

Results From a Prospective Acute Inpatient Rehabilitation Database: Clinical Characteristics and Functional Outcomes using the Functional Independence Measure

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Abstract

Introduction: Rehabilitation improves functional outcomes, but there is little data on the profiles and outcomes of patients undergoing inpatient rehabilitation in Singapore. The aims of this paper were to document the clinical characteristics and functional outcomes, using the Functional Independence Measure (FIM), of all patients admitted to an inpatient rehabilitation unit in a tertiary teaching hospital, and to identify and analyse factors significantly associated with better discharge functional scores and higher functional gains. **Materials and Methods:** In this prospective cohort study over a 4-year period, clinical and functional data for 1502 patients admitted consecutively to the Singapore General Hospital inpatient rehabilitation unit were charted into a custom-designed rehabilitation database. The primary outcome measures were the discharge total FIM scores, FIM gain and FIM efficiency. Multiple linear regression analysis was used to identify independent variables associated with better discharge FIM scores and FIM gain. **Results:** The mean age was 61.3 ± 15.0 years and 57.2% of the patients were male. Stroke (57.9%) followed by spinal cord injury (9.7%) were the most common diagnoses. The average rehabilitation length of stay was 21.5 ± 19.0 days. The mean admission total FIM score was 70.3 ± 23.2 and the mean discharge total FIM score was 87.3 ± 23.0 , with this gain being highly significant ($P < 0.001$). The mean FIM gain was 17.0 ± 13.4 and FIM efficiency was 0.95 ± 0.90 points/day. Factors associated with better functional outcomes were higher admission motor and cognitive FIM scores, male gender, a longer rehabilitation length of stay and the use of acupuncture. Factors associated with poorer functional outcomes were older age, clinical deconditioning, ischaemic heart disease, depression, pressure sores and the presence of a domestic worker as a caregiver. **Conclusions:** The FIM is an easy-to-use, standardised and robust general measure of functional disability. Multiple demographic, clinical and socio-cultural variables are associated with the primary functional outcomes and should be taken into account in rehabilitation and discharge planning. Nevertheless, rehabilitation improves functional outcomes across a wide range of diagnoses. Further research should be aimed at evaluating long-term disability post-discharge from inpatient rehabilitation and translating these findings into improving rehabilitation and healthcare resource utilisation.

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Key words: Database, Functional Independence Measure, Functional outcomes, Rehabilitation,

Introduction

Rehabilitation improves functional outcomes.¹ Dedicated rehabilitation facilities employing a multidisciplinary model of care further improve outcome and quality of life compared to rehabilitation in general medical wards.² With the ageing of the population in developed countries, as well as the increasing prevalence of disability from chronic disease

due to improved acute medical care, the demand for rehabilitation care will continue to rise. This has resulted in spiralling costs for rehabilitation due to the staff-intensive nature of the specialty.³

The field of rehabilitation medicine has also seen an exponential increase in research and knowledge, which has resulted in the reduction of disability and better clinical

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care.^{4,5} This has led to an increasing number of rehabilitation facilities offering an even larger array of therapeutic options and subspecialty programmes.

For the reasons stated above, there is a pressing need for rehabilitation approaches which are evidence-based, not just to justify the efficacy of inpatient rehabilitation but also to select processes that best improve functional outcome cost-effectively.^{3,6} The complexity and difficulty of this task is reflected in the variety of reimbursements systems that different countries employ for rehabilitation services.⁷⁻¹⁰ This ranges from case-mix and functional-related group systems to classify disease, and to payment systems which may be prospective, per diem or per episode.⁷⁻¹⁰ What is clear, however, is the need to develop and establish a basic data set and functional outcome measures that are standardised, easy to use and applicable to a wide variety of rehabilitation conditions. This would allow for baseline comparisons of rehabilitation cohorts, establish quality standards, assist clinicians in prognostication and eventually plan economic and rehabilitation resources effectively.¹¹

In the United States, Australia and continental Europe, where the practice of rehabilitation medicine is well-developed, databases specific to rehabilitation outcomes have been established to meet this important need. The United States National Model Systems Spinal Cord Injury and Traumatic Brain Injury Rehabilitation databases are examples of such multicentre registries which maintain a minimum data set and utilise the Functional Independence Measure (FIM) as the common primary functional outcome measure.^{12,13} The FIM, in turn, is the most widely used general measure of disability in North America and Australia, and is increasingly being adopted by Asian countries with developed rehabilitation facilities such as Japan and Taiwan.^{1,14,15} Advantages of using the FIM as compared to other generalised disability scales include the capability to compare functional outcomes by diagnosis, as well as by facility and internationally with the large FIM database maintained by central coordinating centres.¹⁵ The FIM is also subject to continuous review and refinement to maintain standards and relevance. In addition, clinicians in subscribing centres undergo training courses and accreditation examinations in order to maintain competency.

There is scarce data in Singapore with regard to baseline rehabilitation demographics and outcomes. Adopting existing models is only a partial solution, as there are important social, cultural, ethics, political and healthcare considerations which all impact on rehabilitation outcomes and vary considerably between countries.^{13,15,16} In addition, many local centres, including acute hospitals, community hospitals, nursing homes and a large number of outpatient locations, offer rehabilitation services with varying degrees

of intensity and specificity with no consistent functional outcome measures employed.

The aims of this paper were to prospectively chart all patients admitted to an inpatient tertiary rehabilitation facility, data relating to demographics, clinical characteristics and functional outcomes using the FIM as the primary outcome measure. We also aim to identify and analyse factors significantly associated with better discharge functional scores and higher functional gains.

Materials and Methods

The inpatient rehabilitation unit of the Department of Rehabilitation Medicine, Singapore General Hospital (SGH) is located within the acute hospital premises and admits patients across a wide range of diagnoses and severities.

All patients admitted to the Department of Rehabilitation Medicine, SGH are prospectively included into the Department Rehabilitation Database. The admission criteria to the rehabilitation unit are (1) age 15 or older, (2) presence of impairments or disabilities which may benefit from a comprehensive inpatient rehabilitation programme regardless of diagnosis, (3) patient has the potential to participate in a goal-oriented rehabilitation programme and (4) sufficient medical stability to participate in a rehabilitation setting. Rehabilitation Medicine specialists select patients for rehabilitation during consultation rounds and coordinate the transfer of appropriate candidates from the acute referring units.

We reviewed the Rehabilitation Database for the 4-year period from 1 July 2002 to 30 June 2006. There were 1502 patients with complete records. There were 28 patients with incomplete records or missing data and these were excluded from the analysis. The custom-designed database was developed using Microsoft Access 97 (Microsoft Inc, Redmond, VA) and is stored securely within the hospital's intranet.¹¹ The parameters to be charted were determined after a review of the rehabilitation literature, particularly focusing on variables collected by similar large rehabilitation databases and previously studied consistent predictors of functional outcomes. Input was also obtained from the unit's multidisciplinary rehabilitation team. In addition, data pertinent to local cultural practices which may impact rehabilitation outcomes, such as domestic workers as caregivers, were also included.

The data collected were classified into 6 categories: (1) demographics, (2) social and cultural characteristics, (3) diagnosis and diagnostic details, (4) co-morbidities, (5) medical complications, and (6) functional outcomes. Demographic data collected were age, gender, race and marital status. Socio-cultural characteristics such as housing, employment and availability of post-discharge

transportation were documented. Co-morbidities documented included established cardiovascular risk factors such as hypertension, diabetes mellitus and smoking. Complications charted included nosocomial infections, pressure sores and falls. Depression was diagnosed by consensus amongst the managing team based on patient-reported symptoms and clinician or caregiver observations, since standard criteria and questionnaires were difficult to apply in conditions such as aphasia or Parkinson's disease.¹⁷ For inclusion as a depressed subject in our study, this further necessitated a need for medical or non-medical intervention. The presence of deconditioning was also clinically diagnosed by managing team consensus, as no standardised clinical or laboratory criteria exists.¹⁸

The FIM is the primary functional outcome measure used in our facility and database, and is collected prospectively at admission (AFIM) and discharge (DFIM). The FIM is a widely used standardised functional outcome measure in medical rehabilitation. It consists of 13 motor and 5 cognitive items, with established content and construct validity, sensitivity and inter-rater reliability for the measurement of general functional ability across a wide range of rehabilitation conditions.¹⁴ Motor items include disability assessment in feeding, grooming, dressing, toileting and mobility. Cognitive items assess communication, social interaction, problem-solving and memory. Scores range from 1 (totally dependent) to 7 (totally independent) for each of the 18 items, with a maximum score of 126 indicating total functional independence. The FIM gain is the difference between DFIM and AFIM scores and measures functional improvement. The FIM efficiency is the FIM gain divided by the length of stay (LOS), and measures the rate of functional improvement.¹ The Department of Rehabilitation Medicine, SGH, is a FIM-accredited facility. All physicians, nurses and therapists who perform FIM assessments are trained and accredited in FIM scoring and are subject to a continuous 2-yearly renewal.

A multidisciplinary team led by a rehabilitation physician assesses and scores the FIM within 72 hours of admission and discharge to our unit. All patients go through a comprehensive rehabilitation programme, which includes medical and nursing care, physical therapy and occupational therapy. Speech or language therapies and medical social work interventions are arranged where appropriate. Patients received approximately 2 to 3 hours of therapy per day. Weekly multidisciplinary staff meetings are conducted to assess progress, review functional goals, plan further therapies and formulate discharge plans.

The Student's *t*-test and one-way analysis of variance (ANOVA) were used to assess differences in group means. We performed 2 multiple linear regression analyses to

identify independent clinical variables associated with the discharge total FIM score and FIM gain. The independent variables chosen were based on prior literature review as well as a consensus among the authors. This included age, gender, LOS, social demographics, employment status, cardiovascular risk factors, medical complications and initial functional scores. The variables were then entered simultaneously into the linear regression models. In both these linear models, assessments for violation of assumptions were made, including analyses of normality of the residuals and linearity of the continuous variables. The adjusted R^2 was calculated for these models to assess whether they were good predictors of the discharge FIM score and FIM gain.

The SPSS version 10.1 software (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Unless otherwise indicated, statistical analyses performed were parametric when groups were compared and a *P* value of <0.05 was considered statistically significant.

This study was approved by the Institutional Review Board of SGH.

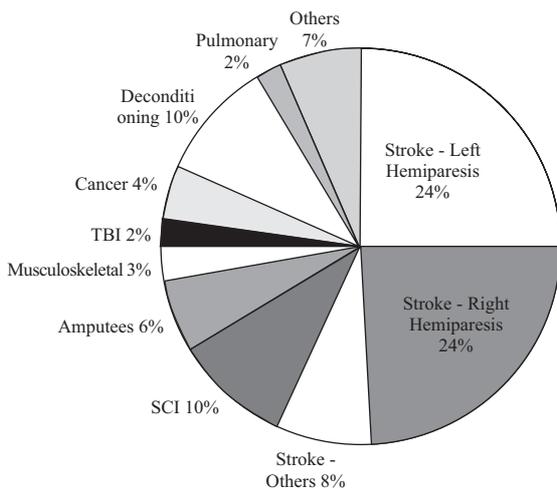
Results

General Demographics

There were a total of 1502 patients in the study period and 859 (57.2%) were male. Chinese patients constituted 77.5% and Malay patients made up 12.2% of the study cohort. The mean age was 61.3 ± 15.0 years (range, 15 to 96). At the time of admission, 489 (32.6%) patients were employed.

Stroke (865 patients, 57.9%) was the most common diagnosis, followed by spinal cord injury (SCI) (145, 9.7%) and musculoskeletal conditions, including amputees (130, 8.7%). In addition, 66 (4.4%) patients had cancer, 35 (2.3%) patients had traumatic brain injury (TBI) and 31 (2.1%) patients were admitted specifically for a pulmonary rehabilitation programme. Significant deconditioning not associated with the above conditions was present in 148 (9.9%) patients, and 49 of these patients continued to receive long-term intravenous antibiotics for chronic infections. In addition, 58 patients continued to undergo dialysis for end-stage renal failure during their inpatient rehabilitation programme. This wide spectrum of diagnoses is depicted in Figure 1.

The mean acute and rehabilitation LOS were 14.5 ± 17.5 days and 21.5 ± 19.0 days, respectively. There is a moderate positive correlation between the acute and rehabilitation LOS (Spearman's $\rho = 0.208$, $P < 0.001$). One thousand three hundred and forty-nine patients (89.8%) were discharged home successfully. The main discharge caregivers were family members in 58.9% of cases, a domestic worker in 19.2% of cases or approximately equal



Pulmonary: patients admitted specifically for inpatient pulmonary rehabilitation programme. SCI: Spinal Cord Injury; Stroke-Others: stroke with bilateral paresis or minimal paresis; TBI: traumatic brain injury. The deconditioning category *excludes* patients with stroke, SCI, TBI, musculoskeletal diagnoses, amputees, cancer and pulmonary rehabilitation patients.

Fig. 1. Diagnostic profile of patients (n = 1502) admitted to an acute inpatient rehabilitation facility.

responsibilities for both family members and domestic workers in 9.3% of cases.

Functional Outcomes and Subgroup Analyses

The mean admission total FIM score was 70.3 ± 23.2 and the mean discharge total FIM score was 87.3 ± 23.0. This gain in FIM scores is highly significant (P <0.001, paired t-test). There were also highly significant gains in motor and cognitive FIM scores (Table 1). The mean FIM gain was 17.0 ± 13.4 and the FIM efficiency was 0.95 ± 0.90 points/day.

There were also significant improvements in all individual items in the FIM scores. The improvements in the motor FIM items are graphically represented in Figure 2.

Table 2 lists the admission and discharge total FIM scores as well as FIM subscores by major diagnostic groups commonly seen in our unit. On admission to rehabilitation, we can arrange sequentially from least to the most disabled based on the admission total FIM scores: pulmonary rehabilitation patients, amputations, SCI, stroke and TBI. This sequential order is maintained on the discharge total FIM scores, with TBI and stroke patients relatively more disabled compared to patients with SCI and amputations on discharge. However, all groups made significant improvements in function after rehabilitation.

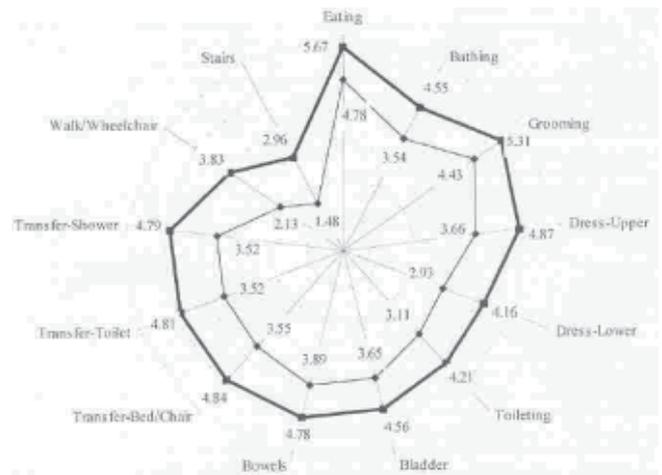
All groups also had significant FIM gains and FIM efficiency, and there is an inverse relationship between lower admission total FIM scores and better FIM gains and FIM efficiency. Hence, while patients with TBI and stroke

Table 1. FIM Scores of All Patients in Our Cohort (n = 1502)

	Admission (mean ± SD)	Discharge (mean ± SD)	P*
Total FIM Scores	70.3 ± 23.2	87.3 ± 23.0	<0.01
Motor FIM Scores	44.2 ± 17.6	59.4 ± 17.9	<0.01
Cognitive FIM Scores	26.1 ± 8.4	28.0 ± 7.6	<0.01

FIM: Functional Independence Measure (range from 18, most disability to 126, no disability)

* paired t-test



The inner polygon represents the mean individual item scores on admission, and the outer polygon represents the mean individual item scores on discharge. Item scores range from 1 (most disability) to 7 (no disability).

From clockwise: Dress-Upper: dressing of the upper body; Dress-Lower: dressing of the lower body; Bladder, Bowel: indicates bladder or bowel function respectively; Transfer items refer to transfer to a bed or chair, transfer to a toilet or transfer to a tub or shower respectively; Walk/Wheelchair: either walk or wheelchair ambulation, the mode must be the same on admission and discharge.

Fig. 2. Radar chart: graphic representation of individual items in the motor component of the FIM.

had lower admission total FIM scores, they also had the highest FIM gains and FIM efficiency (Table 2).

Regression Analyses

The first regression model on the discharge total FIM score estimated about three-quarters of the variance in this variable (Adjusted R² = 0.73, Table 3). Factors associated with a higher discharge total FIM score were higher admission motor and cognitive FIM scores, male gender, a longer rehabilitation LOS and the use of acupuncture. Factors associated with a lower discharge total FIM score were older age, a clinical diagnosis of deconditioning, a history of ischaemic heart disease, depression during rehabilitation and the presence of a domestic worker as caregiver. The factors with the highest impact on the discharge total FIM scores were the admission motor FIM scores (β = 0.55) and the admission cognitive FIM scores (β = 0.38).

Table 2. FIM Scores of Patients Categorised by Selected Diagnoses Common in Rehabilitation

	All cases (n = 1502)	Pulmonary rehabilitation (n = 31)	Amputations (n = 130)	Spinal cord injury (n = 145)	Stroke (n = 865)	Traumatic brain injury (n = 35)	P†
Primary FIM Outcome Measures							
Admission Total FIM	70.3 ± 23.2	109.0 ± 14.9	85.4 ± 16.0	68.5 ± 21.1	67.9 ± 23.1	60.6 ± 25.6	<0.01
Discharge Total FIM	87.3 ± 23.0	114.7 ± 13.5	97.3 ± 16.1	86.6 ± 23.6	85.9 ± 23.0	82.7 ± 25.9	<0.01
P*	<0.01	0.005	<0.01	<0.01	<0.01	<0.01	
FIM Motor and Cognitive Subscores							
Admission Motor FIM	44.2 ± 17.6	75.3 ± 13.2	54.7 ± 12.7	37.7 ± 18.8	43.2 ± 17.0	43.1 ± 19.5	<0.01
Discharge Motor FIM	59.4 ± 17.9	80.8 ± 11.7	66.1 ± 12.6	54.9 ± 20.6	58.9 ± 17.5	61.7 ± 20.5	<0.01
P*	<0.01	0.003	<0.01	0.037	<0.01	<0.01	
Admission Cognitive FIM	26.1 ± 8.4	33.6 ± 2.4	30.7 ± 5.6	30.8 ± 5.9	24.7 ± 8.5	17.5 ± 9.5	<0.01
Discharge Cognitive FIM	28.0 ± 7.6	33.8 ± 2.3	31.2 ± 5.2	31.6 ± 5.7	26.9 ± 7.7	21.0 ± 8.1	<0.01
P*	<0.01	0.519	0.02	<0.01	<0.01	<0.01	
Derivative FIM Scores							
FIM Gain‡	17.0 ± 13.4	5.7 ± 9.0	11.9 ± 8.2	18.1 ± 16.7	18.0 ± 13.0	22.1 ± 19.4	<0.01
FIM Efficiency§	0.95 ± 0.90	0.41 ± 0.56	0.68 ± 0.62	0.81 ± 1.34	1.00 ± 0.84	1.32 ± 1.11	<0.01

Functional Independence Measure (range from 18, most disability to 126, no disability); Pulmonary Rehab: patients admitted specifically for inpatient pulmonary rehabilitation programme
 All scores are mean ± SD; * paired *t*-test; † one-way analysis of variance (ANOVA); ‡ Discharge Total FIM - Admission Total FIM; § FIM Gain divided by length of stay in rehabilitation

Table 3. Multiple Linear Regression Analysis Model on Total Discharge FIM Scores

Variable	B*	SE	β†	P
Admission Motor FIM Scores	0.72	0.02	0.55	<0.01
Admission Cognitive FIM Scores	1.03	0.04	0.38	<0.01
Male	3.12	0.68	0.06	<0.01
Age	-0.12	0.02	-0.08	<0.01
Length of stay in rehabilitation	0.08	0.02	0.07	<0.01
Clinical deconditioning	-3.80	0.99	-0.05	<0.01
History of ischaemic heart disease	-2.49	0.80	-0.04	0.002
Depression in rehabilitation	-3.73	0.85	-0.06	<0.01
Presence of domestic worker	-2.63	0.76	-0.05	0.001
Acupuncture	2.50	1.20	0.03	0.037

FIM: Functional Independence Measure; SE: standard error
 Adjusted R² = 0.73

* unstandardised coefficient; † standardised coefficient

The second regression model on FIM gain estimated only about one-quarter of the variance in this variable (adjusted R² = 0.23, Table 4). Factors associated with a higher FIM gain were male gender, a longer rehabilitation LOS and employment at the time of illness. Factors associated with a lower FIM gain were *higher* admission FIM scores, older

age, clinical diagnosis of deconditioning, a history of ischaemic heart disease, depression during rehabilitation and the presence of pressure sores.

Marital status, complications in rehabilitation (excluding depression) and the presence of cardiovascular risk factors were not associated with the discharge total FIM scores or FIM gain in our regression models.

Discussion

This study provides important data on functional outcomes after inpatient rehabilitation for a wide range of chronic diseases in Singapore. This potentially allows us to compare functional differences between diagnoses and across rehabilitation facilities. More importantly, these data confirm that inpatient rehabilitation programmes improve functional outcomes across a wide range of diagnoses.

The racial distribution in our cohort is similar to that of the national racial distribution.¹⁹ The average age of our patients (61.3 years) is lower than the age cut-off for geriatric services in Singapore (≥65 years).²⁰ This may dispel a common misconception that chronic disease and functional disability is mainly confined to the elderly. Furthermore, a significant number of these younger patients were working at the time of their illness and disruption of employment and financial remuneration, particularly for sole-bread winners, can be devastating for these patients'

Table 4. Multiple Linear Regression Analysis Model on FIM Gain

Variable	B*	SE	β †	P
Admission motor FIM scores	-0.28	0.02	-0.37	<0.01
Male	2.91	0.68	0.10	<0.01
Age	-0.08	0.03	-0.09	0.001
Length of stay in rehabilitation	0.09	0.02	0.13	<0.01
Clinical deconditioning	-3.78	1.01	-0.09	<0.01
History of ischaemic heart disease	-2.36	0.81	-0.07	0.003
Presence of domestic worker	-2.47	0.78	-0.08	0.01
Depression in rehabilitation	-3.60	0.85	-0.10	<0.01
Pressure sores	-7.15	2.30	-0.07	0.002
Working at time of illness	2.84	2.77	0.10	<0.01

FIM: Functional Independence Measure; SE: standard error

Adjusted R² = 0.23

* unstandardised coefficient; † standardised coefficient

families and children. Vocational rehabilitation programmes have been shown to improve the eventual re-employment rate and should be developed and supported to reduce the caregiver and societal burden on the country in the long run.²¹

Although stroke accounted for approximately half of our patients, there is a wide range of diagnoses admitted to our unit. These include patients with cancer, end-stage renal failure patients on dialysis and pulmonary rehabilitation patients on long-term oxygen therapy. The rehabilitation of these latter medically fragile subsets of patients provides a strong argument for an acute inpatient rehabilitation unit to be located within or in close proximity to an acute hospital due to the number of medical complications that can occur, as inpatient rehabilitation is a medically active service.²² The acute and rehabilitation LOS is similar to those in facilities across the United States, but shorter than those in Japan.^{1,15}

The high rate of home discharge is encouraging. Although the majority of the caregivers of disabled patients are family members, the fairly high proportion of domestic workers who are employed for the purposes of caregiving appears to be a unique local phenomenon. Education and counselling programmes for caregivers are important provisions to optimise functional and social patient outcomes.²³

Patients with non-neurological diagnoses (pulmonary rehabilitation and amputee patients) had mean FIM scores that were *higher* than the overall cohort mean FIM scores, compared to patients with neurological diagnoses (SCI, stroke and TBI) who had mean FIM scores that were *lower* than the overall cohort mean FIM scores. This reiterates the need to consider the diagnosis when interpreting functional

outcome measures such as the FIM gain and FIM efficacy, as these will differ by diagnosis.¹ This also highlights the difficulty of comparing the rehabilitation efficiency of various facilities as their disease spectrum will be different. For example, facilities with higher proportions of patients with stroke and TBI may have an overall lower mean discharge FIM score but higher FIM gain and FIM efficiencies.

The ceiling effect inherent in most disability scales, where functional gains are incrementally smaller as the scale measurement reaches a maximum (no disability), can explain the lower FIM gains and FIM efficiencies in patients with higher admission FIM scores.²⁴ Other disability scales may need to be used in conjunction with the FIM to measure functional improvements in certain patient subsets. This includes patients at the very severe or minimally disabled end of the FIM scale, such as pulmonary rehabilitation or amputee patients, where the FIM is less sensitive to changes. Examples are high-level balance scales in minimally disabled stroke patients, and the 6-minute walk test, which is evaluated in all our patients in the pulmonary rehabilitation programme.²⁵ Regardless of diagnosis, it is very encouraging to note that functional outcomes for all diagnoses improved in all patients who participated in the inpatient rehabilitation programme.

It is worth highlighting that apart from clinical factors, there are a variety of demographic, functional, social and cultural factors that have an impact on the functional status of the patient at discharge. This further emphasises the idea that goal-setting and discharge-planning in rehabilitation should take into account these factors which will be unique to individual countries and societies with different healthcare systems.

In the first regression model for prediction of the discharge FIM scores, the identified independent variables in Table 3 predicted a substantial three-quarter of the variance in the discharge FIM scores. The important association that the severity of disability at admission best predicts the discharge functional capacity has been reported by numerous outcome studies in rehabilitation, and is also true in our cohort.²⁶ In addition, poorer admission cognitive status is also associated with worse discharge FIM scores in our study, and this important predictor may not be captured by older disability scales such as the Modified Barthel Index.²⁷ The finding that male patients have better functional outcomes is intriguing and needs to be further explored in future studies. The association of longer rehabilitation LOS with better discharge functional scores is not surprising as it allows more time for natural recovery and also for more rehabilitation interventions. The demand for and the use of complementary medicine is common in Singapore and the finding that acupuncture is associated with better discharge

FIM scores is important and needs to be validated in larger trials with a more uniform patient cohort.²⁸ The presence of ischaemic heart disease probably represents a high vascular disease burden and associated co-morbidity which impairs the recovery process during rehabilitation.²⁹

We also found that deconditioning itself is associated with poorer outcomes, and this is indirectly supported by recent literature supporting the benefits of therapeutic exercise in inactive, chronically disabled patients.^{18,30} Research needs to be aimed at refining clinical and laboratory definitions of deconditioning in order to identify the most at risk patients for early and more intensive rehabilitation.¹⁸ We believe that the presence of a domestic worker correlates to a lower discharge FIM score for 2 reasons. Firstly, these workers may be employed for patients who are more disabled on discharge and who therefore require more assistance after discharge. Secondly, the presence of a domestic worker may paradoxically reduce the motivation for patients to try harder during rehabilitation therapies as more of the activities of daily living can be provided for by these workers. Depression is common during rehabilitation and has been established to correlate to worse outcomes and this is supported by our study. Vigilance, early detection and intervention for depression may help ensure optimal results.³¹

Since only about one-quarter of the variance in the FIM gain was accounted for in the second model, there are likely to be many other factors that are associated with functional change that were not included in our database. The association of lower FIM gains with higher FIM scores is probably due to the ceiling effects as described above. Pressure sores have been correlated to lower FIM scores due to a variety of reasons such as diminished mobility, and continued vigilance in prevention is necessary during the course of rehabilitation.^{20,32} Depression, deconditioning and ischaemic heart disease are likely to be associated with lower FIM gains for similar reasons to their associations with the discharge total FIM scores.

Age significantly affects FIM scores in both models. In most functional outcome studies, older patients have lower admission and discharge functional scores, but the functional gains remain approximately the same as younger patients.²⁴ In our study, although age is negatively associated with the discharge FIM score and FIM gain, the actual absolute impact is very small ($B = -0.12$ and -0.08 respectively). This means that a 10-year increase in age is associated with approximately only a 1-point decrease in the discharge FIM score or FIM gain. Certainly, appropriate elderly patients can benefit and should receive rehabilitation, and good functional gains have been established in such patients.²⁴

The major limitation in this study is inclusion bias. Only patients who were selected as suitable candidates for inpatient rehabilitation in our hospital were included. This may not reflect the wide range of patients with disabilities who may have benefited from rehabilitation, as these patients may have been triaged to receive, or had preferences for rehabilitation at other facilities such as inpatient rehabilitation units at other acute hospitals, community rehabilitation hospitals, nursing homes or outpatient rehabilitation facilities. In addition, over the 4-year period of this study, important parameters of inpatient rehabilitation, such as LOS and functional outcomes, may have changed and our study was not large enough to detect these changes over time. These include generally shorter LOS and better FIM efficiencies in recent years in countries with well-developed rehabilitation resources.¹ This is because there will be changes to rehabilitation systems, intensity of therapy or rehabilitation interventions over a 4-year period either due to manpower or healthcare policy changes. Finally, this rehabilitation cohort comprised diverse clinical conditions and multiple other factors associated within each diagnosis, which could have contributed to the differences in outcomes but were not explored.

In summary, rehabilitation improves functional outcomes for patients with disabilities regardless of diagnosis. The FIM is a reliable general measure of functional disability and has the added advantages of measuring cognitive function, a large database for comparison and is subject to continuous review and refinements. Apart from the initial functional status, many demographic, medical, social and cultural factors are associated with functional improvements. Further research could include evaluating outcomes in different diagnostic and functional related groups, following long-term functional outcomes after discharge from inpatient rehabilitation and translating these data to more effectively plan limited rehabilitation and national healthcare resources for patients with disabilities.

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