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# Understanding the Functional Independence Measure: a Study of Rehabilitation Inpatients

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The Functional Independence Measure (FIM) provides a seven level ordinal scale for measuring functional performance on 18 activities considered essential for daily living. In routine practice, the scores on the individual activities are usually summed giving a total FIM score that ranges from 18 to 126. We present an analysis of FIM using factor analysis and multiple linear regression with data from 506 inpatients in a rehabilitation unit. The set of hierarchical subscales based on components of the 18 FIM item devdop and show that after adjusting for age and impairment group, these subscales explain a greater proportion of variance than the summed 18 item in the length of stay in a rehabilitation unit.

**Key words:** FIM, factor analysis, proportion of variance

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## Introduction

The Functional Independence Measure, known as the FIM (Keith *et al.*, 1987), was developed in the United States by a joint task force including the American Academy of Physical Medicine and Rehabilitation and the American Congress of Rehabilitation Medicine, in response to the need to uniformly define, measure, document and report patient disability and the outcomes of rehabilitation (Hamilton and Granger, 1994). It was designed for use in rehabilitation inpatient facilities as an instrument for measuring functional performance on 18 activities considered essential for daily living. These activities fall into five broad categories: personal care, sphincter control, mobility, locomotion and communication. Each activity is rated on a seven level ordinal scale ranging from 1 (complete dependence) to 7 (complete independence). In routine practice, the scores on the individual items are usually summed giving a total FIM score that ranges from 18 to 126. The difference between admission and discharge FIM scores is taken to indicate improvement or deterioration of patient's ability to perform daily activities.

It has been recognized that the FIM is a minimal data set. There is some controversy over the reliability, validity and precision of the FIM but many clinicians still regard it as a useful measure of a patient's disability status. There are other areas not assessed by the FIM, where effective rehabilitation interventions are administered. Various techniques have been used in the analysis of the FIM but much work has centred around Rasch analysis (Rasch, 1960) a method that transforms a set of FIM scores into a single measurement using a probability decomposition and then applies a logistic regression model to these transformed measurements.

This paper presents an analysis of the FIM scores using standard statistical methods. We begin with an exploratory of FIM scores with a view to determining the dimensionality of the FIM and then assess our results by predicting the length of stay.

## Materials and Methods

This study examines data from 519 patients admitted consecutively between July 1991 and December 1994 to the 24-bed rahabilitation unit of the Fairfield Hospital, a general hospital in Sydney, Australia. Data were collected according to the Uniform Data Set for Medical Rehabilitation (Hamilton *et al.*, 1987). The data include demographic information, length of stay in the rehabilitation facility, admission and discharge FIM scores for the 18 items. Admission FIM scores were measured prior to admission to ward and discharge FIM scores were measured on day of discharge from ward. Patients who were transferred to an acute hospital but who returned within 14 days are included. Length-of-stay data comprise only the number of days spent in the rehabilitation unit. Thus 506 patient records were available for analysis.

Factor analysis (Harman, 1976) was used to explore the underlying structure in the eighteen FIM items and multiple linear regression analysis was used to determine predictors for length of stay.

## Results

The patients were classified into three main impairment groups according to their diagnosis: stroke, orthopaedic and other54.1, 27.8, and 18.1% respectively. The latter consisted of amputees (6.7%), patients with brain dysfunction, nuerological conditions and spinal cord dysfunction, with arthritis, pain syndrome and cardiac problems making up 6.7, 3, 3.8, 2.6 and 1% respectively of patients. The distribution of their age, gender, and impairment group is shown in Table 1.

Maximum likelihood foactor analysis using promax rotation (Harman, 1976) was used as a means of exploring the underlying correlation structure among the 18 component FIM items, and to represent these items in terms of a smaller number of hypothetical variables, known as common factors. Analysis for admission FIM scores and change in FIM scores from admission to discharge each produced six significant factors, with factor loadings, ideally close to 0 or 1, as shown in Tables 2 and 3, respectively. Loadings with a magnitude of 0.4 or greater are highlighted in order to display the grouping pattern of individual FIM items within each factor.

For admission FIM scores, Table 2 shows factor 1 to have high loadings on eight items: three lower body items (*bathing, dressing-lower body, toileting*), three transfer items (*transfer-bed, transfer-tub, transfer-toilet*) and two mobility items (*walk, stairs*). Factors 2, 3 and 4 display three distinct subgroups of FIM items; the five cognitive/socialisation items (*comprehension, expression, social interaction, problem solving, memory*), the three personal care items (*eating, grooming, dressing upper body*), and the two sphincter control items (*bladder, bowel*), respectively. From Table 3, the six factors resulting from the difference in FIM scores display a much clearer separation of items into distinct groups. Here the lower body items, the mobility items and the transfer items are clearly disjoint, while the cognitive/socialisation items have been separated into smaller subgroups.

Table 1: Distribution of inpatients by age, gender and impairment group

| Age in years | Impairment group | | | | | |
|---|---|---|---|---|---|---|
| | stroke | | orthopaedic | | other | |
| | male | female | male | female | male | female |
| 18 - 64 | 47 | 40 | 10 | 10 | 22 | 17 |
| 64 – 69 | 33 | 18 | 7 | 10 | 8 | 2 |
| 70 – 74 | 20 | 31 | 7 | 22 | 12 | 6 |
| 75 – 79 | 21 | 21 | 8 | 22 | 4 | 7 |
| 80+ | 19 | 23 | 8 | 37 | 6 | 8 |
| Total | 140 | 133 | 40 | 101 | 52 | 40 |

The breakdown of the underlying assumption of normality of the error structure, required for factor analysis, limits direct use of the factors given in Tables 2 and 3. However, the pattern of clustering suggested in these factors may be used to develop a set of six artificial modular variables. Pearson's correlation coeficients for these modular factors, using admission scores, discharge scores and change in scores show that the variables are all significantly correlated with each other at the 5% significant level.

The six modular variables are as follows:

1: (eating + grooming + dressing-upper body)/3
2: (bathing + dressing-lower body + toileting)/3
3: (bladder managemant + bowel management)/2
4: (transfer-bed/chair/wheelchair + transfer-toilet + transfer-tub/shower)/3
5: (walk/wheelchair + stairs)/2
6: (comprehension + expression + social interaction + problem solving + memory)/5

 

Table 2: Matrix of factor loadings for admission FIM scores

| FIM item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 |
|---|---|---|---|---|---|---|
| Eating | -0.06 | 0.13 | 0.78 | 0.01 | 0.05 | -0.06 |
| Grooming | 0.08 | 0.09 | 0.76 | 0.04 | -0.01 | -0.01 |
| Bathing | 0.58 | 0.02 | 0.13 | 0.09 | -0.03 | 0.31 |
| Dressing Upper Body | 0.35 | 0.09 | 0.52 | -0.08 | -0.02 | 0.17 |
| Dressing Lower Body | 0.69 | 0.04 | 0.00 | -0.02 | -0.01 | 0.45 |
| Toileting | 0.72 | 0.05 | 0.11 | 0.05 | 0.02 | 0.19 |
| Bladder | 0.14 | 0.12 | -0.08 | 0.74 | -0.01 | 0.01 |
| Bowel | 0.04 | 0.08 | 0.12 | 0.68 | 0.01 | -0.02 |
| Transfer:bed | 0.90 | 0.00 | 0.00 | 0.05 | 0.01 | 0.00 |
| Transfer:toilet | 0.99 | 0.05 | 0.00 | 0.01 | -0.03 | -0.08 |
| Transfer:tub | 0.98 | 0.03 | 0.02 | -0.01 | -0.03 | -0.10 |
| Walk | 0.74 | 0.01 | 0.03 | 0.02 | 0.06 | 0.03 |
| Stairs | 0.62 | -0.16 | -0.08 | -0.02 | 0.04 | 0.11 |
| Comprehension | 0.02 | 0.93 | -0.04 | 0.02 | 0.30 | 0.03 |
| Expression | 0.02 | 0.95 | 0.05 | -0.02 | 0.42 | -0.02 |
| Social interaction | -0.03 | 0.74 | 0.14 | 0.08 | -0.09 | -0.04 |
| Problem solving | 0.00 | 0.76 | 0.09 | 0.04 | -0.22 | 0.01 |
| Memory | -0.06 | 0.94 | -0.06 | -0.05 | -0.24 | 0.04 |

Table 3: Matrix of factor loadings for change in FIM scores

| FIM item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 |
|---|---|---|---|---|---|---|
| Eating | -0.03 | -0.02 | 0.06 | 0.55 | 0.00 | 0.03 |
| Grooming | 0.01 | 0.01 | -0.02 | 0.83 | 0.06 | -0.02 |
| Bathing | 0.03 | 0.64 | 0.04 | 0.14 | -0.04 | 0.04 |
| Dressing Upper Body | 0.03 | 0.34 | 0.04 | 0.53 | -0.06 | -0.06 |
| Dressing Lower Body | 0.10 | 0.74 | 0.03 | 0.05 | 0.04 | 0.02 |
| Toileting | 0.39 | 0.40 | 0.00 | 0.08 | -0.02 | 0.15 |
| Bladder | 0.08 | 0.06 | 0.03 | -0.06 | -0.01 | 0.66 |
| Bowel | -0.05 | -0.11 | -0.03 | 0.03 | 0.01 | 0.85 |
| Transfer: bed | 0.81 | 0.14 | -0.03 | -0.10 | 0.07 | -0.04 |
| Transfer: toilet | 0.97 | -0.07 | 0.02 | 0.04 | -0.03 | 0.02 |
| Transfer: tub | 0.96 | -0.06 | 0.02 | 0.09 | -0.05 | -0.03 |
| Walk | 0.47 | 0.24 | -0.01 | -0.07 | 0.05 | 0.03 |
| Stairs | 0.10 | 0.46 | -0.07 | -0.07 | 0.02 | -0.14 |
| Comprehension | -0.02 | 0.00 | 0.13 | -0.04 | 0.73 | 0.01 |
| Expression | 0.02 | 0.02 | -0.02 | 0.06 | 0.93 | -0.01 |
| Social interaction | 0.04 | -0.13 | 0.58 | 0.11 | 0.13 | 0.08 |
| Problem solving | -0.06 | 0.04 | 0.85 | 0.00 | -0.06 | -0.01 |
| Memory | 0.04 | 0.03 | 0.72 | -0.02 | 0.09 | -0.05 |

Table 4: Proportion of variance explained by various multiple regression models for predicting length of stay

| Model | Predictors using admission FIM scores | r-squared (adjusted) |
|---|---|---|
| 1 | Total FIM score | 0.252 |
| 2 | 6 modular factors | 0.365 |
| 3 | 18 FIM items | 0.381 |
| 4 | Transfer: bed/toilet/tub, walk/stairs | 0.360 |
| 5 | Bowel, transfer: bed/tub, stairs | 0.354 |

**Length of stay:** The distribution of length of stay are heavily skewed to the right. However, the histogram based on the transformed data using base-2 logarithms suggests that the skewness is largely removed. The proportion of variation (r-squared) in the logarithms of the length of stay accounted for by various multiple regression models involving groups of FIM scores and factors at admission are listed in Table 4. Gender is found not to be a predictor of length of stay, and thus is omitted from the analysis. The adjusted r-squared include 14 additional parameters to adjust for the joint effects of the five age groups and three impairment groups, as defined in Table 1. Model 4 represents the reduced model from the 6 modular factors while model 5 is the reduction of the model containing all 18 FIM items.

From the analysis, Model 4 appears to be the most useful for predicting length of stay, since it explains almost as much of the variation in length of stay as all 18 FIM items (36% versus 38.1%) and it involves only two modular factors. It is also a relatively simple expression involving only five of the 18 FIM items.

## Discussion

Selection of patients for admission to any rehabilitation unit is biased by the expectation on the part of the clinician that the patient would substantially benefit from a program of therapy. The initial or admission FIM scores reflect the result of this selection process. This paper has made use of admission and the change between discharge and admission data to explore the dimensionality of the FIM. Factor analysis was used to determine the underlying grouping structure in the FIM items. This technique was also used by Silverstein, *et al.* (1991) in evaluating the PECS (Patient Evaluation and Conference System), another assessment instrument. They found eight underlying factors and argued that the technique is applicable to most rehabilitation outcome measures. In our analysis, six modular factors were identified using factor analysis. The observed variations in length of stay is best described by considering important components of the FIM, rather than applying a unidimensional summary measure, such as the total FIM score.

Johnston and Keith (1993) noted that for a measure to be useful it must predict certain important events outside itself, that is, it must demonstrate criterion validity. The criterion validity of the various forms of FIM used within this paper has therefore been assessed by determining their usefulness in the prediction of length of stay. Conceptually it is possible to rate the different forms of FIM according to the level of information each conveys about disability. The least information is provided by the total summed FIM score. It is a quantitative global measure only, failing to describe the nature or quality of disability. The subscale reported in this paper falls between these extremes, with the six modular factors providing more qualitative data on disability. This hierarchy of information has been supported in the prediction of outcome.

A number of papers have addressed the prediction of length of stay in a rehabilitation facility and give support to our findings. (Stineman *et al.*, 1994) also identified locomotion, transfer and dressing-lower-body as important determinants of length of stay. The importance of transfer items in determining length of stay is highlighted in our work, with transfer items being significant in both of our reduced models (Table 4). The ability to transfer from bed or toilet markedly reduces the burden of care for family, and so it is not surprising that it should influence length of stay. In addition, it is likely that transfer difficulties are an indicator to general hospital staff, for early referral of the patient to the rehabilitation unit (Stineman *et al.*, 1994). As an initial step in evaluating the FIM, we have used factor analysis in order to determine a underlying grouping structure in the FIM items. Silverstein, *et al.* (1991) also used factor analysis in evaluating the PECS (Patient Evaluation and Conference System), another functional assessment instrument and they argued that the technique is applicable to most rehabilitation outcome measures. We then used the six underlying factors as well as subscales of these factors to predict the determinants of length of stay. The subscales provide a better alternative to the summed raw FIM score or the 18 FIM items. The subscales are intuitively appealing and demonstrate criterion validity. In addition they have been determined using standard statistical techniques which are widely available and easily understood.

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