Original Article

Postoperated Hip Fracture Rehabilitation Effectiveness and Efficiency in a Community Hospital

Adrian KH Tan, [1]*MBBS, MMed, FCFP*, Rangpa Taiju, [1]*MBBS, MD*, Edward B Menon, [2]*MBBS, FAMS, FRCP,* Gerald CH Koh, [3,4]*MMed, M Ger, FCFP*

Abstract

Introduction: This study aims to determine the inpatient rehabilitation effectiveness (REs) and rehabilitation efficiency (REy) of hip fracture in a Singapore community hospital (CH), its association with socio-demographic variables, medical comorbidities and admission Shah-modified Barthel Index (BI) score as well as change in independent ambulation from discharge to 4 months later. Materials and Methods: A retrospective cohort study using data manually extracted from medical records of all patients who had hip fracture within 90 days and admitted to a CH after the operation for rehabilitation. Multiple linear regressions are used to identify independent predictors of REs and REy. Results: The mean REs was 40.4% (95% Confidence Interval (CI), 36.7 to 44.0). The independent predictors of poorer REs on multivariate analysis were older age, Malay (vs non-Malay) patients, fewer numbers of rehabilitative therapy sessions and dementia. The mean REy was 0.41 units per day [CI, 0.36 to 0.46]. The independent predictors of poorer REy on multivariate analysis were higher admission BI and being non-hypertensive patient. The prevalence of independent ambulation improved from 78.9% at the discharge to 88.3% 4 months later. Conclusion: CH inpatient rehabilitative therapy showed REs 40.4% and REy of 0.41 units per day and the optimum number of rehabilitative therapy session was from 28 to 41 in terms of rehabilitation effectiveness and the maximum rehabilitation efficiency was seen in those doing 14 to 27 sessions of rehabilitative therapy. The study also showed improvement in BI at discharge and improvement in the independent ambulation 4 months after discharge from the CH.

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Key words: Modified Barthel Index, Length of stay, Length of weight bearing

Introduction

Individuals who sustained hip fracture may exhibit high mortality and often demonstrate permanent disability and dependency despite successful surgical repair.[1-3] One in 5 persons dies in the first year after sustaining hip fracture. Of those who survive past one year, only 40% can perform all routine activities of daily living and only 54% can walk without aid.[1,4,5] Disability from hip fracture is prevalent among the older population and rehabilitation is essential after hip fracture to maximise recovery and function, re-integrate them into society and regain self-dignity.[6,7] Some studies suggest that intense physical therapy (twice-daily therapy sessions) may help improve long-term functional outcomes.[8,9] Ideally, they should follow a gradual progressive exercise regime prescribed from the first day postoperation.[10]

Functional status of the patients can be assessed by using the 100-point Shah-modified Barthel Index (BI) score.[11] It ranges from 0 to 100, with 5 subcategories for each of the activities of daily living (ADL) and 100 possible discrete values with higher scores indicating greater independence ADLs. A score of 0 indicates total dependency and a score of 100 indicates full independence in ADL. The ADL includes personal hygiene, bathing, dressing, feeding, toileting, bowel control, bladder control, transferring, ambulation and stair climbing. The Shah-Modified Barthel Index is used by all rehabilitative community hospitals (CHs) in Singapore to quantify functional impairment, as recommended by the Ministry of Health Elderly and Continuing Care Division (2004).[12]

[1]Department of Continuing and Community Care, Tan Tock Seng Hospital, Singapore
[2]St Andrew's Community Hospital, Singapore
[3]Saw Swee Hock School of Public Health, Singapore
[4]Dean's Office, Yong Loo Lin School of Medicine, National University of Singapore/ National University Health System, Singapore
Address for Correspondence: Dr Adrian Kok Heng Tan, Department of Continuing and Community Care, Level 2, Annex Building, Tan Tock Seng Hospital, 11 Jalan Tan Tock Seng, Singapore 308433.
Email: adrian_kh_tan@ttsh.com.sg

With increasing elderly population in the country, there will be increased need for rehabilitative services including admission to the rehabilitative centre due to the various disabling conditions in the near future. Knowing the final outcome of rehabilitation for hip fracture or for any other disease, like mortality, discharge BI, or absolute function gain (AFG) at the discharge may not be enough as this does not consider the length of the stay and number of therapy sessions in the calculations as well as the speed of recovery with the rehabilitative therapy. As the need for bed and rehabilitative services increases, it is important that rehabilitative services should be most efficient for maximum gain to the patient as well as in terms of the length of stay. Reducing the length of stay is aimed by many healthcare systems and is thought to indicate the efficiency of the system.[13-15] Thus, there is a need for more effective measures that show how efficient a rehabilitative method is, taking into account the length of stay (time factor) or number of rehabilitative sessions (intervention factor) in the rehabilitation centre. Rehabilitation effectiveness (REs) and efficiency (REy) are such measures which have been used as early as 1987 in many studies for many disabling diseases.[16-26] Rehabilitative impact index like AFG does not consider the potential maximal functional improvement like REs. It also does not take into the account the rate of functional improvement per unit time like REy. A study also found that REs was associated with cognitive impairment while AFG did not have any such association, supporting the superiority of REs over AFG.[27]

Heinemann[19] and Shah[16] and colleagues defined measures of REs as the percentage of potential functional improvement actually achieved. It is calculated as follows:

> REs = [(Final BI score minus initial BI score) ÷ (Maximum possible BI score {i.e. 100 points} minus initial BI score)] X 100%.

REy is the rate of functional recovery during the rehabilitation[16,19] and is calculated as follows:

> REy = (Final BI score minus initial BI score) ÷ (Duration between dates of initial and final BI scoring in days).

The value of REy per day is usually less than one unit per day so it can be multiplied by 30 days to obtain the REy over a month.

Singapore has invested large amounts in upgrading the skills of members of the rehabilitation team in the past decade. However, REs and REy in hip fractures have not been studied much locally. This study aimed at finding overall REs and REy of patients in a CH in Singapore, the factors independently associated with REs and REy and the proportion of postoperative hip fracture patients who became independent between discharge and 4 months later.

Materials and Methods

The study included a retrospective cohort of all patients admitted to a CH from 1 May 2008 to 31 August 2009. This CH uses the 100-point BI to measure functional status of all patients upon admission and before discharge. BI scoring is performed by trained healthcare professionals, usually the rehabilitation therapists in the CH. All patients who had hip fracture within 90 days (day 90th inclusive) upon admission to the CH and were operated on for the fracture management were included in the study. Our aim was to study those patients who have had recent fracture and were operated on for the fracture. We excluded those who did not have hip fracture within the 90 days period upon admission to the CH. We excluded these patients because those who had fractures long time ago would have already plateaued in the functional recovery. Also, those patients with hip fracture but were not operated upon were excluded from the study. For rehabilitation to have an effect, it should be provided for a sustained and sufficient duration. We have included only those patients in the study who were admitted and underwent rehabilitation therapy for at least 14 days. This is an arbitrary cut off for number of days of rehabilitation we have taken, as we wanted to give adequate time frame for rehabilitation. The standard practice in a Singapore CH is to provide the standard 45 minutes inpatient rehabilitative therapy during each session for 2 sessions in a day. These comprise active ranging exercises for hip joints, strengthening exercises for hip musculature and a walking programme with the appropriate walking aids if they are allowed weight bearing activities.

We followed the ambulation status with scores from the BI. In subset of ambulation, a score of 0 represents totally dependent person in ambulation and highest score of 15 represents independent ambulation with or without walking aid and able to walk 50 metres without help or supervision. In the current study, we include those with BI score of 12 or more as walking independently with or without the walking aid. A BI score of 12 is defined as those individuals who are independent in ambulation but unable to walk 50 metres without help, or require supervision for confidence or safety in hazardous situations. This score would correspond to all patients with independent ambulation at home with or without ambulation aid.

Data were manually extracted from medical records by research assistants not involved in the study using a standardised data collection format. Comorbidity burden data was obtained using Charlson Co-Morbidity Index (CCMI). The CCMI is the most extensively studied comorbidity index (Charlson et al, 1987).[28] CCMI is recognised as a valid and reliable clinical research tool with high construct validity and predictive validity for mortality, disability, readmissions and length of stay.[29] It

has 19 categories of comorbidity. Each category has an associated weight which is based on the adjusted risk of one-year mortality. The overall CCMI score is the sum of the weighted scores and it reflects the cumulative disease burden: the higher the score, the greater the burden of comorbidity. We also obtained data for hypertension and ischaemic heart disease (with or without previous myocardial infarction), which are not included in CCMI. Four months post discharge from the CH, patients' ambulation status was again reviewed.

Statistical Package for Social Sciences (SPSS) software version 18 was used for statistical analysis, *P* values are reported in 2-tailed and the level of statistical significance (α) was taken at 0.05. Confidence intervals are reported at 95%. The study was approved by the National University of Singapore Institutional Review Board.

Results

There were 201 admissions during the 16-month study period. Only 166 admissions were eligible for the study (5 patients stayed less than 14 days and 30 patients were not operated on). The ethnicity division comprised 145 (87.3%) Chinese, 18 (10.8%) Malays and 3 (1.8%) Indian. The admission primary diagnosis was fracture neck of femur 101 (60.8%) and inter-trochanteric fracture 65 (39.2%). The demographic profile of the study population is shown in Table 1.

The mean number of days after operation to the CH was 10.9 days. The mean length of stay in CH was 50.4 days (CI, 46.9 to 53.4). The mean length of weight bearing days in inpatient CH stay was 39.9 days. The mean number of 45-minute rehabilitative therapy sessions was 34.3 (standard error mean 1.4) while the mode and median was 30. The BI shows improvement with the rehabilitative therapy. The mean admission BI was 54.1 and the discharge mean BI was 72.2. The mean abbreviated mental test (AMT) was 7.42 out of the maximum score of 10.

Ambulation Status and Mortality 4 Months After Discharge

Three patients died after discharge thus, the mortality rate at 4 months after discharge was 1.8%. Majority of patients who were discharged were ambulating independently with or without walking aid (78.9%). This improved significantly (*P* = 0.0046) to 88.3% at 4 months post discharge review (Fig. 1).

Overall Rehabilitation Effectiveness (REs)

The mean REs score was 40.4% (CI, 36.7 to 44.0). The median REs score was 39.0% and the inter-quartile range (IQR) was 23.2% to 58.3%. None of the subjects had negative REs scores i.e. no declines in REs. Eight (4.8%) subjects had REs score of zero, indicating their functional

Table 1. Demographic Profile of Study Population

Demographic Variable	All (N = 166) n (%)
Age (years)	
50 to 59	4 (2.4)
60 to 69	16 (9.6)
70 to 79	69 (41.6)
80 to 89	61 (36.7)
90 to 99	16 (9.6)
Mean age	78.9 (SD 7.9)
Gender	
Male	26 (15.7)
Female	140 (84.3)
Charlson Co-Morbidity Index	
Mean	2.89 (SD 0.168)
Admission BI score (units)	
0 – 33	21 (12.7)
34 – 66	96 (57.8)
67 – 100	49 (29.5)
Mean Admission BI	54.1 (SD 16.9)
0 – 33	21 (12.7)
34 – 66	96 (57.8)
67 – 100	49 (29.5)
Mean Admission BI	54.1 (SD 16.9)

BI: Barthel Index; SD: Standard Deviation

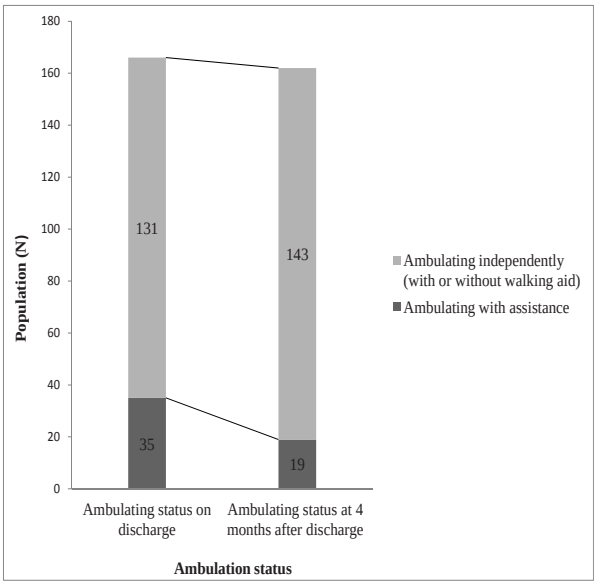

Fig. 1. Ambulating status on discharge and 4 months after discharge.

Note: Of those ambulating independently on discharge, 3 died (1.9%) and 1 (0.6%) was not contactable. McNemar's test for independent ambulation at discharge and 4 months after discharge is significant with *P* = 0.0046.

status did not change during their admission. There was no significant difference of mean REs with gender ($P = 0.26$) or primary diagnosis at admission i.e. neck or inter-trochanteric fracture of femur ($P = 0.934$). The relationships of REs to the other variables are shown in Table 2. On bivariate analysis with specific comorbidities, the mean REs of patients with dementia were significantly ($P = 0.004$) worse than those who did not have dementia. The rest of the comorbidities did not have individual significant differences in REs. From multivariate analysis, factors that are significantly associated with the poorer REs are older age, Malay (vs non-Malay ethnicity), having dementia, non-hypertensive and those doing 27 or less sessions of the 45-minute rehabilitative therapy sessions (all $P < 0.05$) (Table 3, Part A).

Rehabilitation Efficiency (REy)

The mean REy score of all subjects was 0.41 units (CI,

Table 2. Relationship between the Rehabilitation Effectiveness and the Various Variables

Age groups (years) (n)	Mean REs (%)	CI	*P* value (comparing with the mean of the last group)
Overall	40.4 (SD ± 26.3)	36.7 – 44.0	
50 – 59 (4)	33.46	- 4.73 – 71.65	0.788
60 – 79 (85)	44.90	38.71 – 49.29	0.048*
80 – 99 (77)	36.68	31.6 – 41.68	-
Ethnicity			
Indian	36.29	- 8.87 – 81.44	0.677
Malay	28.07	19.22 – 36.91	0.018*
Chinese	41.96	38.04 – 45.89	-
Charlson Co-Morbidity Index Score (n)			
0 (22)	37.02	26.05 – 47.99	0.842
1 – 3 (88)	44.05	38.87 – 49.22	0.042*
≥ 4 (56)	37.11	30.24 – 30.24	-
Admission BI Score (units)			
0 – 33	35.47	25.82 – 45.12	0.325
34 – 66	41.08	36.13 – 46.04	0.369
67 – 100	41.01	34.43 – 47.59	-
Length of stay (days)			
14 – 27	28.57	16.95 – 40.19	0.003*
28 – 55	40.05	35.08 – 45.02	0.05*
56 – 83	42.54	36.23 – 48.84	0.127
≥84	54.04	38.97 – 69.11	-
Length of weight bearing (days)			
0 – 27	31.76	24.66 – 38.86	0.019*
28 – 55	42.66	37.78 – 47.53	0.157
56 – 83	42.66	34.60 – 50.72	0.181
≥84	57.72	18.35 – 97.09	-
No. of rehabilitative therapy sessions			
0 – 13	18.74	1.85 – 35.64	0.014*
14 – 27	35.72	30.54 – 40.91	0.019*
28 – 41	46.11	39.04 – 53.17	0.990
≥42	46.17	39.76 – 52.57	-

*Significant at $P < 0.05$.

BI: Barthel Index; CI: 95% Confidence Interval of mean; SD: Standard Deviation

0.36 to 0.46 units) per day. The median REy score was 0.38 units per day. There was no statistically significant differences between the REy of all the demographic variables i.e. no differences in REy between the different age groups, gender, ethnicity, whether the fracture was neck of femur or intertrochanteric or those with different CCMI score. On bivariate analysis of the various morbidities, those in CCMI as well as with hypertension and ischaemic heart disease, only patients with hypertension had higher rehabilitation efficiency than those who did not have hypertension (P = 0.019). From multivariate analysis, significantly lower REy (P <0.05) was seen with those with higher admission BI and being non-hypertensive patient (Table 3, Part B).

REy decreases with regard to higher admission modified BI. There was a significant difference in the mean of REy with increasing admission BI. The REy also decreases with increasing length of stay beyond 83 days. There was an increase in rehabilitation efficiency with more rehabilitative therapy sessions up to 27 sessions. However, there was a decrease in rehabilitation efficiency with 28 or more rehabilitative therapy sessions. Thus, an inverted 'U- shaped' relationship between the number of rehabilitative therapy sessions with rehabilitation efficiency and the maximum in efficiency was seen in the 14 to 27 sessions group (Fig. 2).

Table 3. Multivariate Analysis of Rehabilitation Effectiveness and Rehabilitation Efficiency

Variable	Unstandardised β coefficient	*P* value
(A) Rehabilitation Effectiveness		
Age (old vs young)	6.812	0.046*
Ethnicity (Malay vs non-Malay)	14.38	0.008*
Charlson Co-Morbidity Index (low vs high)	– 1.661	0.733
Hypertension (no vs yes)	8.695	0.022*
Dementia (no vs yes)	– 26.107	0.002*
Diabetics mellitus with end organ disease (no vs yes)	– 8.389	0.112
Length of stay (days) (short vs long)	4.409	0.527
Duration of weight bearing in days (short vs long)	4.094	0.423
No. of rehabilitative sessions (≤27 vs >27)	11.038	0.003*
(B) Rehabilitation Efficiency		
Hypertension (no vs yes)	0.108	0.031*
Visual impairment (no vs yes)	0.100	0.086
No. of rehabilitative therapy session (≤27 vs >27)	– 0.097	0.055
Admission BI score (≤33 vs >33)	– 0.157	0.003*
Length of weight bearing days (≤27 vs > 27)	– 0.075	0.189

*Significant at P <0.05
BI: Barthel Index

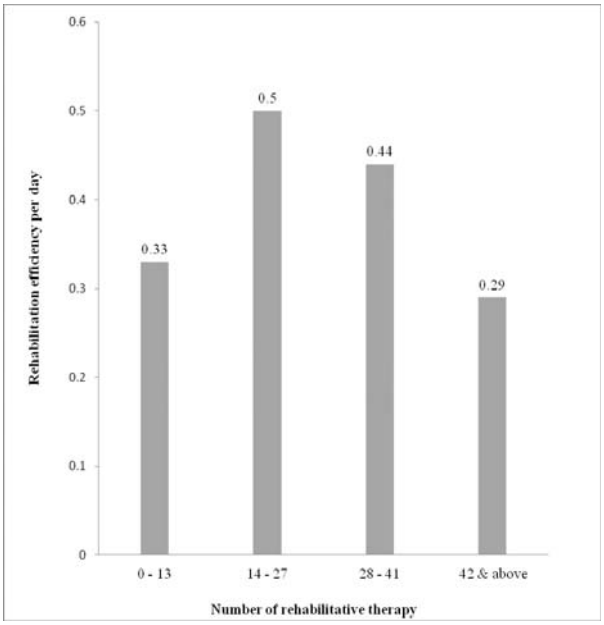

Fig. 2. Relationship between rehabilitation efficiency and number of rehabilitative therapy sessions.

There was no significant social issue in regard to the discharge destination of the patients. From the total of 166 patients included in the study, 155 patients were discharged home with some form of day rehabilitation or daycare. Only 7 patients were discharged to nursing home and 1 patient to the sheltered home. Remaining 3 patients' discharge destinations were not traceable. Analysis of mean REy for those who were discharged home and those to sheltered or nursing home did not show any statistical significance (P = 0.707).

Discussion

The current study shows that the profile of the hip fracture population in a CH setting in Singapore is usually elderly Chinese females with fracture neck of femur. The mean age was 78.9 years with 2.4% of patients below 60 years. Three patients died within 4 months after discharge thus, mortality rate of 1.8 % was similar to a study by Shyu et al with the mortality rate at 0.8% after 3 months of discharge following rehabilitations.[30] Studies done in Singapore have shown all-cause mortality from hip fracture to be as high as 27.1% for all patients, and 26% for those older than 60 years of age over 1 year follow-up period.[5,31] Studies have shown that functional independence was the main predictor of the mortality following the hip fracture.[31,32] The low mortality rate in the current study may be a reflection of significant improvement of the BI with rehabilitative therapy at discharge. Majority of patients were able to ambulate

at the discharge with or without walking aid, as well as exhibit subsequent significant (P = 0.0046) improvement in independent walking from 78.9% to 88.3% at 4 months following the discharge. This was comparatively more than the intervention trial in Taiwan.[30] Studies have shown that early ambulation following the hip fracture surgery is associated with lower mortality and better functional independence.[2,31,32] There was significant longer mean length of stay of 50.4 days (CI, 46.9 to 53.4) in the current study as compared to similar study by Huusko et al with an average total hospital length of stay of 34 days, which perhaps translate into better BI in the current study at the discharge.[33]

There are a few published studies on REs and REy in Singapore. The recent study by Chen at al has REs and REy for all-cause fractures in 4 CHs in Singapore but not for hip fracture alone.[17] Comparing with this study, the current study has slightly older age patients (78.9 years vs 76.2 years, respectively) and more female patients (84.3% vs 73%, respectively). The mean admission and discharge BI were better in the current study (49.1 & 65.1 vs 54.1 & 72.2, respectively). Length of stay (LOS) was also longer in current study with median LOS of 46.5 vs 33 days, respectively.

The median REs of 39% (IQR, 23.2% to 58.3%) in the current study was better than the previous study's[17] median REs of 34.2% (IQR, 10.1 to 58.1) in spite of more females and older age in the current study. This may point to the fact that REs of hip fracture may be better compared to all cases of fractures combined together. But, it may also be better due to the fact that the current study's mean admission BI was much higher and had longer days of rehabilitation in CH (46.5 days vs 33 days). The current study median REy was 11.4 for 30 days compared to 14.3 for 30 days in the recent study.[17] The maximum REy was seen with those who had 14 to 27 sessions of rehabilitative therapy and REy declined as the number of sessions increased. However, the REy for those who had 28 to 41 sessions showed a lesser drop (REy 0.44/day or 13.2/30 days) as compared to those who had stayed beyond 41 sessions (REy 0.29/day or 8.7/30 days).

Comparing the independent and associated predictors of REs and REy (Table 4), the current study also showed that short length stay in CH for rehabilitations and higher score in CCMI was associated with poorer outcome on REs in bivariate analysis. Older age, dementia, fewer numbers of rehabilitative therapy sessions, Malay (vs non-Malay ethnicity) and non-hypertensive patients are the independent predictors of poorer REs in our study. Previous studies[21,22] have found that lower admission ADL scores, age above 80 years and greater comorbidity burden are independent predictors of poorer REy. In this study, the other independent predictors associated with poorer REy were high admission BI (REy less sensitive to change at high Barthel index) and being non-hypertensive.

Table 4. Summary of Predictors of Poorer Rehabilitation Effectiveness and Rehabilitation Efficiency

	Factors associated with poor Rehabilitation Effectiveness (REs)	Factors associated with poor Rehabilitation Efficiency (REy)
Associated Predictors (Bivariate analysis)	1. Short length of stay 2. Dementia* 3. Fewer rehabilitative therapy sessions* 4. Malay* 5. Higher Charlson Co-Morbidity Index 6. Older age*	1. Higher admission BI score* 2. Few or too many no. of rehabilitative therapy sessions 3. Longer weight bearing to discharge 4. Non-hypertensive*
Independent Predictors (Multivariate analysis)	1. Dementia* 2. Fewer rehabilitative therapy sessions* 3. Malay* 4. Non-hypertensive† 5. Older age* 6. Non-hypertensive*†	1. Higher admission BI score*† 2. Non-hypertensive†

*Predictors common to both bivariate and multivariate analysis;
†Predictors common to both REs and REy.
BI: Barthel Score

Limitations

The current findings are limited to a short period of 16 months and one CH only, therefore, the results cannot be fairly extrapolated to other CHs or other inpatient rehabilitation settings. It would be good to know how the rehabilitation was with those who were discharged home or to a nursing home directly from the acute hospital as well as those who were not operated upon or unable to do at least 14 days of rehabilitative therapy at the CH. We also did not have the data regarding the nutritional status of the patients and prior rehabilitation status before the admission to the CH. Other conditions like depression and bone mineral density (not enough data in the records) would have been good to study with relation to REs and REy in the operated hip fracture patients.

Conclusion

Current study has shown that a CH stay was associated with a positive rehabilitation effectiveness and efficiency for patients after an operated hip fracture. The optimum number of rehabilitative therapy sessions was between

28 and 41 in terms of rehabilitation effectiveness. So an estimated length of stay of postoperative hip fracture patient who is weight bearing should correspond to 28 to 41 sessions of rehabilitative therapy in the CH. There is an inverted 'U-shaped' relationship between the number of rehabilitative therapy sessions with rehabilitation efficiency and the maximum efficiency seen in the 14 to 27 therapy sessions group. The independent predictors of REs and REy can be used by healthcare professionals in inpatient elderly rehabilitation settings to gauge the rehabilitation potential and speed of functional recovery in their hip fracture patients.

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