewhere in the State. Many patients are admitted from the acute care tertiary hospital in the inner-south of metropolitan Melbourne that is part of the same hospital network as the SRU. Because the other major SRU in Melbourne focuses on patients with traumatic spinal cord injury (SCI) and does not routinely admit patients with non-traumatic spinal cord myelopathy (SCM). The SRU at Caulfield hospital admits mainly patients with SCM, however, our SRU has no specific bias in its' admission criteria towards or against any particular aetiology of SCD.

[1]Spinal Rehabilitation Service, Caulfield Hospital, Alfred Health, Melbourne, Victoria, Australia and [2]Epworth-Monash Rehabilitation Medicine Unit, Monash University, Melbourne, Victoria, Australia
Correspondence: Dr P New, Spinal Rehabilitation Service, Caulfield Hospital, Alfred Health, 260 Kooyong Road, Caulfield, Victoria 3162, Australia.
E-mail: p.new@cgmc.org.au
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Study design and participants

This was a prospective open cohort case series of consecutive patients with SCD admitted into the SRU between 1st January 2008 and 31st July 2013. Patients in the SRU after the 31st July 2013 were monitored until discharge to determine their outcome. All patients with a recent onset of SCD admitted into the SRU were included in the study. Patients with chronic SCD readmitted to hospital for management of late-onset complications after a previous rehabilitation admission were excluded.

Many of the participants in this study were also included in a recent paper ($n=347$) that reported on the process barriers from acute hospital admission until transfer to the SRU ($n=283$), admission into other rehabilitation units, or alternative destinations.[15] This present project started about 15 months after the study that focussed on the acute hospital process barriers so it does not include all participants from the previous study.

Outcome measures

The main outcome variables were the occurrence of a discharge barrier, the cause(s) and the duration of the additional unnecessary days in hospital arising as a result of the discharge barrier (from onset until resolution). When multiple discharge barriers occurred simultaneously any overlapping days were not double-counted when performing the regression analysis and reporting the total unnecessary days in hospital.

The definition of a discharge barrier and the classification of causes were based on recently validated work in developing these for rehabilitation patients'[16] and include the following categories: family negotiations; occupational therapy home assessment; home modifications; equipment necessary for discharge; carer funding; carer recruiting and training; alternative accommodation (when a patient is not able to return to their previous residence and without any readily available alternative); long-term and supported care or services and equipment assessment/approval; residential care (for example, waiting for nursing home or hostel care to be available); guardian/power of attorney appointment; competency assessment; waiting specialist review; or ambulatory rehabilitation availability, as shown in Table 1.

The need for ongoing inpatient rehabilitation and the occurrence and causes of a discharge barrier were monitored in the weekly multidisciplinary team meeting. The determination that a patient had a discharge barrier and no longer needed admission in the SRU was made on the basis of the treating teams' expertise and the following definition of a discharge barrier,[16] 'A discharge barrier is considered to occur when the treating team believe that there are no longer any goals of therapy or treatment that require inpatient rehabilitation and yet the patient is unable to be discharged.' In applying this definition the following are assumed: (1) the patients' activity limitations, body functions and structural dysfunction have been addressed to an adequate degree, including safety considerations, such that it is no longer necessary to continue rehabilitation in an inpatient setting; and (2) environmental barriers

Table 1 The causes and definitions of the different discharge barriers from SRU, the proportion of patients with each barrier and the associated additional unnecessary days in hospital

Cause and definition of discharge barrier[16]	*Patients with discharge barrier (%)*[a]	*Additional unnecessary days in SRU (%)*[a]	*Median (IQR) additional unnecessary days in SRU*
Long-term and supported care or services and equipment assessment/approval: patient referred to a service or organisation for confirmation of appropriateness and necessity of supported care (nursing home or hostel) or long-term services or equipment. Includes waiting for the assessment; determination of level of care or range of services and equipment; related paperwork; and where relevant, confirmation that no option available for alternative care, where this process is required.	37 (41.9)	606 (19.1)	11 (7–15)
Residential care: waiting for high level (nursing home) or low level (hostel or supported residential service) residential care accommodation to be available.	36 (41.9)	697 (21.9)	15 (9.5–26)
Home modifications: patient waiting home modifications that are essential to ensure safe access and care at home after discharge. Includes funding and completion of modifications.	26 (30.2)	902 (28.4)	20.5 (11–41)
Equipment: delay waiting for necessary equipment to be available, after specific equipment needs have been identified and prescribed that are essential to ensure safe care after discharge. Includes funding and supply of equipment.	15 (17.4)	691 (21.8)	37 (13–63)
Family: negotiations and discussions with family members regarding discharge planning issues that delays discharge processes. In particular, but not limited to, whether family will provide care for the patient or whether the patient will have to be discharged to a care facility.	11 (12.8)	148 (4.7)	8 (3–20)
Carer recruiting and training: waiting for recruiting and training of carers to ensure safe care after discharge.	8 (9.3)	430 (13.5)	38 (16–55.5)
Accommodation: patient has no available suitable accommodation options.	7 (8.1)	540 (17.0)	35 (17–50)
Carer funding: patient waiting funding for carers to ensure safe care after discharge.	3 (3.5)	81 (2.6)	27 (5–49)
Ambulatory rehabilitation: patient waiting assessment and/or availability of ambulatory rehabilitation services and no longer needing intensity of inpatient rehabilitation but the team feels patient is not able to be discharged until ambulatory rehabilitation is confirmed and available.	3 (3.5)	58 (1.8)	28 (1–29)
Guardian/power of attorney appointment: application made for determining power of attorney or guardian for making a decision that is blocking discharge planning and patient not competent and no nominated person existing. Also includes subsequent delay in decisions being made by nominated guardian regarding discharge planning.	3 (3.5)	77 (2.4)	27 (22–28)
Occupational therapy home assessment: patient no longer needs inpatient rehabilitation but home visit not yet done (but believed to be required) to confirm safe access and internal environment.	1 (1.1)	1 (0.0)	1
Other[b]	8 (9.3)	143 (4.5)	13.5 (7.5–25.5)

Abbreviations: IQR, interquartile range; SRU, spinal rehabilitation unit.
[a]Includes patients with multiple barriers so percentage totals greater than 100%.
[b]In this sample all the 'other' barriers were patients waiting for transfer to a rehabilitation unit in a regional centre closer to the patients' home.

and facilitators for discharge have been optimised within the limit of readily available resources. This definition allowed the team to consider a barrier to exist when resources or services (for example, carers, funding for equipment or home modifications or ambulatory rehabilitation) are not readily available to enable discharge to proceed but the patient no longer needed inpatient care.

The following information was also recorded: referral source (same health network or another network); age on admission to acute hospital (years); gender; level of SCD (tetraplegia or paraplegia) and aetiology of SCD (traumatic SCI or non-traumatic SCM). At SRU admission and discharge the American Spinal Injury Association Impairment Scale (AIS) grade of injury[17] and the motor subscale of the Functional Independence Measure (FIM) was recorded.[18]

Patients transferred back to an acute hospital for elective or emergency treatment during the course of their rehabilitation and who were subsequently readmitted back into the SRU were considered as having a continuation of their initial admission and not a separate new admission.

Data collection and storage

The occurrence of a discharge barrier, the cause(s) and date of onset or resolution were noted during the twice-weekly ward rounds and confirmed during the weekly team meeting. The data were recorded in a password-protected database prospectively by the advanced trainee in rehabilitation medicine or the unit head and reviewed by the unit head weekly to confirm their accuracy.

Statistical analysis

Descriptive analysis was performed including proportions, medians and interquartile range. The relationship between the occurrence of a discharge barrier and categorical variables was calculated using the Chi-squared test. The Wilcoxon rank-sum (Mann–Whitney) test was used to calculate the difference in the population distribution between variables that were not normally distributed. Odds ratios for the occurrence of a discharge barrier were calculated for the different comparison groups (males vs females, paraplegia vs tetraplegia, AIS grade A, B or C vs AIS D and SCI vs SCM).

The influence of the patients' age, gender, level of injury, AIS grade (dichotomised as AIS grade A, B or C vs AID D), aetiology (SCI vs SCM) and the discharge FIM-motor subscale on (a) the occurrence of a discharge barrier and (b) total number of unnecessary days in hospital, were assessed using multivariable logistic and linear regressions (backwards inclusion), respectively. The duration of unnecessary hospitalisation was log-transformed to facilitate parametric analysis. Age was categorised into three groups (<50, 50–64 and $\geqslant 65$ years) corresponding to different aged-based criteria for accessing programs or services available to patients at discharge.

All applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research. The Alfred Health Human Research Ethics Committee approved the project. *P* values of less than 0.05 were deemed statistically significant. Stata 12 for Windows (StataCorp, College Station, TX, USA) was used for statistical analysis.

RESULTS

There were 263 patients admitted during the study period but 28 were excluded (elective admissions from community), leaving 235 patients in the analysis, ranging in age from 17 to 88 years. On admission, 51 (21.7%) patients were AIS grade A, 25 (10.6%) were AIS B, 79 (33.6%) AIS C and 80 (34.0%) were AIS D.

Overall, 86 patients (36.6%, 95% confidence interval 30.4–43.1%) patients had a discharge barrier. The reasons for a discharge barrier and their definition,[16] the proportion of patients with each barrier and the number of associated additional unnecessary days in hospital is shown in Table 1. No patient had a discharge barrier due to waiting for competency assessment or a specialist review. The most common causes of a discharge barrier were: waiting for approval for long-term and supported care or services, residential care, home modifications, family deliberations regarding discharge planning and the provision of equipment necessary for discharge. The reasons accounting for the greatest number of additional hospital days were: home modifications, residential care, equipment necessary for discharge, waiting for approval for long-term and supported care or services and waiting for accommodation for people unable to return to their previous residence without readily available alternatives. Among patients with a discharge barrier, 34 had one barrier, 37 had two barriers and 15 patients had three or more barriers to discharge.

The proportion of patients in different categories (gender, level of injury, AIS grade on discharge and aetiology), their age, LOS in the SRU, motor FIM on admission and discharge and the proportion with a discharge barrier are shown in Table 2. Most patients ($n=162$, 68.9%) were discharged home, 35 (14.9%) were transferred to a nursing home, 16 (6.8%) were transferred to another rehabilitation

Table 2 Key patient groups and their disability on admission and discharge, the proportion with a discharge barrier, length of stay and duration of unnecessary additional days in hospital

	n *(%)*	*Age median (IQR)*[a]	*FIM-motor admission median (IQR)*[b]	*FIM-motor discharge median (IQR)*[c]	*Patients with a discharge barrier* n *(%)*[d]	*Odds Ratio of discharge barrier*[e] *(95%CI)*	*LOS median (IQR)*[f]	*Additional unnecessary days in hospital median (IQR)*[g]
Males	138 (58.7)	61 (48–72)	32 (20–45)	73 (47–82)	47 (34.1)	1	60.5 (29–111)	27 (15–41)
Females	97 (41.3)	65 (52–74)	29 (23–35)	63 (36–77)	39 (40.2)	1.3 (0.8–2.2)	70 (42–107)	26 (7–49)
Paraplegia	177 (75.3)	63 (48–73)	31 (24–43)	70 (43–80)	60 (33.9)	1	59 (34–102)	25.5 (9.5–45.5)
Tetraplegia	58 (24.7)	62 (52–72)	24 (13–37)	71 (32–81)	26 (44.8)	1.6 (0.9–2.9)	88.5 (47–120)	30.5 (22–41)
AIS A, B, C	100 (42.5)	63 (51–75)	25 (19–31)	40.5 (25.5–65)	45 (45)	1	81.5 (46.5–132)	26 (11–46)
AIS D	135 (57.5)	62 (47–73)	35 (28–49)	77 (68–83)	41 (30.4)	0.5 (0.3–0.9)	55 (28–97)	29 (14–42)
SCI	48 (20.4)	58.5 (39.5–72)	28 (14–41.5)	74.5 (52–83)	17 (35.4)	1	72.5 (28–111.5)	28 (26–35)
SCM	187 (79.6)	64 (51–73)	30 (23–42)	69 (40–79)	69 (36.9)	0.9 (0.5–1.8)	64 (36–108)	26 (11–45)
Total	235	63 (49–73)	30 (22–42)	71 (40–80)	86 (36.6)	—	64 (34–111)	27 (11–45)

Abbreviations: AIS, American Spinal Injury Association (ASIA) Impairment Scale; FIM-motor, functional independence measure motor subscale; IQR, interquartile range; LOS, length of stay; SCI, spinal cord injury; SCM, spinal cord myelopathy; 95%CI, 95% confidence interval.
[a]Age: gender $Z=-1.9$, $P=0.06$; level $Z=0.05$, $P=1.0$; AIS $Z=0.8$, $P=0.4$; aetiology $Z=1.6$, $P=0.1$.
[b]FIM-motor admission: gender $Z=1.1$, $P=0.3$; level $Z=3.4$, $P=0.0006$; AIS $Z=-5.9$, $P<0.0001$; aetiology $Z=1.5$, $P=0.1$.
[c]FIM-motor discharge: gender $Z=2.3$, $P=0.02$; level $Z=0.05$, $P=1.0$; AIS $Z=8.9$, $P<0.0001$; aetiology $Z=1.7$, $P=0.08$.
[d]Patients with discharge barrier: gender $\chi^2=1.4$, $P=0.2$; level $\chi^2=1.8$, $P=0.2$; AIS $\chi^2=4.4$, $P=0.04$; aetiology $\chi^2=0.04$, $P=0.8$.
[e]Gender $\chi^2=0.9$, $P=0.3$; level $\chi^2=2.2$, $P=0.1$; AIS $\chi^2=5.3$, $P=0.02$; aetiology $\chi^2=0.04$, $P=0.8$.
[f]LOS in SRU: gender $Z=1.1$, $P=0.3$; level $Z=-2.3$, $P=0.02$; AIS $Z=3.4$, $P=0.0007$; aetiology $Z=-0.04$, $P=1.0$.
[g]Additional unnecessary days in hospital: gender $Z=0.5$, $P=0.6$; level $X=-1.2$, $P=0.2$; AIS $Z=0.04$, $P=1.0$; aetiology $Z=-0.4$, $P=0.7$.

Table 3 Multivariable logistic regression for the occurrence of a discharge barrier

Variable	*Odds ratio (95%CI)*	Z, P
Age group		
<64	1[a]	—
⩾65	2.2 (1.2–4.0)	2.6, 0.01
Discharge motor FIM	0.97 (0.96–0.99)	−3.6, 0.001

Abbreviations: 95%CI, 95% confidence interval; FIM, functional independence measure.
[a]Reference group.

unit in a regional centre closer to their home for ongoing rehabilitation and 22 (9.4%) went to other destinations (acute hospitalization and did not return, $n=17$; retirement to village, $n=1$; hostel, $n=2$; palliative care, $n=1$; other, $n=1$). Patients discharged to a nursing home had much higher odds of a discharge barrier (odds 16.6, 95%CI 5.3–52.2, $\chi^2=43$, $P<0.0001$) compared with patients who went to other destinations.

Over the study period 17.5% (3176/18 184) of all bed-days were occupied by patients who were deemed to be clinically ready for discharge from the SRU but who had a discharge barrier. Thirty-five patients (40.7%) with a discharge barrier spent more than one additional month in rehabilitation and five patients had greater than 100 additional unnecessary days of hospitalisation (maximum 357 days). The LOS (median 107 days, IQR 74–149) for patients with a discharge barrier was significantly ($Z=-7.9$, $P<0.0001$) greater than that for patients who did not have a discharge barrier (median LOS 48 days, IQR 26–77).

Regression analysis showed that older patients (⩾65 years) had significantly greater odds of a discharge barrier than the younger group and the odds were reduced significantly with lesser disability on discharge (Table 3). The discharge FIM-motor subscale was the only variable that was significant ($P=0.004$) in the linear regression assessing the variables predicting the number of additional days in hospital but this explained only 9% of the variance in additional unnecessary bed-days.

DISCUSSION

Barriers to discharge from the SRU were relatively common and the number of unnecessary bed-days 'blocked' by these patients was substantial. These unnecessary days in hospital represent a substantial waste of health-care resources. Our hypothesis was proved—patients with a barrier to discharge have a significantly longer LOS.

Older patients had increased odds of a discharge barrier, in contrast to a previous study.[11] This might reflect the difficulty in sometimes predicting neurological and functional recovery in patients with SCM that formed the majority of patients due to the incomplete nature of their SCD and who typically were older. Family deliberations regarding discharge decisions (home with family providing care themselves or paying for cares vs residential care) were certainly a factor in numerous cases.

Barriers to the discharge of patients with SCD from a SRU can result in a number of adverse consequences. There is a flow-on affect that reduces access for other patients with SCD in acute hospital waiting for a SRU bed.[15] As well as wasting limited health-care resources that could be better utilized, when patients are in hospital for longer than necessary each additional day of hospitalisation is reported to increase by 6% the risk of iatrogenic complications, such as medication errors, nosocomial infections and falls.[19]

Our findings are consistent with previous studies regarding the causes of barriers to discharge for people with SCD. A study from The Netherlands highlighted problems for patients with SCD waiting for home modifications or alternative accommodation—a third of patients had their discharge delayed by a median of 15 weeks.[20] A study from the USA on barriers to community integration for patients with SCI found that the most common barriers were equipment issues and lack of environmental and home assistance.[21] Our findings provide substantiation of the survey results of perceptions from SRUs in 10 countries regarding problems with admission and discharge barriers, which found that the most common barriers matched those identified in this project.[14]

In a study of barriers to discharge from two rehabilitation units in a separate network to the SRU elsewhere in Melbourne, Australia, I found that 16.4% of patients had a barrier to discharge that accounted for 21.0% of all bed-days.[11] In this present study the proportion of patients with a discharge barrier was almost double but the proportion of bed-days occupied unnecessarily was slightly less. The reasons for a discharge barrier accounting for the greatest number of bed-days in hospital unnecessarily in the previous study were patients' non-weight bearing after lower limb fractures, home modifications, carer funding, family negotiations, accommodation and equipment necessary for discharge. Besides the non-weight bearing category, which is not relevant for patients with SCD in SRU, all the other barriers featured prominently in this study.

A strength of this study is the use of a validated classification for discharge barriers to identify opportunities for improvement.[16] Although delays to discharge from SRUs for patients with SCD have been highlighted previously,[14] these delays have not been systematically classified nor has the duration of the unnecessary days in hospital been quantified.

The results of this study cannot be generalised to other SRUs. This is because of the variability in hospital reimbursements systems and the organisation of care for patients with SCD that can influence length of stay.[22] It is important to emphasise, however, that SRUs from many different countries have also reported problems with barriers to discharge.[14] Furthermore, unless discharge barriers are measured, they cannot be improved. There is support internationally among those working in SRUs for prospective documentation of discharge barriers for benchmarking and quality improvement processes.[14] A framework for planning strategies to address barriers to discharge has been presented previously.[11]

Limitations of this study are that data was collected from only one SRU. There was potentially subjectivity involved with identifying discharge barriers and their duration. This was mitigated by having senior team members reach consensus during the team meeting regarding the occurrence and duration of a barrier using the validated categories and definition of discharge barrier.[16]

In conclusion, further study of discharge barriers for patients in SRUs is necessary. Including different centres and an increased number of participants, with adequate power to explore predictors of discharge barriers and the interaction between barriers, would be ideal. Qualitative studies and process mapping of the patient journey would provide additional insights into exploring and addressing barriers to discharge for all patients, including those with SCD. Health care policy makers and managers should allocate greater resources to tackling patient-flow inefficiencies for patients with SCD. Although these patients are low volume compared with other impairments, they are responsible for considerable costs.[23] Reducing discharge barriers for patients with SCD will potentially reduce iatrogenic complications and improve the efficiency of the hospital system.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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9.4 Appendix 4: Letters to the editor

9.4.1 BMJ letter on 'speeding up patient flow in rehabilitation'

BMJ 2015;350:h1290 doi: 10.1136/bmj.h1290 (Published 10 March 2015)

LETTERS

Speeding up patient flow in rehabilitation

Peter W New *rehabilitation physician*

Kingston Centre, Cheltenham, VIC 3192, Australia

Wise's recent news article made the important point that barriers to the discharge of patients from elsewhere in the hospital can contribute to problems with emergency department access.[1] This important problem has received scant attention in most discussions and publications on this topic.

An Australian survey of 101 key stakeholders in subacute patient flow and an international survey of specialists in spinal rehabilitation units show that most settings have major problems with patient flow.[2 3] Respondents reported barriers to the transfer of acute hospital patients to subacute hospitals and barriers to their discharge. Such barriers to patient flow are substantiated by reports that a noteworthy proportion of patients' hospital stay is spent in the wrong setting. Among patients waiting for rehabilitation, the proportion of the total acute hospital admission spent waiting for transfer ranged from 12% for general rehabilitation patients to 34% for those waiting for specialist spinal rehabilitation.[4 5] The proportion of total bed days spent waiting for barriers to discharge to be resolved was 21% for general rehabilitation patients and 18% for those with spinal cord damage.[6 7]

Dealing with the barriers to discharge from acute and subacute hospitals will improve patient outcomes by facilitating transfer to a more appropriate setting, reduce the risk of iatrogenic complications (such as falls and medication errors), and improve the flow of patients through the whole hospital system, including the emergency department. Policy makers and healthcare managers should consider allocating greater resources to dealing with this problem and not just focus on the emergency department. This strategy is patient centred (which patient wants to be in the wrong setting?) and likely to be more cost effective.

Competing interests: None declared.

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Cite this as: *BMJ* 2015;350:h1290

9.4.2 MJA letter from Dr McCarthy

Inpatient subacute care in Australia: perceptions of admission and discharge barriers

To the Editor: The recent article by New and colleagues[1] is an important piece in the "bed-block" picture, providing insight into perceived difficulties for patients on discharge, as a result of insufficient appropriate facilities.

The authors suggested that "Redistributing proposed funding for inpatient subacute beds to measures for overcoming these barriers" may improve patient flow through the whole hospital system. This idea fits well with current federal health policy that "bed equivalents" are an important aspect of innovative and flexible models of care for rehabilitation services in Australia.[2] Most states are reviewing how rehabilitation services are best designed to ensure the most effective use of limited resources, both in terms of programs and workforce.

Improving the coordination of programs managed by the various levels of government, across health, disability and the aged care sectors, will help overcome the barriers identified in this study. The Australasian Faculty of Rehabilitation Medicine applauds efforts to increase research on rehabilitation and patient care, and supports federal and state initiatives providing increased resources for subacute care, both within hospitals and in the community. Investment in rehabilitation services at the community level is one of the most viable solutions and will meet the needs of an ageing population. Effective community care and the proposed National Disability Insurance Scheme (http://www.ndis.gov.au), if well executed, will reduce the burden on other parts of the health and aged care sectors and help ease the burden on hospitals.

Kathleen McCarthy President

Australasian Faculty of Rehabilitation Medicine, Royal Australian College of Physicians, Sydney, NSW.
afrm@racp.edu.au

Competing interests: No relevant disclosures.

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9.5 Appendix 5: Media interest – AMA Victoria magazine ('Vicdoc' August 2013)

Study shows some rehab hospital stays unnecessary

A Victorian study has shown that many patients in rehabilitation units may face barriers to discharge even though they are fit to leave the unit. The study, by researchers from Monash University and Southern Health, found that 16 per cent of patients admitted to two Melbourne inpatient rehabilitation units had barriers to leaving once deemed clinically ready to be discharged.

Barriers included lack of alternative care for non-weight-bearing patients, family deliberations about discharge arrangements, no available accommodation, lack of carer funding and delays in availability of specialised equipment.

Over the course of the study, 21 per cent of all bed-days in the units were occupied by patients clinically ready for discharge from rehabilitation but who had a discharge barrier. According to the authors, this "significant" waste of health care resources is part of a wider issue of patient flow in hospitals, a concern usually focused on emergency departments or acute hospitals. This is the first study to address this issue in rehabilitation.

New P, Jolley D, Cameron P et al. A prospective multicentre study of barriers to discharge from inpatient rehabilitation. *MJA* **2013; 198: 104–08.**

9.6 Appendix: copy of web-based survey – perceptions of admission and discharge barriers

A Survey of subacute inpatient access and exit block

1. Introduction

This short survey is in reference to adult inpatients in subacute care. In particular, rehabilitation and aged-care units, but excluding dementia and psychogeriatric units.

The focus is on access barriers for acute hospital patient admission into subacute inpatient units, and subsequent exit block, or barriers to discharge, from inpatient care.

The results of this survey may be presented at conferences and published in a peer-reviewed journal with a view to stimulating debate and further research in this area.

The survey should take about 10 minutes to complete.

Please note, the survey will only to able to be completed once from any individual computer.

Thank you very much in anticipation of your participation and help with this research.

Dr Peter New
-Head, Acute Rehabilitation, Southern Health, Victoria, AUSTRALIA

If you have any questions regarding this survey, please email me at: [redacted]

*** 1. This survey is directed at either:**
a) Consultant Physicians or other medical practitioners involved in clinical work with adults admitted into rehabilitation or aged care subacute inpatient units, BUT excluding psychogeriatric and dementia units.
OR
b) Senior hospital management staff with responsibility that includes optimising patient flow/discharge from either:
- acute hospitals into subacute units, or
- from inpatient subacute units into the community.

Do either of these apply to you?

- ☐ Yes
- ☐ No

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2. State

*** 2. Where do you work? If more than one, indicate where you work most.**

- New South Wales/ACT
- Victoria
- Queensland
- South Australia
- Western Australia
- Tasmania
- Northern Territory

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3. Demographic details

*** 3. Which sector do you work in?**

- ☐ Public
- ☐ Private
- ☐ Both

*** 4. What is your gender?**

- ☐ Male
- ☐ Female

5. How old are you?

In years

*** 6. Please indicate your current position**

- ☐ Rehabilitation physician
- ☐ Aged care physician
- ☐ Senior hospital management with responsibility that includes optimising patient flow/discharge from hospital

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4. Rehabilitation medicine position details

This section is regarding your position in relation to inpatient rehabilitation

*** 7. Please indicate your current position**

- ☐ Consultant -head of subacute services at a hospital, health network or organisation
- ☐ Consultant -clinician

*** 8. How many inpatient rehabilitation beds do you have responsibility for?**

Clinically or as head of service (give latter if applicable)

*** 9. How many years have you worked as a consultant?**

Since Fellowship or other specialisation

*** 10. Please indicate your specialist training**

- ☐ AFRM
- ☐ RACP
- ☐ Both AFRM and RACP
- ☐ Dip Geriatric Medicine
- ☐ Other

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5. Other medical training or specialisation

*** 11. What is your medical specialisation or training?**

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6. Access to inpatient rehabilitation

Patients in acute hospital who are deemed to need inpatient rehabilitation and are stable and ready for transfer can wait a variable amount of time for a bed.

*** 12. How accessible are rehabilitation inpatient beds for acute hospital patients needing admission into**

	no access problem at all	minor access problem	moderate access problem	severe access problem	extreme access problem
your unit?	☐	☐	☐	☐	☐
your hospital or organisation?	☐	☐	☐	☐	☐
the health system in general?	☐	☐	☐	☐	☐

*** 13. It may help improve patient outcomes, and health system processes, to collect data on the timeliness of acute hospital patient access to inpatient rehabilitation and by using this information for benchmarking and quality improvement purposes.**

	strongly disagree	disagree	unsure	agree	strongly agree
To what extent do you agree with this	☐	☐	☐	☐	☐

14. Please indicate if you believe that any of the following contribute to difficulties with access to inpatient rehabilitation beds for your hospital/organisation

- ☐ number of inpatient rehabilitation beds
- ☐ physical/environmental issues eg lack of single rooms
- ☐ equipment issues eg lack of hoists, bariatric equipment
- ☐ staffing issues-nursing
- ☐ staffing issues-allied health

15. Please describe any other factor that you believe contributes to difficulties with access to inpatient rehabilitation.

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*** 16. As far as you know, does your organisation, service or unit currently collect data related to the timeliness of acute hospital patient access to inpatient rehabilitation that is used for benchmarking or quality improvement purposes?**

- Yes
- No

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7. Access to rehabilitation inpatient beds-what data

*** 17. What data on the timeliness of acute hospital patient access to rehabilitation inpatient beds does your organisation, service or unit currently collect?**

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8. Access to inpatient rehabilitation-possible indicators

It may be unrealistic to expect that all patients will be transferred from acute hospital to a rehabilitation unit on the day they are deemed to be appropriate and ready.

There is no established benchmark for what the waiting time should be for these patients.

With this in mind, and from the prespective of your area of clinical responsability, please indicate your thoughts on the following.

*** 18. What do you think is a realistic median waiting time from when acute hospital patients are deemed to be ready for inpatient rehabilitation by the designated assessment staff and the patients' subsequent admission?**

- 0 days-ie day deemed ready
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days
- 8 days
- 9 days
- 10 days
- 11 days
- 12 days
- 13 days
- 14 or more days

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*** 19. Alternatively, consider the percentage of time that acute hospital patients deemed to need subacute inpatient care spend out of their total acute hospital length of stay waiting for transfer.**

What do you think is a realistic target maximum % of total acute hospital length of stay spent waiting

for an inpatient rehabilitation bed?

*** 20. Also relevant to this issue is the time between referral from the acute hospital unit to the rehabilitation assessment service and when the patient is assessed.**

What do you think is a realistic median waiting time for this interval between referral and when the patient is assessed?

- 0 days-ie day of referral
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days
- 8 days
- 9 days
- 10 days
- 11 days
- 12 days
- 13 days
- 14 or more days

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21. Please list any other suggestions for other possible indicators of access to subacute inpatient care suitable for benchmarking or quality improvement purposes

*** 22. Do you think that any of the above suggested targets should be considered as possible Key Performance Indicators of access to subacute inpatient care?**

- No
- Yes

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9. Inpatient rehabilitation access: KPI

*** 23. Which of the 3 suggested Key Performance Indicators (KPI) for access to subacute inpatient beds would you favour? (you can indication more than one answer)**

- a nominated median waiting time from when acute hospital patients are referred until when they are assessed by the designated assessment staff
- a nominated median waiting time from when acute hospital patients are deemed to be ready for subacute inpatient care by the designated assessment staff until subsequent admission into a subacute inpatient unit
- a nominated percentage of total acute hospital length of stay that patients spend waiting for transfer to subacute inpatient care

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10. Rehabilitation speciality access Key Performance Indicators (KPIs)

*** 24. If access targets are adopted, do you think the targets for access to inpatient rehabilitation applied to both 'general' inpatient rehabilitation units and 'speciality' units (e.g. amputee, spinal cord injury, traumatic brain injury etc) should be**

- different
- the same

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11. Speciality rehabilitation and same rehab access KPIs

25. Please give your reasons for why you believe that the same inpatient rehabilitation access KPI should apply to both general and speciality rehabilitation units

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12. Speciality rehabilitation and different rehab access KPIs

*** 26. Do you believe that speciality inpatient rehabilitation units should have access KPIs that are lower or higher compared to general rehabilitation units?**

- Lower
- Higher

27. Please give your reasons for why you believe that different inpatient rehabilitation access KPI should apply to general and speciality rehabilitation units

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13. Discharge barriers for rehabilitation inpatients

Some rehabilitation inpatients care can have barriers to discharge after the treating team feel that there are no longer any additional goals that need ongoing inpatient rehabilitation, and yet the patient is unable to be discharged. In particular, after environmental barriers and facilitators for discharge had been optimised within the limit of readily available resources and the patients' activity limitations, body functions and structures dysfunction had been addressed as completely as possible and appropriately to no longer justify the need for an inpatient program to continue.

*** 28. How great a problem do you believe discharge barriers are for rehabilitation inpatients**

	no problem at all	minor problem	moderate problem	severe problem	extreme problem
in your unit?	☐	☐	☐	☐	☐
in your hospital or organisation?	☐	☐	☐	☐	☐
in the health system in general?	☐	☐	☐	☐	☐

*** 29. It may help improve patient outcomes and health system processes for subacute inpatients to collect data on discharge barriers and use this information for benchmarking and quality improvement purposes.**

	strongly disagree	disagree	unsure	agree	strongly agree
To what extent do you agree with this	☐	☐	☐	☐	☐

30. Please indicate if you believe that any of the following contribute to discharge barriers for subacute inpatients in your hospital/organisation

- ☐ Patients who are non-weight bearing after lower limb fractures
- ☐ Waiting for high level care
- ☐ Locating suitable accomodation
- ☐ Carer funding
- ☐ Home modification funding
- ☐ Equipment funding
- ☐ Lack of suitable ambulatory therapy options

31. Please list any other factors or causes that you believe contribute to discharge barriers for subacute inpatients

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*** 32. As far as you know, does your organisation, service or unit currently collect data related to discharge barriers for subacute inpatients that is used for benchmarking or quality improvement purposes?**

- Yes
- No

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14. Barriers to discharge from inpatient rehabilitation-what data

*** 33. What data on barriers to discharge from inpatient rehabilitation does your organisation/service or unit currently collect?**

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15. Barriers to discharge from inpatient rehabilitation-possible indicators

By nature of the current organisation of inpatient rehabilitation services in Australia, and the associated access to community services for disability support/carers/high level care, it is unrealistic to expect that all patients will be able to be discharged from inpatient rehabilitation on the day they are deemed to be ready for discharge.

There is no established benchmark for what is 'unreasonable' in terms of barriers to patient discharge from subacute care.

With this in mind, and from the prespective of your area of clinical responsibility, please indicate your thoughts on the following

*** 34. A realistic target maximum % of rehabilitation inpatients with a discharge barrier is:**

percent=

*** 35. Alternatively, consider the percentage of total inpatient rehabilitation bed days that are occupied by patients with a discharge barrier.**

A realistic target maximum % of total inpatient rehabilitation bed days that are occupied by patients with discharge barriers is:

percent=

36. Please list any other suggestion for other possible indicators of barriers to discharge for inpatient rehabilitation suitable for benchmarking or quality improvement purposes

*** 37. Do you think that either of the above suggested options should be considered as a Key Performance Indicator (KPI) for discharge from subacute inpatient care?**

- ☐ Yes
- ☐ No

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16. Rehabilitation discharge barriers: KPI

*** 38. Which of the 2 mentioned possible Key Performance Indicators (KPI) for discharge from subacute inpatient care would you favour?**

- A target maximum percentage of subacute inpatients with a discharge barriers
- A target maximum % of total subacute inpatient bed days that are occupied by patients with discharge barriers
- either
- both

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17. Rehabilitation discharge barriers: specialist vs general unit KPIs

*** 39. If targets are adopted for discharge barriers, do you think that the targets for discharge from inpatient rehabilitation applied to both 'general' inpatient rehabilitation units and 'speciality' units (e.g. amputee, spinal cord injury, traumatic brain injury etc) should be**

- the same
- different

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18. Speciality rehabilitation and same discharge barriers KPIs

40. Please give your reasons for why you believe that the same inpatient rehabilitation discharge KPI should apply to both general and speciality rehabilitation units

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19. Speciality rehabilitation and different rehab discharge KPIs

*** 41. Do you believe that speciality inpatient rehabilitation units should have discharge KPIs that are lower or higher compared to general rehabilitation units?**

- Lower
- Higher

42. Please give your reasons for why you believe that different inpatient rehabilitation discharge KPIs should apply to general and speciality rehabilitation units

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20. Aged care medical position details

This section is regarding your position in relation to subacute inpatients

*** 43. Please indicate your current position**

- ☐ Consultant -head of subacute services at a hospital, health network or organisation
- ☐ Consultant -clinician

*** 44. How many aged care inpatient beds do you have responsibility for?**

Clinically or as head of service (give latter if applicable)

*** 45. How many years have you worked as a consultant?**

Since Fellowship or other specialisation

*** 46. Please indicate your specialist training**

- ☐ AFRM
- ☐ RACP
- ☐ Both AFRM and RACP
- ☐ Dip Geriatric Medicine
- ☐ Other

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21. Medical training or specialisation

* **47. What is your medical specialisation or training?**

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22. Access to inpatient aged care

Patients in acute hospital who are deemed to need inpatient aged care and are stable and ready for transfer can wait a variable amount of time for a bed.

*** 48. How accessible are aged care inpatient beds for acute hospital patients needing admission into**

	no access problem at all	minor access problem	moderate access problem	severe access problem	extreme access problem
your unit?	☐	☐	☐	☐	☐
your hospital or organisation?	☐	☐	☐	☐	☐
the health system in general?	☐	☐	☐	☐	☐

*** 49. It may help improve patient outcomes and health system processes to collect data on the timeliness of acute hospital patient access to inpatient aged care and by using this information for benchmarking and quality improvement purposes.**

	strongly disagree	disagree	unsure	agree	strongly agree
To what extent do you agree with this	☐	☐	☐	☐	☐

50. Please indicate if you believe that any of the following contribute to difficulties with access to inpatient aged care for your hospital/organisation

- ☐ number of aged care inpatient beds
- ☐ physical/environmental issues eg lack of single rooms
- ☐ equipment issues eg lack of hoists, bariatric equipment
- ☐ staffing issues-nursing
- ☐ staffing issues-allied health

51. Please describe any other factor that you believe contributes to difficulties with access to inpatient aged care.

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*** 52. As far as you know, does your organisation, service or unit currently collect data related to the timeliness of acute hospital patient access to inpatient aged care that is used for benchmarking or quality improvement purposes?**

- Yes
- No

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23. Access to aged care inpatient beds-what data

*** 53. What data on the timeliness of acute hospital patient access to aged care inpatient beds does your organisation, service or unit currently collect?**

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24. Access to inpatient aged care-possible indicators

It may be unrealistic to expect that all patients will be transferred from acute hospital to an aged care unit on the day they are deemed to be appropriate and ready.

There is no established benchmark for what the waiting time should be for these patients.

With this in mind, and from the prespective of your area of clinical responsability, please indicate your thoughts on the following.

*** 54. What do you think is a realistic median waiting time from when acute hospital patients are deemed to be ready for inpatient aged care by the designated assessment staff and the patients' subsequent admission?**

- 0 days-ie day deemed ready
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days
- 8 days
- 9 days
- 10 days
- 11 days
- 12 days
- 13 days
- 14 or more days

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*** 55. Alternatively, consider the percentage of time that acute hospital patients deemed to need subacute inpatient care spend out of their total acute hospital length of stay waiting for transfer.**

What do you think is a realistic target maximum % of total acute hospital length of stay spent waiting

for an inpatient aged care bed?

*** 56. Also relevant to this issue is the time between referral from the acute hospital unit to the aged care service for consideration of admission and when the patient is assessed.**

What do you think is a realistic median waiting time for this interval between referral and when the patient is assessed?

- 0 days-ie day of referral
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days
- 8 days
- 9 days
- 10 days
- 11 days
- 12 days
- 13 days
- 14 or more days

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57. Please list any other suggestion for other possible indicators of access to subacute inpatient care suitable for benchmarking or quality improvement purposes

*** 58. Do you think that any of the above suggested targets should be considered as possible Key Performance Indicators of access to subacute inpatient care?**

- Yes
- No

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25. Inpatient aged care access: KPI

*** 59. Which of the 3 suggested Key Performance Indicators (KPI) for access to subacute inpatient beds would you favour? (you can indication more than one answer)**

- a nominated median waiting time from when acute hospital patients are referred until when they are assessed by the designated assessment staff
- a nominated median waiting time from when acute hospital patients are deemed to be ready for subacute inpatient care by the designated assessment staff until subsequent admission into a subacute inpatient unit
- a nominated percentage of total acute hospital length of stay that patients spend waiting for transfer to subacute inpatient care

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26. Discharge barriers for aged care inpatients

Some inpatients in aged care can have barriers to discharge after the treating team feel that there are no longer any additional goals that need ongoing inpatient care, and yet the patient is unable to be discharged. In particular, after environmental barriers and facilitators for discharge had been optimised within the limit of readily available resources and the patients' activity limitations, body functions and structures dysfunction had been addressed as completely as possible and appropriately to no longer justify the need for a subacute inpatient program to continue.

*** 60. How great a problem do you believe discharge barriers are for aged care inpatients**

	no problem at all	minor problem	moderate problem	severe problem	extreme problem
in your unit?	☐	☐	☐	☐	☐
in your hospital or organisation?	☐	☐	☐	☐	☐
in the health system in general?	☐	☐	☐	☐	☐

*** 61. It may help improve patient outcomes and health system processes for subacute inpatients to collect data on discharge barriers and use this information for benchmarking and quality improvement purposes.**

	strongly disagree	disagree	unsure	agree	strongly agree
To what extent do you agree with this	☐	☐	☐	☐	☐

62. Please indicate if you believe that any of the following contribute to discharge barriers for aged care inpatients in your hospital/organisation

- ☐ Patients who are non-weight bearing after lower limb fractures
- ☐ Waiting for high level care
- ☐ Locating suitable accomodation
- ☐ Carer funding
- ☐ Home modification funding
- ☐ Equipment funding
- ☐ Lack of suitable ambulatory therapy options

63. Please list any other factors or causes that you believe contribute to discharge barriers for subacute inpatients

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*** 64. As far as you know, does your organisation, service or unit currently collect data related to discharge barriers for subacute inpatients that is used for benchmarking or quality improvement purposes?**

- Yes
- No

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27. Barriers to discharge from inpatient aged care-what data

*** 65. What data on barriers to discharge from inpatient aged care does your organisation/service or unit currently collect?**

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28. Barriers to inpatient aged care discharge-possible indicators

By nature of the current organisation of inpatient aged care in Australia, and the associated access to community services for disability support/carers/high level care, it is unrealistic to expect that all patients will be able to be discharged from inpatient aged are on the day they are deemed to be ready for discharge.

There is no established benchmark for what is 'unreasonable' in terms of barriers to patient discharge from aged care.

With this in mind, and from the prespective of your area of clinical responsibility, please indicate your thoughts on the following

*** 66. A realistic target maximum % of aged care inpatients with a discharge barrier is:**

percent=

*** 67. Alternatively, consider the percentage of total aged care inpatient bed days that are occupied by patients with a discharge barrier.**

A realistic target maximum % of total aged care inpatient bed days that are occupied by patients with discharge barriers is:

percent=

68. Please list any other suggestion for other possible indicators of barriers to discharge for subacute inpatients suitable for benchmarking or quality improvement purposes

*** 69. Do you think that either of the above suggested options should be considered as a Key Performance Indicator (KPI) for discharge from subacute inpatient care?**

- Yes
- No

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29. Inpatient aged care discharge barriers: KPI

*** 70. Which of the 2 mentioned possible Key Performance Indicators (KPI) for discharge from subacute inpatient care would you favour?**

- A target maximum percentage of subacute inpatients with a discharge barriers
- A target maximum % of total subacute inpatient bed days that are occupied by patients with discharge barriers
- either
- both

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30. Hospital management position details

The section is in relation to your position as a hospital manager and subacute inpatient bed access or discharge efficiency

*** 71. Please indicate your current management position?**

- Senior hospital management with responsibility for optimising patient discharge from acute hospitals into subacute inpatient units.
- Senior hospital management with responsibility for optimising patient discharge from subacute inpatient units into the community or alternative care.
- Senior hospital management with responsibility for optimising patient discharge from BOTH acute hospitals into subacute inpatient units and from subacute inpatient units into the community or alternative care.

*** 72. How many years have you worked as a hospital manager at a level where you have responsibility for patient discharge?**

or related areas

*** 73. How many subacute inpatient beds does your hospital or organisation have**

that you are involved with access or discharge responsibility for?

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31. Hospital management: Access to subacute care

Patients in acute hospital who are deemed to need inpatient subacute care and are stable and ready for transfer can wait a variable amount of time for a bed.

*** 74. How accessible are subacute inpatient beds for acute hospital patients needing admission into**

	no access problem at all	minor access problem	moderate access problem	severe access problem	extreme access problem
your hospital or organisation?	☐	☐	☐	☐	☐
the health system in general?	☐	☐	☐	☐	☐

*** 75. It may help improve patient outcomes and health system processes to collect data on the timeliness of acute hospital patient access to subacute inpatient care and by using this information for benchmarking and quality improvement purposes.**

	strongly disagree	disagree	unsure	agree	strongly agree
To what extent do you agree with this	☐	☐	☐	☐	☐

76. Please indicate if you believe that any of the following contribute to difficulties with access to subacute inpatient beds for your hospital/organisation

- ☐ number of subacute inpatient beds
- ☐ physical/environmental issues eg lack of single rooms
- ☐ equipment issues eg lack of hoists, bariatric equipment
- ☐ staffing issues-nursing
- ☐ staffing issues-allied health

77. Please describe any other factor that you believe contributes to difficulties with access to subacute inpatient beds.

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*** 78. As far as you know, does your organisation, service or unit currently collect data related to the timeliness of acute hospital patient access to subacute inpatient beds that is used for benchmarking or quality improvement purposes?**

- Yes
- No

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32. Access to subacute inpatient beds-what data

*** 79. What data on the timeliness of acute hospital patient access to subacute inpatient beds does your organisation, service or unit currently collect?**

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33. Access to subacute inpatient care-possible indicators

It may be unrealistic to expect that all patients will be able to be transferred from acute hospital to a subacute rehabilitation or aged care unit on the day they are deemed to be appropriate and ready.

There is no established benchmark for what the waiting time should be for these patients.

With this in mind, and from the prespective of your area of clinical responsability, please indicate your thoughts on the following.

*** 80. What do you think is a realistic median waiting time from when acute hospital patients are deemed to be ready for subacute inpatient care by the designated assessment staff and the patients' subsequent admission into a subacute unit?**

- ☐ 0 days-ie day deemed ready
- ☐ 1 day
- ☐ 2 days
- ☐ 3 days
- ☐ 4 days
- ☐ 5 days
- ☐ 6 days
- ☐ 7 days
- ☐ 8 days
- ☐ 9 days
- ☐ 10 days
- ☐ 11 days
- ☐ 12 days
- ☐ 13 days
- ☐ 14 or more days

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*** 81. Alternatively, consider the percentage of time that acute hospital patients deemed to need subacute inpatient care spend out of their total acute hospital length of stay waiting for transfer.**

What do you think is a realistic target maximum % of total acute hospital length of stay spent waiting

for a subacute inpatient bed?

*** 82. Also relevant to this issue is the time between referral from the acute hospital unit to the subacute assessment service and when the patient is assessed.**

What do you think is a realistic median waiting time for this interval between referral and when the patient is assessed?

- 0 days-ie day of referral
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days
- 8 days
- 9 days
- 10 days
- 11 days
- 12 days
- 13 days
- 14 or more days

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83. Please list any other suggestion for other possible indicators of access to subacute inpatient care suitable for benchmarking or quality improvement purposes

*** 84. Do you think that any of the above suggested targets should be considered as possible Key Performance Indicators of access to subacute inpatient care?**

- No
- Yes

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34. Inpatient subacute access: KPI

*** 85. Which of the 3 suggested Key Performance Indicators (KPI) for access to subacute inpatient beds would you favour? (you can indication more than one answer)**

- a nominated median waiting time from when acute hospital patients are referred until when they are assessed by the designated assessment staff
- a nominated median waiting time from when acute hospital patients are deemed to be ready for subacute inpatient care by the designated assessment staff until subsequent admission into a subacute inpatient unit
- a nominated percentage of total acute hospital length of stay that patients spend waiting for transfer to subacute inpatient care

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35. Discharge barriers for subacute inpatients

Some inpatients in subacute care can have barriers to discharge after the treating team feel that there are no longer any additional goals that need ongoing inpatient rehabilitation or aged care, and yet the patient is unable to be discharged. In particular, after environmental barriers and facilitators for discharge had been optimised within the limit of readily available resources and the patients' activity limitations, body functions and structures dysfunction had been addressed as completely as possible and appropriately to no longer justify the need for a subacute inpatient program to continue.

*** 86. How great a problem do you believe discharge barriers are for subacute inpatients**

	no problem at all	minor problem	moderate problem	severe problem	extreme problem
in your hospital or organisation?	☐	☐	☐	☐	☐
in the health system in general?	☐	☐	☐	☐	☐

*** 87. It may help improve patient outcomes and health system processes for subacute inpatients to collect data on discharge barriers and use this information for benchmarking and quality improvement purposes.**

	strongly disagree	disagree	unsure	agree	strongly agree
To what extent do you agree with this	☐	☐	☐	☐	☐

88. Please indicate if you believe that any of the following contribute to discharge barriers for subacute inpatients in your hospital/organisation

- ☐ Patients who are non-weight bearing after lower limb fractures
- ☐ Waiting for high level care
- ☐ Locating suitable accomodation
- ☐ Carer funding
- ☐ Home modification funding
- ☐ Equipment funding
- ☐ Lack of suitable ambulatory therapy options

89. Please list any other factors or causes that you believe contribute to discharge barriers for subacute inpatients

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*** 90. As far as you know, does your organisation, service or unit currently collect data related to discharge barriers for subacute inpatients that is used for benchmarking or quality improvement purposes?**

- Yes
- No

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36. Barriers to discharge from inpatient subacute care-what data

* **91. What data on barriers to discharge from subacute inpatient care does your organisation/service or unit currently collect?**

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37. Barriers to subacute inpatient discharge-possible indicators

By nature of the current organisation of subacute inpatient services in Australia, and the associated access to community services for disability support/carers/high level care, it is unrealistic to expect that all patients will be able to be discharged from subacute inpatient care on the day they are deemed to be ready for discharge.

There is no established benchmark for what is 'unreasonable' in terms of barriers to patient discharge from subacute care.

With this in mind, and from the prespective of your area of clinical responsibility, please indicate your thoughts on the following

*** 92. A realistic target maximum % of subacute inpatients with a discharge barrier is:**

percent=

*** 93. Alternatively, consider the percentage of total subacute inpatient bed days that are occupied by patients with a discharge barrier.**

A realistic target maximum % of total subacute inpatient bed days that are occupied by patients with discharge barriers is:

percent=

94. Please list any other suggestion for other possible indicators of barriers to discharge for subacute inpatients suitable for benchmarking or quality improvement purposes

*** 95. Do you think that either of the above suggested options should be considered as a Key Performance Indicator (KPI) for discharge from subacute inpatient care?**

- No
- Yes

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38. Subacute discharge barriers: KPI

*** 96. Which of the 2 mentioned possible Key Performance Indicators (KPI) for discharge from subacute inpatient care would you favour?**

- A target maximum percentage of subacute inpatients with a discharge barriers
- A target maximum % of total subacute inpatient bed days that are occupied by patients with discharge barriers
- either
- both

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39. Almost finished...

97. Please give any other comments or thoughts on access to subacute inpatient beds for acute hospital patients OR their subsequent barriers to discharge

*** 98. Would you be interested in participating in a follow-up survey on subacute inpatient access and discharge barriers**

- Yes
- No

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40. Contact details for follow-up survey

99. Please give your email address for a follow-up survey on subacute inpatient access and discharge barriers.

This will not be used for any other purpose or passed on to any other organisation or person

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41. Contact details for copy of results

100. Please give your email address if you are interested in a copy of the results of this survey.

This will not be used for any other purpose or passed on to any other organisation or person.

A Survey of subacute inpatient access and exit block

42. And finally, thank you very much for your time and interest in completing t...

101. In appreciation for your time and effort in completing this survey, a $100 gift voucher will be given away at random. To be in the draw for this please give your email address below.

cheers
:-)
Dr Peter New