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Research Article

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A six-year audit in a rehabilitation centre with mod barthel index and FIM as outcome measures

Abstract

A rehabilitation audit was performed comparing admission and discharge values of FIM and Barthel Index (self report) of the last 6 years. The results indicate substantial changes in FIM and BI thus justifying the rehabilitation process. Performing an audit of the used instruments we found a small group of patients (between 6% (post surgery patients) and 26.4% (rheumatological patients)) for whom no overall improvement could be indicated. These patients differ significantly from the other patients in reaching higher values on admission thus indicating a possible ceiling effect in FIM and in BI.

Volume 3 Issue 4 - 2018

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Received: August 03, 2018 | **Published:** August 31, 2018

Introduction

Current rehabilitation standards require evidence based rehabilitation procedures and a significant outcome improvement as a consequence of the implemented rehabilitation programmes. While the analyses on which medicine bases its evidence stem from prospective, control studies performed mostly by university centres with the highest methodological vigour, the routine outcome measure analyses have to be conducted using locally available resources. Additionally, it has been suggested that the demonstration of outcome improvement is complicated by many problems such as small numbers and heterogeneity in the study population.[1,2] There are strategies to overcome this particular problem. Multicentre trials or meta-analyses provide some possibilities; a long-term data collection offers another one.

Selecting an outcome measure for a rehabilitation centre a broad spectrum of patients, diagnoses and treatments should be considered in addition to validity, reliability and sensitivity to the relevant changes targeted by the intervention. The measures must also be feasible to use in routine practice and the team should find them useful.

Analysing data collected over a long time span as in our case the assumptions and decisions made at the time of the planning and implementation of the outcome measures must be to some degree adhered to. There has been a high increase in the last years in publication of relevant studies dealing with the issue of outcome measure in rehabilitation that added to our knowledge on outcome measures in a substantial way. In the early nineties when our system of outcome measures was designed the therapists constructed a net of global and of specific measures of which they believed would provide a comprehensive monitoring of their goal attainment in rehabilitation. The dimensions of independence, disability and resources play an important role in most rehabilitation goals. Several global measures of independence in a range of tasks gained in popularity in the last decades. A survey of rehabilitation units in the UK[3] demonstrated that the Barthel Index (BI),[4] the Functional Independence Measure (FIM)[5] or the Functional Assessment Measure (FIM+FAM)[6] are the most commonly used global measures. Sulter, Steen and De Keyser[7] analysed all randomized trials between 1995 and 1998 in which the efficacy of thrombolytic, neuroprotective drugs or antithrombotic compounds was investigated and found that BI was the most often used outcome measure.

Although the BI and FIM were published a long time ago and gained wide acceptance,[8–10] a series of substantial controversies were carried out in professional journals indicating number of essential shortcomings,[11] such as floor and ceiling effects (BI), (see[12] for ceiling effect in amputee patients;[13] for ceiling and floor effect in stroke rehabilitation,[14] for floor effect in patients with severe brain damage, insensitivity of FIM to cognitive and psychosocial disability, insensitivity to change in BI, dependence of FIM on the health care system in the USA and many other.[1] It has particularly been proposed that the various modifications of BI[15–17] should be considered because of their psychometric qualities. However, some authors were not able to confirm its assumed improvement in sensitivity.[18]

A systematic analysis of ADL measures has been conducted by Law and Letts[19] comparing the ADL measures available between 1960 and 1988, among them the BI. Although the authors report poor internal consistency for BI their overall recommendation is positive. BI with some other measures shows the best reliability (see also[20] and validity (see also[21] evidence, is short, and appears to discriminate among levels of ADL function. It has demonstrated evidence of the ability to predict function against other standards. It also belongs to the group of instruments with the best potential for responsive measuring change in ADL function. Its concurrent and predictive validity has been well established against extent of motor loss,[22] prognosis,[23] severity of stroke[24] and other criteria.

The BI has predictive validity in terms of survival,[25] functional recovery[26] and other criteria.[27] Walker and colleagues[28] measured significant outcome differences with BI in the group of stroke survivors who were not admitted to hospital and did vs. did not receive occupational therapy. Alarcon and colleagues[29] report that the only variable predictive of prolonged stay in hospital was a Barthel score of <45 on admission.

There are reports on reliability of BI indicating that test-retest reliability and inter-code reliability (22), inter-observer-reliability[30]

and inter-method reliability[31] are satisfactory. However, it has also been indicated that BI scored upon a physicians' interview with a patient is not reliable compared to scoring based upon nurses' observation.[32]

As its sensitivity to small improvements in the rehabilitation process is relatively crude a modified index with a five-point scoring has been proposed.[17] However, Wood-Dauphinee and co-workers[27] report that BI was the most efficient measure and therefore required the fewest subjects to identify a significant outcome effect in stroke rehabilitation. The assessment by BI can also be reliably conducted by a telephone interview by health professional and lay-persons alike.[33]

The self-rating BI has been less extensively evaluated.[34–36] Collin and colleagues[20] found that Barthel Index as a self-report measure is highly reliable in a series of 25 consecutive admissions to an acute rehabilitation unit. However, they indicate that the most disagreement between self-report and observation was in the self-reports of cognitively impaired patients. Analysing the internal consistency they maintain that most of the disagreement was minor and was associated with more complex items such as transfers. Wade maintains that ADL indices should report actual performance in the relevant setting.[37] It has been shown that the self-report BI is also reliable as a postal questionnaire as all items except 'toilet' and 'mobility' had at least moderate reliability by the kappa coefficient.[36]

The Functional Independence Measure (FIM)[5,38] is a well-established and widely used measure of functional status. The first 13 items of the FIM represent a measure of motor function and the last 5 items represent a measure of cognitive function. It has been indicated that FIM item difficulties vary across impairment groups.[39] The authors calculated item difficulties and report that 'feeding' and 'grooming' are the easiest motor items whereas 'stair climbing', 'tub/shower transfers' and 'locomotion' are the most difficult ones. Among the cognitive items 'comprehension' and 'expression' are the easiest items, 'problem solving' is the most difficult.

Chau and colleagues[40] studied inter rater agreement of the French version and report that all activities of self care, sphincter control, and of transfer, stair, expression and problems solving were rated with very good agreement (kappa coefficient higher than 0.80) and locomotion walk - wheelchair, comprehension, social interaction (kappa coefficient 0.7-0.8) and memory (kappa coefficient 0.63) with good agreement. They also found certain differences between the ratings by educators and by physio or occupational therapists.

There is a number of studies reporting using BI as well as FIM, comparing them and analysing their relationship. Van der Putten and colleagues[41] compared the BI and FIM as outcome measures after inpatient rehabilitation and report that BI and FIM total, FIM motor and FIM cognitive scales were appropriate measures for the stroke patients, but that FIM cognitive scale has limited usefulness in progressive multiple sclerosis because of its notable ceiling effect. Nyein and McMichael[42] and Turner-Stokes (1) demonstrated that BI can be derived from the FIM motor.

This article addresses the issue whether the ongoing measure with FIM and the self-report BI provides an adequate and satisfactory outcome measure in a community based rehabilitation centre and whether the patients improved in the course of rehabilitation

Methods and Subjects

This investigation uses data collected as part of the routine outcome measures in the Rehabilitation Centre. The patients are screened at the point of entry and prior to their discharge. The FIM data were collected by the nurses, the BI was administered by the occupational therapists. As the FIM assessment is possible to perform independently of the patients' abilities the FIM screening covers nearly 100% if the patients. BI (self-rating), on the other hand, relies on the language and cognitive abilities of the patient and was, therefore, not completed as often as FIM. Consequently, the data set contains only those patients for whom both of the screening measures are available (N=1033).

The table 1 describes the characteristics of the patients with FIM and self-report BI. The diagnoses are summarized in 6 groups. The median age is between 49 (patients after brain injury) and 80 years (geriatric multiorgan illness). The proportion of female patients lies between 41% (brain injury) and 63% (geriatric multiorgan illness). The patients were referred mostly from an acute hospital (63% of brain surgery patients; 80% of post surgery patients) with the exception of patients with rheumatological illness (27%) and patients with other neurological illness (47%) (Table 1).

Table 1 Patients' characteristics

Diagnosis	**1**		**2**		**3**		**4**		**5**		**6**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Marital status												
Single	22	6.5	6	22.2	28	13.9	15	7.6	8	9.5	35	18.2
Married	214	63.5	14	51.9	97	48	128	65	40	47.6	111	57.8
Separated												
divorced	24	7.1	1	3.7	19	9.4	15	7.6	2	2.4	15	7.8
Widowed	77	22.8	6	22.2	58	28.7	39	19.8	34	40.5	31	16.1
Gender												
Male	153	45.4	11	40.7	109	54	118	59.9	53	63.1	114	59.4
Female	184	54.6	16	59.3	93	46	79	40.1	31	36.9	78	40.6
Referred from:												
Home	91	27	6	22.2	31	15.3	134	68	21	25	90	46.9

Citation: Valach L, Selz B, Hofer K, et al. A six-year audit in a rehabilitation centre with mod barthel index and FIM as outcome measures. *Int Phys Med Rehab J.* 2018;3(4):342–358. DOI: 10.15406/ipmrj.2018.03.00128

Table Continued

Diagnosis	**1**		**2**		**3**		**4**		**5**		**6**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Acute hospital Rehab.	233	6901	17	63	162	80.2	55	27.9	58	69	89	46.4
Clinic Care	0	0	0	0	2	1	1	5	0	0	3	1.6
institution	6	1.8	2	7.4	2	1	5	2.5	3	3.6	6	3.1
Other	5	1.5	2	7.4	5	2.5	2	1	2	2.4	4	2.1
Referred to:												
Home	271	80.4	25	92.6	155	76.7	171	86.8	63	75	155	80.7
Acute hospital Rehab.	4	1.2	0	0	8	4	5	2.5	4	4.8	5	2.6
Clinic Care	3	0.9	0	0	3	1.5	2	1	2	2.4	4	2.1
institution	37	11	2	7.4	22	10.9	11	5.6	11	3.1	21	10.9
Other	32	6.5	0	0	14	6.9	8	4.1	4	4.8	7	3.6
Year of admission:												
1995	91	27	3	11.1	34	16.8	37	18.8	25	29.8	33	17.2
1996	60	17.8	6	22.2	35	17.3	37	18.8	15	17.9	35	18.2
1997	52	15.4	7	25.9	38	18.8	41	20.8	16	19	44	22.9
1998	61	18.1	5	18.5	44	21.8	38	19.3	16	19	37	19.3
1999	56	16.6	5	18.5	32	15.8	31	15.7	7	8.3	33	17.2
2000	17	5	1	9	19	9.4	13	6.6	5	6	10	5.2
Age												
Mean	68.9		50		72.5		58.7		79.3		61.6	
Median	71		49		75		55		80		65	
stddev	13.281		21.131		12.566		18.993		9.081		16.061	

Diagnoses
(1)Vascular brain damage (N= 337)
(2)Brain injury (N= 27)
(3)Post surgery (N= 202)
(4)Rheumatologic illness (N= 197)
(5) Geriatric multiorgan illness (N= 84)
(6) other neurological ilness (N= 192)
all (N=1017)

Instruments

Barthel Index is a scale of activities of daily living that includes 10 fundamental items from 2- to 4-level scales and is one of the standard measuring devices of functional disabilities or resources. We used the modified version by Granger and colleagues[16,22,43] to measure each patient's ADL performance on admission and on discharge. Fifteen items related to self-care ability, continence and mobility are scored by determining whether the patient can perform them independently, with assistance or supervision, or not at all. The scores for each item are summed and the total ranges from 0 (complete dependence) to 100 (independence in terms of ADL). The BI can be divided to measure the discrete functions of self-care (0-53 points) or mobility (0-47 points). The Barthel Index was originally developed as a means of assessing the level of independence in patients with neuromuscular or musculoskeletal disorders.

The Functional Independence Measure (FIM) is an 18 item observational sheet and interview schedule. Each of the patient's activities (self care, sphincter management, transfer, locomotion, communication and social cognition) is rated between 1 (totally dependent) and 7 (fully independent). The FIM was filled out for every patient treated at the Rehabilitation Centre of the Medical Clinic, Buerger Hospital in Solothurn during 1995-2000. Additional personal and socio demographic data were also collected. This evaluation contains data of the observations made on admission and on discharge of the patients.

The setting

The Rehabilitation Centre is a 25 bed in patient hospital adjoined to an acute hospital in a small town in Switzerland. It cares for a broad range of patients although recently the rehabilitation of geriatric multi organ illnesses was outsourced to another centre. The rehabilitation team is active in implementing and optimising treatment informed by M. Johnstone's teaching and is in process of restructuring the rehabilitation organization according to the Total Quality Management principles and it reached good benchmarking results in rehabilitation outcome[44] and in time spent with patients.[45]

Results

Floor and ceiling effects of FIM and BI

As there were several indications and complaints about the floor and ceiling effects of the used instruments a simple floor and ceiling effect check was performed. The Table 2 summarizes the amount of patients in % who assessed or were assessed with the lowest degree of independence on the admission measure. There are some variation in the items and in the type of diagnosis the patients received. The items 'bathing' and 'washing' contain a large number of patients with the lowest rating thus indicating a possible floor effect. The group of post surgery patients contains the highest number of patients with the lowest rating in the highest number of items suggesting that in this group of patients some functions may not be sufficiently differentiated in the lower rating. 'Drinking' seems to posses the highest ceiling effect in BI. The patients with rheumatological illness reached the highest number of the patients with the highest rating in the most items. Consequently, an improvement in these patients could not be monitored by this measure. Using the total sum of all items we found less floor effects (between 0 and 7.4% of patients of a diagnosis group) and less ceiling effect (between 8 and 47%). The highest total sum on discharge as a measure of a ceiling effect suggests between 17 and 70% of patients who could have not scored higher because of the limitation of the scale. The BI self care scale showed a lower floor effect and higher ceiling effect that the mobility scale (Table 2).

Table 2 Floor and ceilling effect in mod. Barthel index (self assessment)
Floor effect (the amount of patient with the lowest level on admission in %)

Diagnosis	1	2	3	4	5	6
Drinking	5	7.4	1	0.5	2.4	7.8
Eating	22	18.5	6.9	4	14.3	16.1
Upper body dressing	5.3	7.4	1	0	0	4.7
Lower body dressing	14.5	7.4	9.9	2	7.1	15.1
Application of mech. devices	8	3.7	16.3	1	9.5	5.2
Personal hygiene	35.9	18.5	32.7	15.7	33.3	35.4
Washing	43	33.3	53	22.8	45.2	43.2
Bladder control	8.9	11.1	6.4	2	8.3	14.1
Bowel control	4.5	11.1	3	1	1.2	6.3
Getting in/out of bed	5.3	7.4	4	1	4.8	8.9
Toilet	7.4	7.4	6.9	13.2	4.8	7.8
Bathing	67.7	44.4	77.2	33.5	81	58.9
Walking	28.2	14.8	32.2	9.6	26.2	27.1
Stairs	30.6	18.5	52	15.7	31	30.7

Ceilling effect (the amount of patient with the highest level on admission in %)

Diagnosis	1	2	3	4	5	6
Drinking	95	92.6	99	99.5	97.6	92.2
Eating	78	81.5	93.1	95.9	85.7	83.9
Upper body dressing	61.1	74.1	88.1	91.9	69	72.4
Lower body dressing	50.1	66.7	34.7	66.5	42.9	50
Application of mech. devices	92	96.3	83.7	99	90.5	94.8
Personal hygiene	64.1	81.5	67.3	84.3	66.7	64.6
Washing	57	66.7	47	77.2	54.8	56.8
Bladder control	80.1	77.8	83.7	91.4	71.4	67.7
Bowel control	88.7	85.2	92.1	95.4	92.9	80.2
Getting in/out of bed	58.5	74.1	51.5	82.7	56	57.8
Toilet	55.8	77.8	48.5	86.8	58.3	62
Bathing	32.3	55.6	22.8	66.5	19	41.1
Walking	45.1	63	41.6	79.7	47.6	51
Stairs	39.5	70.4	20.8	67	36.9	39.1

Diagnoses
(1)Vascular brain damage (N=337)
(2)Brain injury (N= 27)
(3)Post surgery (N=202)
(4)Rheumatologic illness (N=197)
(5)Geriatric multiorgan illness (N= 84)
(6)Other neurological ilness (N=192)

Although there are more possibilities to differentiate in FIM because of the 1-7 value scales the floor and ceiling effects are also noticeable (Table 3). The items differ but the highest number of patients with the lowest assessment can be see in regard to 'climbing stairs' in all diagnosis groups (17-59%). The ceiling effect is indicated by a high number of patients reaching the highest rating on admission for 'bowel management ' and for 'eating'. However, the amount of patients reaching the highest rating in all 18 items on admission and thus not being able to respond with improvement is relatively low (between 0.3 to 3.7% with the exception of patients with rheumatological illness (14%) (Table 3).

Table 3 Floor and ceilling effect in FIM Floor effect (the amount of patients with the lowest FIM level on admission in %)

Diagnosis	1	2	3	4	5	6
A. Eating	2.7	7.4	0.5	0	1.2	4.2
B. Grooming	4.7	7.4	1	0.5	3	8.3
C. Bathing	18.4	14.8	12.4	5	11.9	19.8
D. Upper body dressing	8	11.1	3.5	2	4.8	10.4
E. Lower body dressing	33.8	18.5	41.6	10.7	34.5	37
F. Toileting	31.5	18.5	26.7	8.6	32.1	34.4
G. Bladder management	14.8	14.8	7.4	3.6	14.3	18.8
H. Bowel management	7.1	14.8	1.5	1	4.8	10.9
I. Bed/chair/WC	10.1	11.1	4	2	8.3	13
J. Toilet	15.4	14.8	6.4	2	9.5	15.6
K. Tub/shower	24.3	18.5	21.3	5.1	22.6	20.8
L. Walk/WC	18.4	14.8	14.8	3	13.1	10.9
M. Stairs	39.5	29.6	58.9	16.8	40.5	40.6
N. Comprehension	1.2	7.4	0.5	0	1.2	1
O. Expression	5	14.8	0.5	0	1.2	2.6

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Table Continued

Diagnosis	1	2	3	4	5	6
P. Social interaction	1.5	11.1	1.5	0	2.4	1.6
Q. Problem solving	11	11.1	2.5	0.5	9.5	9.4
R. Memory	3.3	11.1	1	0	2.4	3.6

Ceilling effect:(the amount of patients with the highest level on admission in %)

Diagnosis	1	2	3	4	5	6	All
A. Eating	23.4	44.4	62.9	80.7	50	47.9	
B. Grooming	21.1	37	28.2	66.5	22.6	29.2	
C. Bathing	8	18.5	8.4	40.6	4.8	12	
D. Upper body dressing	21.1	22.2	32.7	62.9	21.4	28.6	
E. Lower body dressing	16.6	18.5	11.9	43.7	13.1	21.9	
F. Toileting	21.1	33.3	24.8	67	17.9	27.1	
G. Bladder management	43.3	66.7	45.5	76.1	33.3	40.6	
H. Bowel management	49.3	74.1	46.5	76.6	39.3	44.3	
I. Bed/chair/WC	22.8	29.6	12.4	54.8	14.3	22.9	
J. Toilet	28.2	37	20.3	59.4	15.5	24	
K. Tub/shower	15.7	18.5	8.4	44.2	7.1	15.1	
L. Walk/WC	16.3	18.5	6.9	39.6	4.8	18.2	
M. Stairs	8.3	14.8	3.5	27.4	3.6	13	
N. Comprehension	35.6	33.3	50	62.4	44	45.3	
O. Expression	29.1	29.6	54	65.5	46.4	45.8	
P. Social interaction	39.5	29.6	56.9	68.5	38.1	44.8	
Q. Problem solving	13.6	18.5	29.2	52.8	17.9	20.8	
R. Memory	23.4	18.5	36.6	68.5	23.8	38.5	
Total	**0.3**	**3.7**	**1.5**	**14.5**	**1.2**	**2.1**	**3.5**

Diagnoses:
(1) Vascular brain damage (N=337)
(2) Brain injury (N= 27)
(3) Post surgery (N=202)
(4) Rheumatologic illness (N=197)
(5) Geriatric multiorgan illness (N= 84)
(6) other neurological ilness (N=192)

This assessment of floor and ceiling effects is very crude as there are many items in BI with just a two value scale as compared to 7 point scale of the FIM.

However, it indicates substantial differences between items (eating, understanding: between 0 and 7.4% of patients indicate the lowest value; stairs climbing: 17-59% of patients indicate the lowest value), between diagnosis groups (rheumatologic illness: 17% and post surgery patients: 59% indicate the lowest value in one of the functions) and between measures (BI: 81% of the patients of one diagnosis group indicate in regard to one function the lowest value compared to FIM with 59 %).

Similarly, the ceiling effect is also stronger in BI (99.5% of the patients of one diagnosis group report the highest value in regard to one function) than in FIM (80.7%).

Factor structure of FIM

The widespread practice of adding all values of the 18 FIM items into an overall score has been occasionally questioned. Although the FIM items correlate highly among themselves and the reliability coefficient alpha is very high, the issue of the linearity, interchangeability, equal distances etc. is still open. Recently, Ravaud and colleagues[46] warned of using the FIM total score without precaution because of the multidimensionality of the FIM items. They recommend using various subscores. Consequently, before using FIM scale it is advisable to analyse the factorial structure of FIM as gained with the given sample.

We performed a factor analysis with the patients of each diagnostic group separately for the admission and discharge data. The admission FIM total data in patients with vascular brain damage, with brain injury and with other neurological illness were presented as being two dimensional separating clearly between FIM motor and FIM cognitive and accounting for 73.6%, 87.5% and 72.8% (Tables 4, 5). We obtained a 3 dimensional solution in post surgery patients (accounting for 68.7%), in patients with rheumatology illness (accounting for 78%) and in patients with geriatric multiorgan illness (accounting for 70.1%). The third factor comprises either of 'eating', 'grooming' and 'upper body dressing' as in post surgery patients or of 'comprehension' and 'expression' as in the other two patient groups (Table 4) (table 5).

Table 4 Factor analysis FIM all items (admission)

Factor	Eigenvalue	Pct of var	Cum pct
I	**Vascular brain damage**		**(N=337)**
1	11.006	61.1	61.1
2	2.245	12.5	73.6
II	**Brain injury**		**(N= 27)**
1	13.559	75.3	75.3
2	2.197	12.2	87.5
III	**Post surgery**		**(N=202)**
1	8.906	49.5	49.5
2	2.219	12.3	61.8
3	1.239	6.9	68.7
IV	**Rheumatologic illness**		**(N=197)**
1	10.377	57.7	57.7
2	2.636	14.6	72.3
3	1.019	5.7	78
V	**Geriatric multiorgan illness**		**(N= 84)**
1	8.446	46.9	46.9
Factor	**Eigenvalue**	**Pct of var**	**Cum pct**
2	2.627	14.6	61.5
3	1.543	8.6	70.1
VI	**other neurological ilness**		**(N=192)**
1	10.055	55.9	55.9
2	3.046	16.9	72.8

Table 5 Factor analysis of FIM items on admission in each diagnosis Rotated factor matrix (Diagnosis, factor):

	1.1	1.2	2.1	2.2	3.1	3.2	3.3
Eating	0.62	0.3	0.55	0.54	0.13	0.14	0.87
Grooming	0.76	0.39	0.73	0.58	0.34	0.2	0.69
Bathing	0.85	0.29	0.85	0.34	0.65	0.15	0.52
Upper body dressing	0.84	0.3	0.81	0.54	0.44	0.22	0.72
Lower body dressing	0.89	0.19	0.89	0.37	0.73	0.22	0.36
Toileting	0.9	0.25	0.88	0.31	0.73	0.27	0.37
Bladder management	0.63	0.5	0.75	0.56	0.46	0.39	0.29
Bowel management	0.59	0.52	0.76	0.56	0.44	0.38	0.22
Bed/chair/WC	0.9	0.2	0.9	0.35	0.83	0.22	0.24
Toilet	0.92	0.18	0.91	0.34	0.84	0.24	0.26
Tub/shower	0.9	0.18	0.93	0.25	0.81	0.15	0.34
Walk/WC	0.84	0.27	0.83	0.45	0.76	0.15	0.16
Stairs	0.85	0.18	0.91	0.04	0.73	0.09	-0.05
Comprehension	0.1	0.83	0.39	0.88	0.03	0.83	0.2
Expression	0.12	0.81	0.26	0.89	0.09	0.82	0.27
Social interaction	0.3	0.72	0.2	0.92	0.19	0.79	0.08
Problem solving	0.37	0.78	0.39	0.85	0.31	0.83	0.11
Memory	0.24	0.79	0.25	0.91	0.35	0.73	0

	4.1	4.2	4.3	5.1	5.2	5.3	6.1	6.2
Eating	0.56	0.18	0.38	0.49	0.32	0.16	0.64	0.27
Grooming	0.81	0.15	0.2	0.65	0.23	-0.06	0.76	0.3
Bathing	0.89	0.24	0.07	0.82	0.22	-0.08	0.87	0.2
Upper body dressing	0.87	-0.02	0.19	0.79	0.33	0.08	0.84	0.27
Lower body dressing	0.85	0.19	0.05	0.81	0.26	0.02	0.87	0.15
Toileting	0.88	0.24	0.04	0.79	0.29	0.03	0.87	0.19
Bladder management	0.8	0.26	0.03	0.38	0.65	-0.07	0.75	0.27
Bowel management	0.73	0.26	0.15	0.45	0.58	-0.04	0.75	0.23
Bed/chair/WC	0.91	0.1	0.07	0.89	0.08	0.09	0.91	0.1
Toilet	0.89	0.2	0.04	0.87	0.24	-0.03	0.92	0.07
Tub/shower	0.89	0.18	-0.06	0.82	0.33	-0.11	0.9	0.07
Walk/WC	0.84	0.19	0.1	0.79	-0.01	0.14	0.8	0.2
Stairs	0.79	0.25	0.05	0.8	-0.07	0.15	0.78	-0.02
Comprehension	0.07	0.28	0.92	0	0.18	0.94	0.09	0.87

Citation: Valach L, Selz B, Hofer K, et al. A six-year audit in a rehabilitation centre with mod barthel index and FIM as outcome measures. *Int Phys Med Rehab J.* 2018;3(4):342–358. DOI: 10.15406/ipmrj.2018.03.00128

Table Continued

	1.1	1.2	2.1	2.2	3.1	3.2	3.3	
Expression	0.05	0.28	0.92	0.11	0.18	0.93	0.17	0.87
Social interaction	0.2	0.86	0.24	0.15	0.82	0.09	0.11	0.8
Problem solving	0.28	0.82	0.29	0.11	0.84	0.27	0.25	0.84
Memory	0.26	0.82	0.19	0.07	0.8	0.26	0.2	0.87

Diagnoses
(1) Vascular brain damage (N=337)
(2) Brain injury (N= 27)
(3) Post surgery (N=202)
(4) Rheumatologic illness (N=197)
(5) Geriatric multiorgan illness (N= 84)
(6) other neurological ilness (N=192)

Factor analysing the discharge FIM data we obtained two-factorial solution only in vascular brain diseases patients (accounting for 74.2%) and in patients with other neurological illness (accounting for 74%) (Table 6). The FIM data of patients with traumatic brain injury, rheumatological illness and geriatric multiorgan illness indicated three dimensions. The third dimension comprises of 'bladder management', 'bowel management' and 'transfer to toilet' in traumatic brain injury patients and of 'comprehension' and 'expression' in the other two groups of patients (Table 7).

Table 6 Factor analysis (principal-components analysis (pc), varimax rotation, kaiser normalization) FIM all items (discharge)

Factor	Eigenvalue	Pct of var	Cum pct
I	Vascular brain damage		(N=337)
1	11.31694	62.9	62.9
2	2.04397	11.4	74.2
II	Brain injury		(N= 27)
1	11.69436	65	65
2	2.34747	13	78
3	1.10984	6.2	84.2
III	Post surgery		(N=202)
1	9.09305	50.5	50.5
2	2.18527	12.1	62.7
3	1.12119	6.2	68.9
4	1.0003	5.6	74.4
IV	Rheumatologic illness		(N=197)
1	10.5052	58.4	58.4
2	2.60032	14.4	72.8
3	1.04344	5.8	78.6
V	Geriatric multiorgan illness		(N= 84)
1	8.67759	48.2	48.2
2	2.50119	13.9	62.1
3	1.77356	9.9	72
VI	other neurological ilness		(N=192)
1	10.28102	57.1	57.1
2	3.03811	16.9	74

Table 7: Factor analysis (principal-components analysis (pc), varimax rotation, kaiser normalization) FIM all items (discharge) Rotated factor matrix: (Diagnosis; factor)

	1.1	1.2	2.1	2.2	2.3	3.1	3.2	3.3	3.4
Eating	0.69	0.24	0.81	0.25	0.19	0.19	0.26	0.75	0.06
Grooming	0.79	0.37	0.74	0.61	0.05	0.27	0.23	0.78	0.18
Bathing	0.87	0.32	0.8	0.28	0.26	0.54	0.13	0.53	0.3
Upper body dressing	0.85	0.32	0.74	0.5	0.3	0.39	0.25	0.74	0.17
Lower body dressing	0.87	0.31	0.77	0.42	0.29	0.61	0.12	0.57	0.14
Toiletting	0.88	0.31	0.65	0.54	0.44	0.68	0.21	0.46	0.29
Bladder management	0.67	0.38	0.31	0.29	0.86	0.3	0.29	0.14	0.8
Bowel management	0.65	0.34	0.29	0.27	0.88	0.23	0.22	0.23	0.83
Bed/chair/WC	0.91	0.16	0.67	0.29	0.63	0.82	0.19	0.27	0.11
Toilet	0.92	0.17	0.61	0.23	0.72	0.81	0.11	0.25	0.33
Tub/shower	0.89	0.24	0.63	0.27	0.48	0.78	0.18	0.17	0.34

Table Continued

	1.1	1.2	2.1	2.2	2.3	3.1	3.2	3.3	3.4
Walk/WC	0.85	0.19	0.72	0.12	0.53	0.71	0.21	0.21	-0.02
Stairs	0.86	0.21	0.82	-5	0.3	0.78	0.13	0.13	0.11
Comprehension	0.14	0.82	0.26	0.86	0.26	0.05	0.78	0.18	0.17
Expression	0.18	0.8	0.25	0.8	0.12	0.08	0.74	0.32	0.24
Social interaction	0.3	0.69	0.1	0.91	0.12	0.11	0.78	0.19	0.09
Problem solving	0.37	0.79	0.25	0.82	0.27	0.26	0.82	0.17	0.18
Memory	0.26	0.8	0.17	0.82	0.23	0.33	0.81	0.03	0.04

	4.1	4.2	4.3	5.1	5.2	5.3	6.1	6.2
Eating	.49	0.47	-0.01	0.47	0.34	0.27	0.6	0.3
Grooming	.86	0.25	0.09	0.71	0.04	0.28	0.78	0.35
Bathing	0.83	0.36	-0.01	0.82	0.31	0.01	0.85	0.2
Upper body dressing	0.91	0.18	0.06	0.81	0.08	0.25	0.86	0.3
Lower body dressing	0.81	0.36	-0.01	0.81	0.19	0.04	0.88	0.15
Toiletting	0.83	0.33	-0.03	0.82	0.33	0	0.88	0.21
Bladder management	0.89	0.09	0.07	0.63	0.45	-0.13	0.79	0.21
Bowel management	0.83	0.07	0.03	0.68	0.43	-0.1	0.82	0.14
Bed/chair/WC	0.88	0.17	0.11	0.91	0.06	-0.02	0.92	0.1
Toilet	0.91	0.13	0.17	0.9	0.09	0.02	0.93	0.09
Tub/shower	0.88	0.2	0.02	0.79	0.26	0.01	0.92	0.08
Walk/WC	0.8	0.16	0.13	0.78	-0.06	0.08	0.77	0.2
Stairs	0.79	0.26	0.02	0.8	-0.06	0.07	0.8	0.02
Comprehension	0.06	0.27	0.93	0.03	0.08	0.94	0.09	0.87
Expression	0.06	0.26	0.94	0.11	0.19	0.93	0.13	0.88
Social interaction	0.23	0.84	0.24	0.2	0.82	-0.06	0.13	0.82
Problem solving	0.24	0.79	0.31	0.1	0.87	0.25	0.26	0.83
Memory	0.19	0.82	0.19	0.02	0.85	0.21	0.21	0.83

Diagnoses
(1) Vascular brain damage (N=337)
(2) Brain injury (N= 27)
(3) Post surgery (N=202)
(4) Rheumatologic illness (N=197)
(5) Geriatric multiorgan illness (N= 84)
(6) other neurological ilness (N=192)

Factor analysis of BI

There is a well-documented discussion on the dimensionality of BI. Factor analytical and various multidimensional scaling methods were applied and reported. In order to analyze the factorial structure of BI we calculated factor analysis for various diagnosis groups with admission and discharge data. In all except vascular brain damage and traumatic brain injury groups we obtained more than the two factors which are prescribed as subscales explaining accounting for between 56 and 80% (Table 8). The BI mobility factor crystallised in all diagnostic groups (Getting in/out of bed, going to the toilet, bathing, walking, stairs climbing) but in addition to this we found also 'lower body dressing, 'personal hygiene' and 'washing' in all except in the post surgery and geriatric multiorgan illness group as a part of the first factor. Further, the first factor in some diagnosis group also contained 'upper body dressing' (Table 9). The factorial structure of the vascular brain illness group consists of the firsts factor shared by other diagnostic groups, the second factor containing 'drinking', 'eating', 'bladder control' and 'bowel control'. The BI of the post surgery patients indicates a four factorial structure. First factor containing mobility items, second self care, third 'eating', 'drinking' and 'upper body dressing' and fourth 'bladder' and 'bowel control'. The rheumatological illness patients relate motor and self care items in factor 1, 'eating', 'upper body dressing', 'bowel' and 'bladder control' in factor 2 from which 'drinking' is separated in factor 3. The BI data of the geriatric multiorgan illness patients indicate a 4 factor structure with motor items (factor 1), self-care, 'dressing' and 'eating' (factor 2), 'bowel' and 'bladder control' (factor 3) and 'drinking' (factor 4). The factor analysis of the discharge data

seems to fit to a similar factorial structure as the admission data. The vascular brain illness patients have a nearly identical factor 1. The bladder and bowel control build a separate factor in discharge data, as do the items 'drinking' and 'eating'. The traumatic brain injury patients fit to 3 dimensions instead of 2 as on admission. The motor and self-care items need two dimension and bowel and bladder control build one factor. The following picture could be found in the group 'other neurological illness' (some mobility items with self care (F1), bladder and bowel control (F2), eating and drinking (F3). In the geriatric multiorgan illness group the items 'bladder' and 'bowel control', together with 'going to the toilet' are related to each other building one factor in the discharge data, while the motor and self care items distributed over two factors. Thus, we obtain a 2-4 factorial structure, depending on diagnosis and on the fact whether they are admission or discharge data.

Table 8 Factor analysis BI (13 items)

Admission				discharge		
Fact.	**E.VAL**	**VAR CUM**	**PCT**	**E.VAL**	**VAR CUM**	**PCT**
All patients						
1	6.06	46.6	46.6	5.99	46.1	46.1
2	1.37	10.6	57.2	1.19	9.2	55.2
3	1.07	8.2	65.4	1.11	8.5	63.7
1) Vascular brain damage				**(N=337)**		
1	6.44	49.6	49.6	6.53	50.2	50.2
2	1.45	11.2	60.7	1.2	9.3	59.5
3				1.06	8.1	67.6
(3) Post surgery				**(N=202)**		
1	4.45	34.3	34.3	5.11	39.3	39.3
2	1.75	13.5	47.7	1.53	11.8	51.1
3	1.19	9.2	56.9	1.26	9.7	60.7
4	1.13	8.7	65.6			
(4) Rheumatologic illness					**(N=197)**	
1	5.67	43.6	43.6	5.56	46.4	46.4
2	1.29	9.9	53.6	1.35	11.2	57.6
3	1.04	8	61.6			
(5) Geriatric multiorgan illness				**(N= 84)**		
1	5	38.5	38.5	4.39	33.7	33.7
2	1.5	11.5	50	1.7	13.1	46.8
3	1.21	9.3	59.3	1.15	8.9	55.7
4	1.05	8.1	67.4			
(6) other neurological illness				**(N=192)**		
1	6.44	49.5	49.5	6.21	47.8	47.8
2	1.3	10	59.5	1.58	12.2	60
3	1.19	9.1	68.7	1.04	8	68

Table 9 Factor analysis BI (total).

All (N=1039)	**admission**			**discharge**		
	Fact 1	**Fact 2**	**Fact 3**	**Fact 1**	**Fact 2**	**Fact 3**
Drinking	2	.61*	0.42	.06 .	14	.83*
Eating	0.14	.76*	0.13	0.24	-0.03	.77*
Upper body dressing	0.42	.67*	0.09	.59*	0.24	0.32
Lower body dressing	.69*	0.42	0.11	.79*	0.21	0.11
Personal hygiene	.57*	0.47	-0.03	.61*	0.15	0.29
Washing	.70*	0.36	0.02	.74*	0.13	0.14
Bladder control	0.28	0.13	.81*	0.29	.82*	0.06
Bowel control	0.17	0.19	.83*	0.2	.88*	0.08
Getting in/ out of bed	.74*	0.26	0.24	.71*	0.29	0.14
Toilet	.77*	0.25	0.29	.75*	0.33	0.14
Bathing	.74*	0.08	0.07	.66*	0.06	0.05
Walking	.78*	0.05	0.25	.78*	0.17	0.1
Stairs	.83*	1	0.23	.81*	0.13	0.08

(1) Vascular brain damage (N=337)	**admission**		**discharge**		
	fact 1	**fact 2**	**fact 1**	**fact 2**	**fact 3**
Drinking	0.04	.72*	0.06	0.25	.84*
Eating	0.3	.44*	0.34	-0.11	.70*
Upper body dressing	.76*	0.18	.69*	0.32	0.16
Lower body dressing	.81*	0.21	.84*	0.21	0.12
Personal hygiene	.69*	0.16	.60* .	20	0.19
Washing	.76*	0.19	.75*	0.17	0.1
Bladder control	0.27	.73*	0.32	.82*	-0.04
Getting in/out of bed	.84*	0.21	.77*	0.21	0.16
Toilet	.83*	0.3	.77*	0.34	0.2
Bathing	.66*	0.08	.70*	0.03	0.01
Walking	.79*	0.24	.81*	0.15	0.22
Stairs	.81*	0.21	.85*	0.15	0.17

(2) Brain injury (N= 27)	**admission**		**discharge**		
	fact 1	**fact 2**	**fact 1**	**fact 2**	**fact 3**
Drinking	.92*	0.14			
Eating	0.52	.60*	0.12	-0.21	.94*
Upper body dressing	.87*	0.29	0.6	.64*	0.08
Lower body dressing	.69*	.67*	.86*	0.01	0.4
Personal hygiene	.67*	0.53	0.33	0.31	.80*

Citation: Valach L, Selz B, Hofer K, et al. A six-year audit in a rehabilitation centre with mod barthel index and FIM as outcome measures. *Int Phys Med Rehab J.* 2018;3(4):342–358. DOI: 10.15406/ipmrj.2018.03.00128

Washing	0.31	.84*	.72*	0.04	0.41
Bladder control	.78*	0.48	0.01	.83*	0
Bowel control	.86*	0.32	0.35	. 83*	-0.02
Getting in/out of bed	.70*	0.62	.82*	0.12	0.26
Toilet	.75*	0.53	.91*	0.23	-0.13
Bathing	0.14	.88*	.75*	0.32	0.02
Walking	.61*	.61*	.85*	0.38	0.27
Stairs	.63*	0.54	.85*	0.21	0.29

(3) Post surgery (N=202)	admission				discharge		
	fact 1	fact 2	fact 3	fact 4	fact 1	fact 2	fact 3
Drinking	0.03	0	.76*	0.35	0.08	0.43	.70*
Eating	0.05	0.2	.73*	0.19	0.2	.77*	-0.07
Upper body dressing	0.12	0.18	.80*	0.01	0.41	.47*	0.29
Lower body dressing	0.21	.79*	0.13	0.08	0.58	0.39	0.01
Personal hygiene	0.17	.57*	0.22	0.07	0.43	0.54	-0.02
Washing	0.14	.86*	0.02	0.1	.67*	0.3	0.16
Bowel control	0	0.08	0.11	.87*	0.02	0.08	.88*

Getting in/ out of bed	.58*	0.49	0.15	0.21	.77*	0.24	0.18
Bathing	.64*	0.23	0.04	0.04	.55*	0.13	0
Walking	0.81	0.07	0.06	0.06	.82*	-0.06	0.18
Stairs	0.85	0.05	0.01	0.01	.83*	0.02	0.08

(4) Rheumatologic illness (N=197)	Admission			Discharge	
	fact 1	fact 2	fact 3	fact 1	fact 2
Drinking	0.07	-0.05	0.95*		
Eating	0.35	0.58*	0.01	.40*	0.33
Upper body dressing	0.25	0.66*	0.01	0.51	0.56*
Lower body dressing	0.76*	0.13	0.11	0.73*	0.27
Washing	0.79*	0.29	-0.06	0.64*	0.41
Bladder control	0.21	0.50*	-0.16	0.36	0.64*
Bowel control	0	0.83*	0.08	-0.13	0.91*
Toilet	0.69*	0.48	-0.14	0.75*	0.19
Bathing	0.75*	0.22	0.07	0.60*	0.37
Walking	0.81*	0.81*	-0.16	0.81*	0.06
Stairs	83*	0.09	0.07	0.82*	0.17

5) Geriatric multiorgan illness (N= 84)	Admission				Discharge		
	fact 1	fact 2	fact 3	fact 4	fact 1	fact 2	fact 3
Drinking	0.14	0.17	-0.06	0.90*	0.7	0.02	-0.13
Eating	-0.01	0.68*	-0.04	0.19	-0.32	0.59	0.08
Upper body dressing	0.15	0.70*	-0.1	0.13	0.52	0.07	0.23
Lower body dressing	0.4	0.64*	0.08	-0.15	0.42	0.54	0.11
Personal hygiene	0.19	0.72*	0.34	0.04	0.33	0.73	-0.11
Washing	0.42	0.56*	0.21	0.03	0.16	0.82*	0.04
Bowel control	0.19	0.04	0.88*	-0.1	-0.03	-0.1	0.86*
Getting in/out of bed	0.76*	0.17	0.21	0.11	0.69*	0.26	0.37
Toilet	0.75*	0.27	0.34	0.05	0.48	0.16	0.69*
Bathing	0.57*	0.38	-0.12	-0.17	0.11	0.44*	0.29
Walking	0.82*	0.11	0.09	0.21	0.70*	0.06	0.47
Stairs	0.87*	0.1	0.12	0.12	0.62*	0.37	0.23

Reliability

The three Barthel scales (total, self care, mobility) reached satisfactory reliability in all patient groups on admission and on discharge (Table 10). Although the lowest reliability coefficient (0.60 in rheumatological illness, on discharge, self care scale) would call for improvement the next lowest reliability coefficients (0.69 in post surgery patients on admission, self care scale; other reaching 0.70) are acceptable. In most cases the reliability coefficients of admission data are very similar to those of discharge data within each of the patient groups.

The reliability coefficients of FIM scales (total, motor, cognitive) are generally higher (the lowest being 0.80 (in geriatric multiorgan illness patients on discharge, cognitive scale) (out of 42 reliability coefficients are only 9 between .80 and .89. The other are equal or higher than .90) (Table 10).

Comparison of scale means on admission and discharge

BI

Analysing whether the patients' BI scores improved between

Citation: Valach L, Selz B, Hofer K, et al. A six-year audit in a rehabilitation centre with mod barthel index and FIM as outcome measures. *Int Phys Med Rehab J.* 2018;3(4):342–358. DOI: 10.15406/ipmrj.2018.03.00128

admission and discharge we calculated t test for dependent samples for each diagnosis group (Table 11). There is a highly significant improvement in the mean values of the BI total (sum of all items) in all groups ($p<0.001$) except in patients with brain injury ($p<0.05$). The mean values of the BI self care scale are significantly higher on discharge than on admission in all patients group ($p<0.001$) except in patients with traumatic brain injury ($p<0.06$). The differences in BI mobility scale between admission and discharge are also significant (traumatic brain injury patients: $p<0.05$; all other groups $p<0.001$) (Table 11).

Table 10 Reliability coefficient of barthel and fim scales.

Diagnosis	1	2	3	4	5	6	all
Barthel sum all							
admission	0.87	0.94	0.77	0.84	0.82	0.87	0.86
discharge	0.88	0.87	0.82	0.84	0.79	0.87	0.86
Barthel self care							
admission	0.79	0.92	0.69	0.72	0.7	0.81	0.78
discharge	0.79	0.7	0.7	0.77	0.6	0.8	0.77
Barthel motor							
admission	0.83	0.84	0.72	0.77	0.78	0.79	0.8
discharge	0.83	0.86	0.78	0.72	0.78	0.78	0.8
FIM sum all items							
admission	0.96	0.98	0.94	0.95	0.93	0.95	0.96
discharge	0.96	0.96	0.94	0.95	0.93	0.95	0.96
FIM motor							
admission	0.97	0.98	0.94	0.96	0.94	0.96	0.96
discharge	0.97	0.97	0.93	0.96	0.95	0.97	0.96
FIM cognitiv							
admission	0.88	0.97	0.89	0.88	0.83	0.92	0.9
discharge	0.88	0.93	0.89	0.86	0.8	0.91	0.89

Diagnoses
(1) Vascular brain damage (N=337)
(2) Brain injury (N= 27)
(3) Post surgery (N=202)
(4) Rheumatologic illness (N=197)
(5) Geriatric multiorgan illness (N= 84)
(6) other neurological ilness (N=192)

Table 11 Barthel scales admission vs discharge (T-test for dependent samples)

scale	admission			discharge				
	mean	stddev	std err	mean (N=326)	stddev	std err.	t	p
(1) Vascular brain damage(N=326)								
All items	73.17	25.815	1.43	85.54	20.827	1.153	-12.4	0
Self care	41.94	12.15	0.673	46.81	9.608	0.532	-9.73	0
Mobility	31.24	15.537	0.861	38.73	12.522	0.694	-11.72	0
(2) Brain injury (N= 27)								
All items	80.93	30.368	5.844	92.7	14.982	2.883	-2.24	0.034
Self care	43.59	16.049	3.089	49.19	7.174	1.381	-1.99	0.057
Mobility	37.33	14.705	2.83	43.52	8.763	1.687	-2.4	0.024
(3) Post surgery (N=199)								
All items	70.9	20.137	1.428	88.32	16.168	1.146	-14.11	0
Self care	43.13	9.364	0.664	48.67	6.881	0.488	-9.55	0
Mobility	27.77	13.795	0.978	39.65	11.025	0.782	-13.8	0

Citation: Valach L, Selz B, Hofer K, et al. A six-year audit in a rehabilitation centre with mod barthel index and FIM as outcome measures. *Int Phys Med Rehab J.* 2018;3(4):342–358. DOI: 10.15406/ipmrj.2018.03.00128

Table Continued

scale	admission			discharge				
	mean	stddev	std err	mean (N=326)	stddev	std err.	t	p
All items	89.1	17.063	1.228	93.61	13.29	0.957	-5.89	0
Self care	48.61	7.314	0.526	49.88	7.056	0.508	-3.23	0.001
Mobility	40.49	10.885	0.784	43.73	7.441	0.536	-6.43	0
(5) Geriatric multiorgan illness (N= 84)								
All items	73.11	22.191	2.451	84.78	16.797	1.855	-6.29	0
Self care	42.34	9.964	1.1	45.62	8.187	0.904	-3.72	0
Mobility	30.77	14.69	1.622	39.16	10.914	1.205	-6.29	0
(6) other neurological ilness (N=190)								
All items	72.23	26.6	1.93	80.26	24.51	1.778	-8.34	0
Self care	40.9	13.296	0.965	44.5	11.975	0.869	-6.86	0
Mobility	31.33	15.338	1.113	35.76	14.256	1.034	-7.23	0
All patients (N=1017)								
All items	75.78	24.205	0.759	86.76	19.547	0.613	-21.05	0
Self care	43.32	11.354	0.356	47.29	9.22	0.289	-15.43	0
Mobility	32.46	14.878	0.467	39.47	11.842	0.371	-20.5	0

FIM

A comparison of FIM total means on admission and discharge indicates a significant improvement of all patient groups (patients with traumatic brain injury: $p<0.005$; all other groups: $p<0.001$) (Table 12). The lowest FIM total mean was achieved by the vascular brain disease patients (83 points on admission) and the highest by the rheumatological patients (115 points on discharge). The smallest difference between admission and discharge FIM total can be find in rheumatological patients (5 points), the largest in patients with vascular brain disease (14 points) and in traumatic brain injury patients (15 points). The FIM motor scale indicates highly significant changes in all groups of patients ($p<0.001$) with the exception of traumatic brain injury patients ($p=0.008$) (Table 12). The FIM cognitive admission - discharge comparison shows significant changes in vascular brain disease, in post surgical patients and in patients with other neurological illness ($p<0.001$). Patients with rheumatological illness ($p=0.013$), patients with traumatic brain injury ($p=0.057$) and geriatric multiorgan illness patients ($p=0.424$) achieved less noticeable improvement (Table 12).

Table 12: Comparisson of FIM (admission) and FIM (discharge) (FIM total (sum), FIM motor and FIM cognitive (mean))

	admission		discharge			
	mean	stddev	mean	stddev	t	p
(1) vascular brain dissease (N=337)						
FIM total	82.92	27.716	97.12	24.847	-16.61	0
FIM motor	4.45	1.754	5.38	1.567	-16.39	0
FIM cognitive	5.14	1.385	5.51	1.244	-9.58	0
(2) traumatic brain injury (N= 27)						
FIM total	92.44	31.41	108.15	19.108	-3.1	0.005
FIM motor	5.54	1.462	6.16	1.124	-2.89	0.008
FIM cognitive	5.23	1.661	5.66	1.403	-2	0.057
(3) post surgery patients (N=202)						
FIM total	88.11	21.708	101.91	18.408	-15.2	0
FIM motor	4.54	1.386	5.54	1.143	-15.92	0
FIM cognitive	5.83	1.165	5.97	1.084	-3.68	0
(4) rheumatological illness (N=197)						
FIM total	109.83	18.853	114.93	15.757	-7.42	0
FIM motor	6.03	1.255	6.38	1.035	-7.09	0
FIM cognitive	6.29	0.96	6.39	0.869	-2.5	0.013
(5) geriatric multiorgan illness (N= 84)						
FIM total	84.82	21.607	95.13	19.76	-6.57	0
FIM motor	4.39	1.437	5.16	1.342	-6.93	0
FIM cognitive	5.55	1.179	5.61	1.017	-0.8	0.424
(6) other neurological illnesses (N=192)						
FIM total	86.8	26.814	95.9	25.568	-10.13	0
FIM motor	4.6	1.754	5.21	1.703	-9.98	0
FIM cognitive	5.48	1.461	5.71	1.304	-4.62	0

Barthel total and FIM total score on discharge
FIM indicates in all diagnosis groups a higher proportion of improved patients.
A lower amount of patients indicate improvement in comparison with the observation with FIM.
(1) Vascular brain damage (N=337)
(2) Brain injury (N= 27)
(3) Post surgery (N=202)

Citation: Valach L, Selz B, Hofer K, et al. A six-year audit in a rehabilitation centre with mod barthel index and FIM as outcome measures. *Int Phys Med Rehab J.* 2018;3(4):342–358. DOI: 10.15406/ipmrj.2018.03.00128

(4) Rheumatologic illness (N=197)
(5) Geriatric multiorgan illness (N= 84)
(6) other neurological ilness (N=192)

Changes in BI and FIM

The mean comparisons indicate mean changes in the whole groups of patients. However, the declared goal of a rehabilitation team is to help every patient. The information how many patients improved their total score on discharge is an important information on how many patients were judged as more independent on discharge and how many patients judged themselves as being more independent. The table 13 summarizes the data for each diagnostic group of patients. Well over three quarter of patients improved their independence as assessed by the nurses (FIM total) (minimum 64 maximum 87% of all patients of each diagnostic group; 80% of the whole sample). Some 10% did not change in their overall score (5-28%), 10% did not manage to maintain their admission degree of independence (7-17%). The BI scores indicate that patients assess their degree of improvement in their independence more sceptical than the nursing staff (61% patients vs. 80% of nurses indicate a change with discharge score higher than admission score). Less that a half of all brain injury patients and rheumatological patients report improvement in their independence (48% and 40%). Building a group of patients who did change neither in BI nor in FIM we obtained about 12% of patients (whole sample; ranging from 26% (rheumatological illness) to 6% (post surgery)) (Table 14). Who are these patients who did not improve their independence? Are they too severe cases (floor effect) or are they patients with a high admission score (ceiling effect)? (Table 13) (Table 14).

Table 13 Changes in Barthel total and FIM total score on discharge in comparisson to admission (patients in %):

	worse	unchanged	improved	improved by 20BI/25FIM
All patients (N=1039)				
BI	9	30	61	25
FIM all	9	11	80	15
(1) Vascular brain damage (N=337)				
BI	12	25	63	27
FIM	8	5	87	22
(2) Brain injury (N= 27)				
BI	4	48	48	15
FIM	11	11	78	18
(3) Post surgery (N=202)				
BI	5	16	80	40
FIM	7	6	87	18
(4) Rheumatologic illness (N=197)				
BI	7	53	40	10
FIM	8	28	64	5
(5) Geriatric multiorgan illness				
BI	15	17	68	28
FIM	17	5	78	16
(6) other neurological ilness				
BI	12	31	57	27
FIM	10	12	78	8

Table 14 Improvement between admission and discharge either in FIM total or in BI total

	improved		
	N	**N all**	**%**
All	1017	892	87.7
vascular brain dissease	326	304	93.3
traumatic brain injury	27	23	85.2
post surgery	199	187	94
rheumatological illness	193	142	73.6
geriatric multiorgan illness	82	74	90.2
other neurological illnesses	190	162	85.3

A comparison of means of the patients who improved and those who did not in regards to the BI total, BI self care, BI mobility, FIM total, FIM motor, FIM cognitive, indicates that patients who did not improve their independence were more independent on admission that the patents who improved their independence (Table 15). Although this result is significant in the total sample there are some difference in the diagnostic groups. The result is not significant in vascular brain damage patients and in brain injury patients, where it is due to the low number of patients (N=4). In addition, there are some differences between BI being significant in post surgery patients and FIM being significant in 'other neurological illness' group. The results of this comparison would support the thesis that non-improvement of the patients is mostly due to the high admission values, that is, to the ceiling effect of the measures. However, it should be noted that all patients indicate a better value minimally in one of the BI items on discharge, thought some of them also report a worse value thus reaching a total which is either negative or unchanged (Table 15).

Table 15 Comparison (t-test) of patients with and without improvement in scales on admission.

All patients Scales	**no improv. Mean**	**(N=125) stddev**	**improv. Mean**	**(N=892) stdden**	**t**	**p**
1 BI total	87.18.	22.256	74.18	24.008	5.99	0
2 BI self care	48.17	10.284	42.64	11.337	5.26	
3 BI mobility	39.02	13.521	31.54	14.835	5.72	
4 FIM total	106.69	26.38	88.16	25.255	7.39	
5 FIM motor (mean)	5.84	1.742	4.66	1.64	7.14	
6 FIM cognitiv (mean)	6.14	1.165	5.5	1.368	5.6	
Vascular brain damage						

Table Continued

All patients Scales	**no improv. Mean**	**(N=125) stddev**	**improv. Mean**	**(N=892) stdden**	**t**	**p**
Scales	**no improv. Mean**	**(N=22) stddev**	**improv. Mean**	**(N=304) stdden**	**t**	**p**
1 BI total	77.41	31.895	72.87	25.355	0.65	0.52
2 BI self care	43.23	14.931	41.85	11.949	0.42	675
3 BI mobility	34.18	18.16	31.02	15.342	0.8	434
4 FIM total	90.82	34.099	82.88	26.833	1.07	297
5 FIM motor (mean)	4.88	2.231	4.42	1.725	95	354
6 FIM cognitiv (mean)	5.48	1.408	5.09	1.396	1.26	220
Brain injury						
Scales	**no improv. Mean**	**(N=4) stddev**	**improv. Mean**	**(N=23) stdden**	**t**	**p**
1 BI total	90.25	14.66	79.3	32.281	1.1	0.299
2 BI self care	48.75	4.924	42.7	17.187	1.39	0.181
3 BI mobility	41.5	11	36.61	15.341	0.77	0.475
4 FIM total	107.5	16.197	89.83	32.891	1.67	0.133
5 FIM motor (mean)	6.19	1.031	5.04	1.929	1.77	0.118
6 FIM cognitiv (mean)	5.4	1.347	4.87	1.992	0.67	0.529
Post surgery						
Scales	**no improv. Mean**	**(N=12) stddev**	**improv. Mean**	**(N=137) stdden**	**t**	**p**
1 BI total	84.83	18.566	70.01	19.949	2.67	0.02
2 BI self care	48.83	7.826	42.76	9.354	2.57	0.023
3 BI mobility	36	13.239	27.24	13.695	2.22	0.046
4 FIM total	94.67	31.647	87.83	21.113	0.74	0.475
5 FIM motor (mean)	5.19	1.802	4.51	1.357	1.3	0.219
6 FIM cognitiv (mean)	5.43	1.831	5.85	1.116	-0.78	0.449
Rheumatologic illness						
Scales	**no improv. Mean**	**(N=52) stddev**	**improv. Mean**	**(N=142) stdden**	**t**	**p**
1 BI total	96.39	11.137	86.48	18.064	4.56	0
2 BI self care	51.59	5.288	47.54	7.652	4.14	0
3 BI mobility	44.8	6.779	38.94	11.658	4.3	0
4 FIM total	121	11.109	106.01	19.571	6.63	0
5 FIM motor (mean)	6.73	0.821	5.79	1.297	5.99	0
6 FIM cognitiv (mean)	6.69	0.579	6.16	1.021	4.5	0
Geriatric multiorgan illness						
Scales	**no improv. mean**	**(N=8) stddev**	**improv. Mean**	**(N=74) stdden**	**t**	**p**
1 BI total	89.5	10.406	71.34	22.437	4.03	0.001
2 BI self care	50.63	4.502	41.45	9.995	4.66	0
3 BI mobility	38.88	9.717	29.89	14.914	2.33	0.04
4 FIM total	100.88	21.938	82.81	21.201	2.22	0.055
5 FIM motor (mean)	5.35	1.522	4.27	1.413	1.91	0.09
6 FIM cognitiv (mean)	6.28	0.667	5.46	1.212	2.96	0.011
other neurological ilness						
Scales	**no improv. Mean**	**(N=28) stddev**	**improv. Mean**	**(N=162) stdden**	**t**	**p**
1 BI total	78	28.191	71.23	26.278	1.18	0.244

Table Continued

2 BI self care	44.75	13.094	40.23	13.257	1.68	0.101
All patients Scales	**no improv. Mean**	**(N=125) stddev**	**improv. Mean**	**(N=892) stdden**	**t**	**p**
3 BI mobility	33.25	16.338	31	15.187	0.68	0.501
4 FIM total	99.79	28.026	84.98	25.913	2.61	0.013
5 FIM motor (mean)	5.35	1.996	4.45	1.697	2.25	0.031
6 FIM cognitiv (mean)	6.04	1.068	5.42	1.491	2.65	0.011

Discussion

Our data provide some indication of the possible floor and ceiling effects of BI and FIM, though the lack of significant results on discharge in some of the patients is only partly due to ceiling or floor effects. Nevertheless, the only non significant result in Barthel Index was found in the group of the traumatic brain injury patients where also one of the highest number of patients with the highest Barthel self care score could be found. The non-significant admission-discharge comparisons of FIM scores are more difficult to associate with the floor and ceiling effects as the geriatric multiorgan illness patient do not reach exceptional floor or ceiling effect susceptible values. It could be argued that these patients although improving their motor functions do not improve enough their cognitive functions. Their cognitive functions are on admission better than in vascular brain disease patients, traumatic brain injury patients and other neurological illness patients. However, on discharge, although slightly improved, the rating of their cognitive functions is nearly the lowest of the 6 diagnoses group patients.

Van der Putten and colleagues[41] compared the BI and FIM as outcome measures after inpatient rehabilitation and report that BI and FIM total, FIM motor and FIM cognitive scales were appropriate measures for the stroke patients, but that FIM cognitive scale has limited usefulness in progressive multiple sclerosis because of its notable ceiling effect. We also found that FIM cognitive scale has limited usefulness for some diagnosis groups of patients such as geriatric multiorgan illness and traumatic brain injury patients, though the latter group is much too small for conclusive suggestions (N=27).

Laake and colleagues report that BI is unidimensional among stroke patients but not among geriatric patients or patients with hip fracture where one factor related to mobility and the other to bodily functions. Consequently, the sum score is not appropriate. An argument also forwarded by Sulter and co-workers.[7]

Kalra[48] compared BI of stroke patients managed in a stroke rehabilitation unit and in general wards. Although the initial Barthel score (median) was comparable between these two groups the median discharge Barthel score of patients managed in the stroke unit was significantly higher than of patients managed in general wards. There was a significant delay in discharging stroke patients in general wards (20 weeks) compared with those in the stroke unit (6 weeks). These and other similar results indicate that the improvements in our patient groups between admission and discharge cannot be attributed to 'spontaneous' recovery only. Consequently, it could be concluded that there was a significant improvement achieved in all patient groups in regard to independence in activities of daily living as measured by FIM and BI.

As indicated at the beginning of this article measures integrated into a rehabilitation routine do not always reach the standards of a scientific double blind prospective control study. The assessing nurses or occupational therapists are aware of the fact whether the patient has just been admitted to the rehabilitation centre or he or she is going to be discharged. Despite all their working ethics and correct assessment they also are very much interested in patients' improvement although there are no negative sanction if it is not the case. The patients filling out BI are interested in going home and may not be always interested in indicating that their independence did not improve. These are but a few reservations one may have towards this data. However, if there were no improvement the patients would be deeply disappointed and may be interested in indicating how bad his or her situation is thus describing functional independence on discharge even lower than on the admission. Further, regular training of the nurses using FIM training video and discussing unclear cases and false assumptions the nurses may have helped in achieving certain coding standards which should limit the effect of wishful thinking. These would work against the assupmtions listed above.

The differences between BI and FIM as mirrored in our results could be inherent to the measure with FIM being more sensitive to change than the self-report BI. It is also is possible to assume that the changes were first manifested at a low level of action organisation thus being less obvious to the patients. Further, the often-reported depressive symptoms in rehabilitation patients could be responsible for theirs a more pessimistic view of their rehabilitation progress. Finally, it also should be discussed, whether nurses indicate change where there was not enough reason for seeing one. However, even the modest self-assessment shows over 60% of all patients indicating a change that is a result in support of the implemented programme. In many patients their given background for interpreting these results is not a stable condition or even a spontaneous improvement but a deterioration. Consequently, even maintenance of some patients' independence may be cosidered a success.

There may be a number of unsolved measurement and scaling problems in the assessment of the rehabilitation outcome. However, as some authors (such as the Rivermead team) pointed out, the contextual issues of independence should not be forgotten and will not disappear with better scaling methods.

Rehabilitation is a systematic joint goal directed process in which the patient is helped to gain more independence. This is partly the issue of functional independence but also to a very substantial part of the goal directed understanding and organisation of the patient's life. Consequently, actions, projects and goal directed careers be it an occupational, rehabilitational or any other socially embedded process must be monitored in their psychosocial anchoring. Psychology and social psychology offers a series of methods how to capture these processes. Concepts such as empowerment, self-efficacy, goal-directed action, action related cognitions and many other offer a good possibility of merging the functional independence with its psychological and social steering. The new ICIDH-2 classification may help us to redirect our empirical views. In consequently conceptualizing the rehabilitation process as a goal directed we have

to utilize measures that are closely linked to the setting of the goal of the rehabilitation. Approaches such as 'goal-attainment scaling'.[49]

Acknowledgments

None.

Conflict of interest

The author declares no conflict of interest.

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Citation: Valach L, Selz B, Hofer K, et al. A six-year audit in a rehabilitation centre with mod barthel index and FIM as outcome measures. *Int Phys Med Rehab J.* 2018;3(4):342–358. DOI: 10.15406/ipmrj.2018.03.00128