ORIGINAL ARTICLE

Factors predicting rehabilitation outcomes of elderly patients with hip fracture

Raymond PH Chin 錢炳航
Bobby HP Ng 吳顯波
Lydia PC Cheung 張寶治

Objective To identify predictors of rehabilitation outcomes for the development of a case-mix system to rehabilitate patients suffering from hip fractures.

Design Prospective cohort study.

Setting Two hospitals in Hong Kong.

Patients A cohort of hip fracture patients in 2005 (n=303) with a mean age of 82 years was studied. Rehabilitation outcomes were defined as: mortality, length of stay, placement, ambulation status, activity of daily living at the time of discharge and at 6-month follow-up. A comparison between groups and multivariate analysis was conducted to validate the best predictors.

Main outcome measures Potential predictors and rehabilitation outcomes.

Results Two predictors, the Abbreviated Mental Test score of lower than 6 (odds ratio=0.19, P<0.05) and the Functional Independence Measures score of lower than 75 (odds ratio=38.0, P<0.05), at the time of admission to the rehabilitation setting were found to be related to outcomes. Our findings provided further support for a case-mix system based on these two factors, as they could correctly assign patients into three groups with different baseline characteristics and outcomes. A review of the possible limitations of the existing service with respect to each case-mix group was also conducted.

Conclusion A case-mix system utilising the cognition and activity of daily living function is recommended. Revisions of respective care plans are advocated with more realistic outcome expectations and specific actions for the respective case-mix groups. An evaluation study on the usefulness of this case-mix classification could then follow.

Introduction

Hip fracture is a common injury particularly among the elderly, and results in substantial morbidity, mortality, and costs. According to the statistics of the Hong Kong Hospital Authority for the years 2001 to 2003, there were 11 045 admissions for the treatment of hip fracture.[1] The management of elderly hip fractures involves a chain of procedures, including: surgery, mobilisation, and rehabilitation either at home or in an institution, and also coordination of different medical and rehabilitation personnel. Sometimes these belong to different settings, such as acute hospital or rehabilitation hospitals. Coordinated multidisciplinary rehabilitation programmes are gradually being accepted as the standard of practice in the care of this group of patients.[2] Such standardised care plans are supposed to ensure quality of care and optimise resources. However, existing local care plans emphasise the acute aspect without elaborating on rehabilitation aspects. There is a need to develop a rehabilitation plan to fit individual patient needs. Thus, our team decided to identify potential predictors related to the outcomes of rehabilitation, with a view to facilitating the development of a case-mix system. Such a system could help categorise patients into different groups according to their rehabilitation potentials. A specific rehabilitation programme could then be designed for each patient group.

Case-mix represents a group of patients with common characteristics in terms of their clinical condition, needs, rehabilitation potentials, outcomes, and use of resources. Such a case-mix system can facilitate communication, monitor variations in practice, and facilitate seamless management to attain the best outcomes using the available resources.[3] This is

Key words
Aged; Geriatric assessment; Hip fractures; Predictive value of tests; Prognosis

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Kowloon Hospital, Argyle Street, Kowloon, Hong Kong:
Orthopaedic Rehabilitation Centre, Kowloon Central Cluster
RPH Chin, FHKAM (Orthopaedic Surgery)
Department of Occupational Therapy
BHP Ng, MPH, PDOT
Nursing Service
LPC Cheung, RN, BSN

Correspondence to: Ms LPC Cheung
E-mail: cheupc@ha.org.hk

長者髖骨骨折病人預測康復結果的因子

目的 找出長者髖骨骨折病人康復結果的預測因子，作為發展一套病症分類系統之用。

設計 前瞻性分組研究。

安排 香港的兩所醫院。

患者 研究對象為一組2005年，平均年齡為82歲的髖骨骨折病人。康復結果的定義有：死亡率、住院期、安置、活動狀況、出院和第6個月隨訪期的日常生活能力，並進行了組別比較和多變量分析以確認最佳的預測因子。

主要結果測量 潛在的預測因子及康復結果。

結果 研究顯示有兩個因素與康復結果有關，分別為由入院至康復階段簡短智能測驗(Abbreviated Mental Test)得分低於6（比值比＝0.19，P<0.05），和功能獨立自主量表(Functional Independence Measures)得分低於75（比值比＝38.0，P<0.05）。研究亦發現可依照這兩項因素，把病人按不同基本特徵和結果分為三類，故可以藉此發展出病症分類系統。是次研究亦檢討了現行服務對每類病人的可能限制。

結論 我們建議以認知能力和日常生活能力作為病症分類系統的基礎，並檢討對每個病症類別的照顧計劃，令康復結果的期望更切合實際和有更針對性的措施。其後更需對這個病症分類系統作出有效性評估。

especially useful when the patient load is large and the underlying problems are complicated. The causes of hip fractures in the elderly are heterogeneous. The accident and the subsequent fracture need to be viewed as warning signs of the ageing process as well as the symptoms associated with the disease onset, rather than just an accidental trauma.[4] For some of the patients, the recovery to a pre-fracture level of independence may not be realistic, especially within a few weeks. There is a need to ensure a stable support system, including a phase of ambulatory or community rehabilitation, gradually shifting from a rehabilitation to a community setting. Thus, the development of the related care plan should be guided by ethical, social, as well as scientific concerns. On the other hand, the plan should be easily understood by health care workers and integrated into existing clinical practice, without excessive additional effort.

Methods

This was a prospective cohort study conducted in the Kowloon Central Cluster, involving Queen Elizabeth Hospital, an acute facility and Kowloon Hospital, which provides in-patient rehabilitation. All patients (n=303) who had a first-time hip fracture without a major medical contra-indication to surgery were recruited into the cohort. The data collection period started from June 2005 to August 2006, and involved a standardised protocol. It included: (1) data retrieval from current patient medical records, (2) assessment of cognitive function by the Abbreviated Mental Test (AMT)[5] and activities of daily living function by the Functional Independence Measures (FIM)[6] within the first 3 working days of admission to the rehabilitation hospital and at the time of discharge, and (3) a follow-up phone call 6 months after discharge. The standardised protocol was developed by the team, which was composed of professionals from different disciplines. A thorough literature review was conducted, so as to include all potential predictors that might impact rehabilitation outcomes (Box).[7-16] The outcomes chosen for this study were: mortality, length of stay in the rehabilitation hospital, level of ambulation status, level of functional independence, and the type of residential settings at two time-points (on discharge from the programme and at follow-up of 6 months later). Data on mortality at 6 months were validated by reviewing the Clinical Management System of the Hong Kong Hospital Authority. To ensure reliability of data collection, training sessions were arranged for all the involved nursing and paramedical staff. Data input was performed by a trained individual, utilising Microsoft Excel and validated by the service coordinator. When data were at an interval level, a cut-off point was recommended in order to simplify comparison as well as to draw user-friendly criteria for future integration into daily clinical practice. These cut-off points were recommended based on literature review and the team's clinical experience. Data analysis was performed using Statistical Package for the Social Sciences (Windows version 12.0; SPSS Inc, Chicago [IL], US). Independent sample *t* tests were used to compare differences in magnitude and the Chi squared statistic for comparing differences in proportions. All predictors that illustrated a statistically significant difference (P<0.01) in univariate analysis were subjected to logistic regression analysis as covariates, using the 'Enter method' to validate the potential risk factors.

Results

Three hundred and three patients were recruited into our analysis. The proportion of male-to-female patients was 3:7, and the mean age was 82 (standard deviation, 8) years. Twenty-six patients were confirmed dead, and another 21 could not be contacted at the 6-month follow-up. Table 1 lists the potential predictors in order of their relationship with outcomes at 6 months and at discharge, and their ability to separate the patients into two even groups based on univariate analysis. It appeared that the greater the number of outcomes at discharge and at 6 months demonstrating a statistically significant relationship, and the smaller the difference in

distribution between subjects, the higher the rank of that predictor (Table 1). The FIM score (at the time of admission to hospital) demonstrated a significant relationship with outcomes at both 6 months (for mortality and placement) and with four of the five outcomes at discharge. It also demonstrated an even distribution among the groups. Thus it appeared to be the most powerful predictor from this univariate analysis. Other predictors that followed (in that order) were: $AMT_{(admission)}$ score, pre-fracture mobility status, age, ability to self-void$_{(admission)}$, coexisting neurological diseases, type of surgical intervention, and pain$_{(admission)}$. The other three factors—days stay in acute setting, postoperative medical complication, and pressure sore$_{(admission)}$—did not appear to have any relationship with the outcome variables.

Table 2 lists potential predictors in order of their relationship with outcomes at 6 months and at discharge, according to the multivariate analysis based on logistic regression. Also it appeared that the greater the number of outcomes at 6 months and at discharge that demonstrated a statistically significant relationship, the higher the position of that predictor in Table 2. The findings were similar to those of the univariate analysis, with the top four predictors being $FIM_{(admission)}$, $AMT_{(admission)}$, age, and pre-fracture mobility status.

Although patients' age and pre-fracture mobility status were tested to be independent factors for outcomes, the team did not include them in the final case-mix model, so as to minimise potential misunderstanding by relatives that there might be less services for their patients only because of their age. Moreover, fewer predictors would make the case-mix system more practical to implement in busy clinic settings. Thus the team decided to adopt two other top predictors in developing this case-mix system. Both were based on assessments at the point of admission to the rehabilitation hospital. Using these two factors, all patients could be classified into four groups: group 1: $FIM_{(admission)} \geq 75$ and $AMT_{(admission)} > 5$, group 2: $FIM_{(admission)} < 75$ but $AMT_{(admission)} > 5$, and group 3: $FIM_{(admission)} < 75$ and $AMT_{(admission)} \leq 5$, group 4: $FIM_{(admission)} \geq 75$ but $AMT_{(admission)} \leq 5$. However as the number in group 4 was small (n=7), for the subsequent analysis we assigned these patients into group 1. Table 3 describes the outcomes of the different possible classes, and both the baseline characteristics and the outcomes demonstrated significant statistical differences among the classes. Detailed review of the needs as well as the existing rehabilitation programmes for the respective groups were followed, so as to identify limitations and recommend improvements.

BOX. Predictor and outcome variables[7-16]

Predictor variables

Management
- 0 = Closed reduction and internal fixation
- 1 = Arthroplasty

Length of stay in acute setting
- 0 = ≤7 days
- 1 = >7 days

Age
- 0 = <80 years
- 1 = ≥80 years

Comorbidity: with cerebrovascular accident or Parkinsonism
- 0 = No
- 1 = Yes

Postoperative complications (eg chest infection or urinary tract infection)
- 0 = No
- 1 = Yes

Premorbid mobility, MFAC*
- 0 = Independent walker (MFAC, VI-VII)
- 1 = Dependent or non-walker (MFAC, I-V)

Pain$_{(admission)}$
- 0 = Visual analogue scale score <4
- 1 = Visual analogue scale score ≥4

Pressure sore$_{(admission)}$
- 0 = No sore
- 1 = With sore(s)

Ability to self-void$_{(admission)}$
- 0 = Independent
- 1 = Rely on device or napkin

Abbreviated Mental Test (AMT)$_{(admission)}$
- 0 = Intact cognitive function (AMT score, 6-10)
- 1 = Impaired cognitive function (AMT score, 0-5)

Functional Independence Measures (FIM)$_{(admission)}$
- 0 = Good potential for independence (FIM, 75-126)
- 1 = Poor potential for independence (FIM, 18-74)

Outcome variables

Length of stay
- 0 = ≤28 days
- 1 = >28 days

Placement
- 0 = Home
- 1 = Institution

Ambulation status
- 0 = Independent walker
- 1 = Dependent walker

Functional independence
- 0 = Activities of daily living–independent (FIM, 91-126)
- 1 = Activities of daily living–dependent (FIM, 18-90)

Mortality at 6 months
- 0 = Alive
- 1 = Died

* MFAC denotes Modified Version of Functional Ambulation Categories: I=Lyer, II=Sitter, III=Dependent walker, IV=Assisted walker, V=Supervised walker, VI=Indoor walker, VII=Outdoor walker

Discussion

From our experience, patients progress at different rates; some respond to an intensive rehabilitation programme while others find less intensity more suitable. For some functionally dependent patients, it appeared to be more rewarding to train up their carers rather than the patients themselves. A single care plan cannot suit the need of all patients. The case-mix

TABLE 1. Comparison of outcomes between groups classified according to potential predictors, based on univariate analysis (n=303)*

Potential predictors	% Distribution	Outcomes at discharge (n=303)					Outcomes at 6-month follow-up	
		% Discharged home	% Independent walker	Mean (SD) EMS	Mean (SD) FIM	Mean (SD) LOS	% Still alive (n=277)	% Still at home (n=256)
Overall		**60.4**	**38.0%**	**8.99 (5.15)**	**83.93 (24.67)**	**29.30 (16.96)**	**92.4**	**57.8**
$FIM_{(admission)}$								
75-126	41	87.0†	67.5†	12.60 (3.89)†	106.00 (8.81)†	27.51 (15.14)	97.3	85.3†
18-74	59	42.2	17.8	6.52 (4.41)	68.84 (20.25)	30.52 (18.04)	89.1	37.4
$AMT_{(admission)}$								
6-10	63	73.3†	52.9†	10.82 (4.77)†	95.36 (18.89)†	30.90 (17.72)	94.2	69.9†
0-5	37	38.4	12.5	5.88 (4.21)	64.43 (20.89)	26.57 (15.28)	89.4	36.6
Pre-fracture mobility status								
Independent walker	79	66.9†	46.4†	9.85 (5.07)†	89.10 (22.09)†	30.40 (17.31)	93.1	64.2†
Dependent walker	21	35.9	6.3	5.80 (4.12)	64.61 (24.35)	25.17 (15.03)	90.2	34.5
Age (years)								
<80	38	75.7†	57.4†	10.68 (5.18)†	93.94 (21.67)†	28.13 (15.37)	95.3	75.5†
≥80	62	51.1	26.1	7.96 (4.86)	77.80 (24.43)	30.01 (17.87)	90.6	46.1
Ability to self-void$_{(admission)}$								
Independent	35	79.0†	56.2†	11.49 (4.54)†	99.91 (17.50)†	29.37 (17.68)	94.7	76.4†
Dependent	65	50.5	28.3	7.67 (4.97)	75.45 (23.73)	29.26 (16.61)	91.3	47.9
Comorbidity (CVA/ Parkinsonism)								
No	83	63.5	42.5†	9.39 (5.07)†	87.36 (23.15)†	29.67 (16.92)	92.6	61.3
Yes	17	45.1	15.7	7.04 (5.18)	66.94 (25.10)	27.43 (17.20)	91.7	40.9
Fracture management								
CRIF	60	57.9	31.7*	8.37 (5.36)	81.63 (25.06)	30.73 (17.48)	89.8	54.4
Arthroplasty	40	64.2	47.5	9.93 (4.69)	87.43 (23.75)	27.11 (15.97)	96.4	62.6
$Pain_{(admission)}$								
VAS <4	29	56.8	46.6	9.50 (5.27)	85.23 (25.42)	26.30 (18.42)	90.4	56.0
VAS ≥4	71	61.9	34.4	8.78 (5.10)	83.40 (24.39)	30.52 (16.22)	93.3	58.6
Days stay in acute setting								
≤7 days	37	58.9	37.5	9.25 (5.06)	82.69 (24.69)	30.69 (15.92)	94.1	52.1
>7 days	63	61.3	38.2	8.84 (5.21)	84.66 (24.69)	28.48 (17.54)	91.4	61.3
Postoperative medical complication								
No	91	61.6	38.8	9.16 (5.19)	84.35 (24.28)	29.23 (17.19)	92.5	59.1
Yes	9	48.1	29.6	7.26 (4.42)	79.59 (28.50)	30.00 (14.17)	91.3	42.9
Pressure $sore_{(admission)}$								
No	90	60.4	38.1	9.00 (5.14)	84.13 (24.62)	29.09 (16.27)	92.4	57.6
Yes	10	60.0	36.7	8.87 (5.31)	82.13 (25.44)	31.17 (22.54)	92.6	60.0

* FIM denotes Functional Independence Measures, AMT Abbreviated Mental Test, CVA cerebrovascular accident, CRIF closed reduction and internal fixation, VAS Visual Analogue Scale, EMS Elderly Mobility Scale, and LOS length of stay

† Significant difference with P<0.01

system guides the health care team to classify cases with specific needs and to suggest specific care plans, including utilisation of ambulatory rehabilitation and community-based support services in the respective settings. This should be the standard of practice for hip fracture management in the elderly. Providing "seamless health care" for optimising rehabilitation potential and improving quality of life in this group of elderly patients suffering from hip fracture were the goals of the team. "Fragmented care" usually relates to poor long-term outcomes.[17] Geriatric day hospital and paramedical out-patient services within the Hospital Authority system, and the enhanced/ integrated home care teams within the Social Welfare System are all strategic partners in the long run.[18]

A case-mix system with complicated procedures and too many variables would be difficult to integrate into the busy clinical settings of Hong Kong. On the other hand, bias due to sex, age, or pre-morbid living settings (old-age home residents) should be considered and minimised whenever predictors are chosen. Thus, factors based on admission assessment results appear more acceptable. Both functional status and cognitive status at the time of admission demonstrated strong predictive power, which was similar to results in another case-mix system in the United States.[19] Functional scores are generally related to the level of care.[20] The existing "Standardized Care Need Assessment of the Social Welfare Department of Hong Kong" also incorporates

TABLE 2. Odds ratios (as derived from logistic regression, with all variables as covariates and using "Enter Method") of potential predictors for respective outcomes*

Potential risk factors	Odds ratio (95% confidence interval)					
	Outcome variables at discharge (n=303)				Outcome variables at 6-month follow-up	
	Placement (OAH)	LOS (>28 days)	Walker	$ADL_{(discharge)}$ (FIM>90)	Mortality (n=277)	Placement (n=256)
$FIM_{(admission)}$ <75	4.68 (2.23-9.82)†	2.48 (1.29-4.77)†	4.12 (2.05-8.28)†	58.78 (20.55-168.17)†	4.67 (1.04-21.03)†	5.60 (2.46-12.71)†
Age ≥80 years	1.92 (1.04-3.57)†	0.99 (0.58-1.71)	2.65 (1.43-4.90)†	1.70 (0.71-4.05)	1.53 (0.50-4.69)	2.52 (1.30-4.89)†
$AMT_{(admission)}$ <6	1.60 (0.87-2.96)	0.46 (0.25-0.86)†	2.24 (1.04-4.82)†	4.32 (1.71-10.93)†	0.97 (0.34-2.74)	1.10 (0.55-2.22)
Pre-fracture mobility status Assisted or dependent walker	1.84 (0.94-3.60)	0.51 (0.26-0.99)†	5.96 (1.91-18.58)†	3.13 (0.96-10.21)	0.90 (0.30-2.64)	1.62 (0.77-3.40)
Fracture management Arthroplasty	0.99 (0.56-1.73)	0.54 (0.33-0.91)†	0.68 (0.37-1.24)	1.41 (0.60-3.29)	0.36 (0.11-1.13)	0.87 (0.47-1.62)
Days stay in acute setting >7 days	1.05 (0.59-1.87)	0.58 (0.35-0.98)†	1.38 (0.73-2.61)	1.30 (0.54-3.13)	1.75 (0.62-5.00)	0.80 (0.43-1.51)
$Pain_{(admission)}$ VAS pain scale ≥4	0.61 (0.33-1.13)	1.99 (1.14-3.50)†	1.85 (0.96-3.56)	0.92 (0.37-2.27)	0.56 (0.21-1.48)	0.69 (0.36-1.35)
Comorbidity With CVA or Parkinsonism	1.18 (0.56-2.51)	0.75 (0.37-1.53)	2.66 (0.99-7.18)	1.38 (0.41-4.69)	0.89 (0.26-3.07)	1.40 (0.62-3.18)
Complications With chest infection or UTI	1.44 (0.56-3.69)	1.31 (0.55-3.09)	1.26 (0.42-3.79)	0.63 (0.16-2.43)	1.02 (0.21-5.06)	1.88 (0.63-5.61)
$Pressure\ sore_{(admission)}$ Admit to rehabilitation with sore	1.10 (0.44-2.73)	1.05 (0.47-2.37)	1.30 (0.47-3.64)	2.34 (0.51-10.75)	0.89 (0.18-4.32)	1.12 (0.40-3.15)
Ability to $self\text{-}void_{(admission)}$ On device or napkin	1.49 (0.76-2.91)	1.10 (0.61-1.98)	1.03 (0.53-2.00)	1.62 (0.65-4.00)	0.79 (0.23-2.67)	1.26 (0.60-2.65)

* FIM denotes Functional Independence Measures, AMT Abbreviated Mental Test, VAS Visual Analogue Scale, CVA cerebrovascular accident, UTI urinary tract infection, OAH old-age home, LOS length of stay, and ADL activity of daily living

† Significant difference with $P<0.05$

both functional assessment scores and cognitive scores to classify elderly patients for different long-term care packages.[21]

On reviewing the patient characteristics and the existing service, some limitations were identified. First, discharge planning was conducted late in the in-patient rehabilitation process and the relatives may not have had adequate time to catch up with the scheduled date of discharge; sometimes they required an extra stay in the hospital. Second, use of ambulatory or community-based rehabilitation services was not consistent and much depended on individual colleagues' knowledge and decisions. With additional comments from the different professional perspectives of the team members, the following case-mix system and care plans were proposed.

For group 1 ($FIM_{(admission)}$≥75), a 4-week intensive rehabilitation programme was designed, targeting mobility within the community and 100% discharge home (with social support), or a community-based programme for follow-up. For group 2 ($FIM_{(admission)}$<75 but $AMT_{(admission)}$>5), there was a 5-week rehabilitation programme targeting indoor mobility with more input on discharge preparation and pain control and geriatric day-hospital or allied health out-patient follow-up whenever necessary. For group 3 ($FIM_{(admission)}$<75 and $AMT_{(admission)}$≤5), a 4-week of rehabilitation was designed and targeted indoor mobility with more input on discharge preparation, and follow-up by an Enhanced/Integrated Home Care Team, if necessary.

Different disciplines of the team should be

TABLE 3. Description of patient characteristics and outcomes for the three case-mix groups as classified by Functional Independence Measures (FIM) and Abbreviated Mental Test (AMT)*

	Case-mix groups			P value
	Group 1 (n=123)	Group 2 (n=75)	Group 3 (n=105)	
	$FIM_{(admission)}$: 75-126	$FIM_{(admission)}$: 18-74 and $AMT_{(admission)}$: 6-10	$FIM_{(admission)}$: 18-74 and $AMT_{(admission)}$: 0-5	
Patient characteristics, mean (SD)				
Age	78.07 (6.43)	82.04 (6.76)	85.54 (7.26)	<0.001†
$AMT_{(admission)}$	8.08 (1.61)	7.72 (1.46)	2.41 (1.80)	<0.001†
$FIM_{(admission)}$ – total	85.91 (7.62)	63.37 (10.20)	52.57 (13.10)	<0.001†
Outcomes				
At discharge				
% Home	87.0%	52.0%	35.2%	<0.001†
LOS	27.51 (15.14)	35.96 (20.12)	25.62 (15.34)	<0.001†
Pain $VAS_{(discharge)}$	1.77 (1.70)	2.45 (1.87)	2.39 (1.66)	<0.001†
$EMS_{(discharge)}$ – total	12.60 (3.89)	7.76 (4.50)	5.64 (4.14)	<0.001†
$FIM_{(discharge)}$ – total	106.00 (8.81)	78.36 (17.84)	62.05 (19.16)	<0.001†
At 6-month follow-up				
% Discharged home	85.3	42.4	34.1	<0.001†
% Alive	97.3	89.4	88.9	<0.001†

* LOS denotes length of stay, VAS Visual Analogue Scale, and EMS Elderly Mobility Scale

† Chi squared statistics for group proportion and one-way analysis of variance for interval data

expected to adjust their roles for respective patient groups. For example, the named nurses as well as the doctor in-charge could work as coordinators in liaising with other team members. Physiotherapists could target group 1 in particular, because these patients were expected to tolerate more intensive training. The occupational therapists could target training for patients with specific care techniques and solve their psychological as well as physical problems when planning care.[22,23] Social workers could especially target those with low social support, so as to facilitate arrangement of services at an earlier time. To study the effect of the newly implemented case-mix system and the related care plan on rehabilitation outcomes, the team has started a new phase of the study and collected outcomes data for a second cohort.

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