The effectiveness of a physiatrist-led acute hospital based postoperative hip fracture inpatient rehabilitation program: A single-center retrospective study

Jing Chen¹, Chek Wai Bok¹, Yi Ping Ren², Hongyun Xu³, and Yi Chiong¹

Abstract

Background: Postoperative hip fracture rehabilitation in Singapore has historically been carried out in both acute and community hospitals (CH). An increasing majority of patients with hip fractures now receive inpatient rehabilitation in CH, and it is often believed that Acute hospital (AH) - based rehabilitation may be less cost-effective than their CH counterparts. Objective: This retrospective study aims to review the effectiveness of an AH-based hip fracture postoperative rehabilitation program.

Methods: This study retrospectively reviewed the database of postoperative hip fracture patients who underwent a physiatrist-led AH-based inpatient rehabilitation from Jan 2010 to Dec 2016. The primary outcomes were the functional improvement assessed by functional independence measure (FIM) and FIM efficiency. The secondary outcome included the length of stay (LOS), successful discharge to home rate, mortality rate, and complication rate.

Results: A total of 293 cases were included in the study. After participation in the inpatient rehabilitation program, the mean total FIM increased from 83.9 ± 12.7 (mean ± SD) to 93.9 ± 16.2 (p < .001). The motor FIM increased from 47.1 ± 10.9 to 56.1 ± 10.1 (p < .001). 269 (91.8%) patients were successfully discharged home. Inpatient mortality was 0.3% (1/293). The complications rate during inpatient rehabilitation was 16.0% with urinary tract infection being the most frequent complication (10.2%). The median LOS for inpatient rehabilitation was 19 days (15, 28).

Conclusions: After completing a physiatrist-led postoperative hip fracture inpatient rehabilitation program in an acute hospital, patients demonstrated significant functional improvement (p < .0001). The inpatient rehabilitation program has a high discharge home rate and low in-hospital mortality.

Keywords
Hip fracture, inpatient rehabilitation, orthopaedic surgery

Introduction

Hip fracture is a disabling condition that is associated with significant morbidity and mortality. Hip fractures negatively affect patients’ independence in activities of daily living (ADLs), leading to higher institutionalization rates and a substantial loss of healthy life expectancy in patients.¹⁻³ Early integrated care after hip fracture surgery has been shown to improve clinical outcomes for patients with hip fractures.¹⁻³ The importance of postoperative rehabilitation has been emphasized through several studies with the potential to maximize post-operative recovery.
Various postoperative rehabilitation care models have been developed to improve clinical outcomes while maintaining cost-effectiveness.6–9 However, few studies have evaluated how healthcare institutions can better strategize in enhancing functional outcomes specifically post-hip fracture surgery.10–12 Similarly in Singapore, various programmes have been developed to improve postoperative care.13–15 Postoperative hip fracture rehabilitation in Singapore has historically been carried out in both acute (AH) and community hospitals (CH). With the development of new hip fracture pathways, an increasing majority of patients with hip fractures now receive inpatient rehabilitation in CH, and it is often believed that AH-based rehabilitation may be less cost-effective than their CH counterparts. However, the effectiveness of an AH-based postoperative hip fracture rehabilitation in Singapore has been poorly evaluated. This retrospective study aims to review the effectiveness of an AH-based hip fracture postoperative rehabilitation program. We hypothesized that such program is effective in reducing complications and improving functional outcomes in patients with hip fracture.

Methods

Study design and participants

A retrospective analysis was performed on patients who were admitted to the Department of Orthopedic Surgery (OTO) in an acute hospital with a diagnosis of hip fracture, completed hip fixation surgery, and transferred to the Department of Rehabilitation Medicine (RMD) for inpatient rehabilitation from January 2010 to December 2016. The admission criteria to the inpatient rehabilitation program were as follows: (i) patients were admitted to OTO in this acute hospital with the primary diagnosis of hip fracture(s), and they underwent surgical fixation during the same admission; (ii) They were allowed full weight-bearing or partial weight-bearing after the surgery; (iii) they were medically stable and fit for inpatient rehabilitation based on the assessment from a physiatrist. The exclusion criteria were as follows: (i) Patients with hip fractures were admitted to other disciplines rather than OTO; (ii) Patients did not go for surgical fixation; (iii) The weight-bearing status was non weight-bearing after surgery; (iv) Patients were medically not stable.

Demographic information such as age, gender, race, premorbid ADLs reported by patient or family, diagnoses (types of hip fractures), types of surgical fixations, and weight-bearing status after surgery were collected. Pre-existing co-morbidities (hypertension, diabetes, previous stroke, ischemic heart disease, cancer, peripheral vascular disease, osteoporosis) were also collected. The study design was approved by the hospital’s institutional review board (IRB). Data were manually extracted from the hospital’s computer record system.

The inpatient rehabilitation program

All patients were assessed by ward therapists within 24 hours (24 h) after surgery. Patients who were allowed to weight-bear postoperatively were identified for early mobilization and rehabilitation, while patients of non-weight bearing status were taught bedside exercises. Within 48 h after surgery, patients were reviewed by a physiatrist or a rehabilitation-trained advanced practice nurse (APN) to assess the patients’ suitability for the inpatient rehabilitation program. Once patients were accepted, they were transferred to a dedicated rehabilitation ward for the postoperative rehabilitation program.

The rehabilitation program was provided based on the best practice guidelines and tailored to each patient’s needs and tolerance.16–19 This physiatrist-led team consisted of a multidisciplinary team including rehabilitation nurses, physiotherapists, occupational therapists, medical social workers and dietitians. The medical team would conduct a medical ward round daily to review issues encountered during therapy. They would then discuss with therapists how to further plan subsequent sessions, which comprised a one-on-one therapy session by therapists specializing in musculoskeletal disorders. The duration of physio- and occupational therapy were minutes (min) each, for a minimum of 5 days per week. Reviews by dietitians were done regularly to assess each patient’s nutritional status. Medical social workers evaluated and facilitated care arrangements as well as provided psychosocial support to these patients.

Baseline functional assessment was carried out by the rehabilitation team within the first 3 days of RMD transfer using the Functional independence measure (FIM).20 The FIM scores were charted weekly to monitor rehabilitation progress and guide the subsequent therapy plans. A weekly multidisciplinary team meeting was held to discuss each patient’s rehabilitation goals, progress, nutritional status, and discharge plans so as to develop a holistic rehabilitation program personalized to their individual needs.

Outcome measures

The primary outcomes were (i) the total and motor FIM upon transfer to RMD, and upon discharge from RMD; and (ii) the FIM efficiency (FIM gain divided by length of stay). The secondary outcome included the length of stay (LOS), successful discharge to home rate, mortality rate, and complication rate. Postoperative complications analyzed included urinary tract infection, pneumonia, deep vein thrombosis, wound infection, stroke, and acute myocardial infarction.

Statistical analysis

Descriptive analyses were used to summarize patient characteristics. Normality of the continuous variables was examined using the Shapiro-Wilk’s test and histogram. Mean (standard deviation, SD) was presented for normally distributed variables and median (interquartile range, IQR) was presented for continuous variables with skewed distribution. Frequencies and percentages were used to summarize categorical data. The paired t-test was used to analyze if there was a difference in the FIM upon transfer to RMD and upon discharge from RMD. The proportions of patients whose FIM change scores have exceeded the minimally clinically
important difference (MCID; defined as 22 for total FIM gain and 17 for motor FIM gain) were computed, together with Wilson 95% confidence intervals. All analyses were done using R 3.4.2, and a two-sided $p < 0.05$ was used to declare statistical significance.

**Results**

**Baseline characteristics**

From January 2010 to December 2016, a total of 293 hip fracture patients were enrolled into the postoperative inpatient rehabilitation program in this acute hospital. Patient demographics are summarized in Table 1.

The median age of the study population was 75 (71, 81) years, with 69.6% being female. The ethnicity comprised 89.1% Chinese, 5.8% Malay, 3.4% Indian, and 1.9% others. 97.2% of patients were of independent premorbid function. 68.2% of patients had pre-existing hypertension, 46.8% hyperlipidemia, 30.4% Diabetes mellitus (DM) 14.6% ischemic heart disease, 13.6% stroke, 9.6% cancer, and 0.6% peripheral vascular disease. The majority of the cases were allowed partial or full weight-bearing after surgery (95.3%). 61.1% of the patients were diagnosed with a neck of femur (NOF) fracture, 37.2% intertrochanteric (IT) fracture, and 1.7% subtrochanteric fracture. The surgical procedures included hemiarthroplasty (unipolar and bipolar, 49.1%), proximal femoral nail anti-rotation (33.8%), dynamic hip screw insertion (10.6%), intramedullary nailing (3.4%), and total hip replacement (3.1%) (Table 2).

**Outcome measures**

After participation in the inpatient rehabilitation program, the mean total FIM increased from 83.9 ± 12.7 (mean ± SD) to 93.9 ± 16.2 ($p < .001$). The motor FIM increased from 47.1 ± 10.9 to 56.1 ± 10.1 ($p < .001$). Based on a previous study in a stroke population, the minimal clinically important difference (MCID) for total FIM and motor FIM are 22 and 17 respectively. The proportion of patients whose total FIM change exceeded MCID was 10.9%, and the proportion of patients with motor FIM change exceeded MCID was 16.1%. The detailed results are displayed in Table 3.

Of the total 293 cases reviewed, 269 (91.8%) patients were successfully discharged home. Of the remaining 24 (8.2%) patients, 9 (3.1%) were transferred to CH for further rehabilitation, 9 (3.1%) were transferred back to acute disciplines, 5 (1.7%) were transferred to a nursing home, and 1 (0.3%) died. Complications rate during inpatient rehabilitation was 16.0%, with urinary tract infection being the most frequent complication (10.2%), followed by pneumonia (2.0%), deep vein thrombosis (1.7%), wound infection (1.0%), wound breakdown (0.3%), acute myocardial infarction (0.3%), and stroke (0.3%). Mean total FIM gain was 10.3 ± 13.3 (mean ± SD), with mean FIM efficiency of 0.44 ± 0.89. Mean motor FIM gain was 9.0 ± 11.4. The median LOS in RMD was 19 days (15, 28). Median LOS in acute discipline was 9 days (6, 13), and median total LOS was 29 days (23, 35). The above results were shown in Table 4.

**Discussion**

This is a retrospective study assessing the effectiveness of a physiatrist-led AH-based early integrated hip fracture inpatient rehabilitation program. This study revealed that the functional status of patients have improved after participation. High discharge-to-home and low in-hospital mortality rates were observed. In Singapore, some studies have evaluated hip fracture pathways and the effectiveness of CH-based rehabilitation programs. Doshi HK et al. described an integrated care pathway model which involved timely admission, review, surgery, rehabilitation, and transfer (ARSRBT) leading to positive clinical outcomes. Tan AK et al. analyzed the effectiveness of an CH-based rehabilitation. However, few studies evaluate hip fracture programs...
There are a few learning points derived from this study. Firstly, the described rehabilitation program in our study was provided by a physiatrist-led multidisciplinary team in the rehabilitation ward in an acute hospital. Multidisciplinary team care for hip fracture patients has been shown to improve clinical outcomes in previous studies. A randomized controlled trial showed early multidisciplinary daily geriatric care reduces in-hospital mortality and medical complications in elderly patients with hip fractures. To successfully develop and implement a hip fracture rehabilitation program, strong physician leadership is necessary. The previous study done in Japan showed that the participation of board-certified physiatrists is associated with good rehabilitation outcomes in patients with hip fractures. In this physiatrist-led study, significant functional improvement has been achieved in patients with hip fractures. Having a physiatrist as the team leader enables the most updated exercise guidelines to be administered and tailored to the individual’s need, and facilitates more effective communication with the therapists. Secondly, this program emphasized early initiation of rehabilitation, intensive rehabilitation, and continuity of care. The input from a physiatrist or a rehabilitation medicine trained APN was obtained within 48 h after surgery, and the rehabilitation program commenced as soon as patients were medically fit. Continuous care was ensured throughout the rehabilitation journey as the patients continued to receive input from RMD after transfer to inpatient rehabilitation. Although the study by Doshi HK et al. also emphasized early rehabilitation, the rehabilitation program was conducted by the therapists without any input from a physiatrist. The input from physiatrists is important in terms of adherence to the exercise guidelines and tailoring to patients’ needs. Lastly, serial functional assessment with FIM allowed for dynamic monitoring and feedback to guide the planning of an individualized rehabilitation program. Various outcome measures used in hip fracture have been discussed in previous literature. Among these instruments, FIM is a well-

### Table 3. Comparison of functional independence measure (FIM) on admission to department of rehabilitation medicine and on discharge.

|                      | On transfer to RMD  | On discharge       | p-value \(^a\) | Proportion of patients whose FIM change scores have exceeded the MCID \(95\%\, \text{CI}) \(^b\) |
|----------------------|---------------------|--------------------|----------------|---------------------------------|
|                      | mean (SD)           | mean (SD)          |                |                                 |
| Total FIM            | 83.9 (12.7)         | 93.9 (16.2)        | <0.001         | 10.9 (7.7, 15.2)                |
| Motor FIM            | 47.1 (10.9)         | 56.1 (10.1)        | <0.001         | 16.1 (12.1, 21.0)               |

\(^a\) p-value calculated using paired t-test  
\(^b\) 95\% CI computed using Wilson confidence intervals. MCID is 22 for total FIM and 17 for motor FIM. FIM: Functional independence measure; RMD: Department of Rehabilitation Medicine.

### Table 4. Effectiveness of the inpatient rehabilitation program.

| Discharge destination; \(n\) (%)                        | All patients \((n = 293)\) |
|--------------------------------------------------------|----------------------------|
| Home                                                   | 269 (91.8%)                |
| Transfer back to acute disciplines                     | 9 (3.1%)                   |
| Transfer to community hospital for rehabilitation       | 9 (3.1%)                   |
| Transfer to nursing home                               | 5 (1.7%)                   |
| Total FIM gain; mean (SD)                              | 10.3 (13.3)                |
| Motor FIM gain; mean (SD)                              | 9.0 (11.4)                 |
| FIM efficiency; mean (SD)                              | 0.44 (0.89)                |
| Length of stay (days); median (IQR)                    |                            |
| In RMD                                                 | 19 (15, 28)                |
| In acute discipline                                    | 9 (6, 13)                  |
| Total duration of stay in acute setting and RMD        | 29 (23, 35)                |
| In-hospital mortality; \(n\) (%)                       | 1 (0.3%)                   |
| Complications; \(n\) (%)                               |                            |
| Urinary tract infection                                | 30 (10.2%)                 |
| Pneumonia                                              | 6 (2.0%)                   |
| Deep vein thrombosis                                   | 5 (1.7%)                   |
| Wound infection                                        | 3 (1.0%)                   |
| Wound breakdown                                        | 1 (0.3%)                   |
| Acute myocardial infarction                            | 1 (0.3%)                   |
| Stroke                                                 | 1 (0.3%)                   |
| No. of patients with at least 1 complication; \(n\) (%) | 40 (16.0%)                 |

\(^a\) One patient can have multiple complications.  
FIM: Functional independence measure.
recognized functional assessment tool to assess activity and participation and has been used as the outcome measurement in previous hip fracture studies.\textsuperscript{20,28–31} By using FIM, which is a widely accepted outcome measure, the study could evaluate the effectiveness of a rehabilitation program. The trend of the FIM score was reviewed for every patient and the rehabilitation program would be further modified based on the feedback from the FIM improvement. Of note, although the MCID of FIM scores has been established in stroke populations, it has not been established in the hip fracture populations yet.\textsuperscript{21} Hence, the proportion of patients whose FIM change exceeded MCID needs to be interpreted prudently.

There are several limitations of this study design. Firstly, there was no control group to provide a direct comparison with patients who received inpatient rehabilitation in the CH setting. Although there is local data on hip fracture rehabilitation in CH published which showed longer LOS than our study, there could be selection bias as the study group could be different. Without a control group in this study, it is not possible to exclude the possibility that such significant functional gain was from natural recovery and usual care. Secondly, this study did not evaluate the cost-effectiveness of conducting rehabilitation programs in AH. One concern of keeping patients in AH for rehabilitation is cost-effectiveness. Without cost-effectiveness analysis, it would be difficult to compare with rehabilitation in community hospital settings. Thirdly, the data only analyzed the patients that were transferred to RMD for inpatient rehabilitation, but not those who were potentially eligible. Data on the actual duration of each therapy session was not captured. Furthermore, the number of cases with dementia or cognitive impairment was not collected, and there was no post-discharge follow-up of the study group. These are important information factors for rehabilitation programs.

Conclusion
After completing a physiatrist-led postoperative hip fracture inpatient rehabilitation program in an acute hospital, patients demonstrated significant functional improvement ($p < .0001$). The inpatient rehabilitation program has a high discharge home rate and low in-hospital mortality.

Author contributions
CY was involved in study design, protocol development, gaining ethical approval. RYP and XHY were involved in data collection and data analysis. CJ wrote the first draft of the manuscript. BCW reviewed and edited the manuscript. All authors reviewed and approved the final version of the manuscript.

Availability of data
The datasets generated and/or analysed during the current study are available from the corresponding author.

Declarations of conflicting interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval
The study design was approved by the institutional review board (IRB).

Funding
The author(s) received no financial support for the research, authorship, and/or publication of this article.

Informed Consent
This is a retrospective study and informed consent was not taken.

ORCID iD
Jing Chen https://orcid.org/0000-0002-9126-5439

References
1. Dyer SM, Crotty M, Fairhall N, et al. A critical review of the long-term disability outcomes following hip fracture. \textit{BMC Geriatrics} 2016; 16: 158. DOI: 10.1186/s12877-016-0332-0.
2. Papadimitriou N, Tsilidis KK, Orfanos P, et al. Burden of hip fracture using disability-adjusted life-years: a pooled analysis of prospective cohorts in the CHANCES consortium. \textit{The Lancet Public Health} 2017; 2: e239–e246. DOI: 10.1016/s2468-2667(17)30046-4.
3. Tedesco D, Gibertoni D, Rucci P, et al. Impact of rehabilitation on mortality and readmissions after surgery for hip fracture. \textit{BMC Health Services Research} 2018; 18: 701. DOI: 10.1186/s12913-018-3523-x.
4. Beaupre LA, Cinats JG, Senthilselvan A, et al. Reduced morbidity for elderly patients with a hip fracture after implementation of a perioperative evidence-based clinical pathway. \textit{Qual Safety Health Care} 2006; 15: 375–379. DOI: 10.1136/qshc.2005.017095.
5. Flikweert ER, Izaks GJ, Knobben BA, et al. The development of a comprehensive multidisciplinary care pathway for patients with a hip fracture: design and results of a clinical trial. \textit{BMC Musculoskelet Disord} 2014; 15: 188. DOI: 10.1186/1471-2474-15-188.
6. Tarazona-Santabalbina FJ, Belenguer-Varea A, Rovira-Daudi E, et al. Early interdisciplinairy hospital intervention for elderly patients with hip fractures: functional outcome and mortality. \textit{Clinics (Sao Paulo, Brazil)} 2012; 67: 547–556. DOI: 10.6061/clinics/2012(06)02.
7. Lau TW, Fang C and Leung F. The effectiveness of a multidisciplinary hip fracture care model in improving the clinical outcome and the average cost of manpower. \textit{Osteoporos Int} 2017; 28: 791–798. DOI: 10.1007/s00198-016-3845-7.
8. Nordström P, Thorgren KG, Hommel A, et al. Effects of geriatric team rehabilitation after hip fracture: meta-analysis of randomized controlled trials. \textit{J Am Med Directors Assoc} 2018; 19: 840–845. DOI: 10.1016/j.jamda.2018.05.008.
9. Lahtinen A, Leppilaiti H, Vähänikkilä H, et al. Costs after hip fracture in independently living patients: a randomised comparison of three rehabilitation modalities. \textit{Clin Rehabilitation} 2017; 31: 672–685. DOI: 10.1177/0269215516651480.
10. Crotty M, Unroe K, Cameron IDet al. Rehabilitation interventions for improving physical and psychosocial functioning after hip fracture in older people. \textit{Cochrane Database Syst Rev}
11. Handoll HH, Cameron ID, Mak JC et al. Multidisciplinary rehabilitation for older people with hip fractures. Cochrane Database Syst Rev 2009; 7: CD007125, doi:10.1002/14651858.CD007125.pub2.

12. Handoll HH, Sherrington C and Mak JC. Interventions for improving mobility after hip fracture surgery in adults. Cochrane Database Syst Rev 2011; 12: CD001704, doi:10.1002/14651858.CD001704.pub4.

13. Mittal C, Lee HCD, Goh KS, et al. ValuedCare program: a population health model for the delivery of evidence-based care across care continuum for hip fracture patients in Eastern Singapore. J Orthop Surg Res 2018; 13: 129. DOI:10.1186/s13018-018-0819-9.

14. Chong TW, Chan G, Feng L, et al. Integrated care pathway for hip fractures in a subacute rehabilitation setting. Ann Acad Med Singap 2013; 42: 579–584.

15. Tan AK, Taiju R, Menon EB, et al. Postoperated hip fracture rehabilitation effectiveness and efficiency in a community hospital. Ann Acad Med Singap 2014; 43: 209–215.

16. Chehade M and Taylor A. Australian and New Zealand guideline for hip fracture care-improving outcomes in hip fracture management of adults, 2014.

17. Association BO. The Care of Patients with Fragility Fracture. London, UK: British Orthopaedic Association, 2007.

18. Ftoh S, Morga A and Swift C. Management of hip fracture in adults: summary of NICE guidance. Bmj 2011; 342: d3304.

19. Hershkovitz A, Brown R, Burstin A, et al. Measuring rehabilitation outcome in post-acute hip fractured patients. Disabil Rehabil 2015; 37: 158–164. DOI: 10.3109/09638288.2014.911968.

20. Beninato M, Gill-Body KM, Salles S, et al. Determination of the minimal clinically important difference in the FIM instrument in patients with stroke. Arch Phys Med Rehabil 2006; 87: 32–39. DOI: 10.1016/j.apmr.2005.08.130.

21. Doshi HK, Ramason R, Azelarasi J, et al. Orthogeriatric model for hip fracture patients in Singapore: our early experience and initial outcomes. Arch Orthop Trauma Surg 2014; 134: 351–357. DOI: 10.1007/s00402-013-1900-9.