

ORIGINAL REPORT

PSYCHOMETRIC EVALUATION OF THE NORTHWICK PARK DEPENDENCY SCALE

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Objective: To examine the psychometric properties of the Northwick Park Dependency Scale (NPDS).

Design: Review of existing literature and psychometric analysis in relation to other standardized measures of disability in a large neurorehabilitation cohort.

Setting: A regional post-acute specialist inpatient neurorehabilitation unit in London, UK.

Participants: A total of 569 inpatients with complex neurological disabilities (350 males, 219 females; mean age 44.4 years).

Main measures: The NPDS, Barthel Index, Functional Independence and Functional Assessment measures.

Results: A database search found 5 studies that examined the psychometrics of the NPDS. These supported its validity and reliability. The present study added to these by evaluating the internal consistency, factor structure, discriminatory power and responsiveness to change during rehabilitation. The NPDS was found to have good internal consistency ($\alpha=0.90$), suggesting that it can reasonably be summed to a single total score. It discriminated among people with different levels of dependency and was responsive to change, particularly in the higher dependency groups.

Conclusion: The NPDS is a psychometrically robust tool, providing a broader range of information on nursing needs than some other commonly-used disability measures. The Special Nursing Needs subscale provides clinically useful information, but its metric properties require further development, which is now underway.

Key words: Northwick Park Dependency Scale; NPDS; psychometrics; factor analysis; rehabilitation nursing; rehabilitation.

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INTRODUCTION

Tools to measure outcome in rehabilitation should be subject to rigorous evaluation to confirm that they provide a valid and reliable assessment of the clinical parameters in question and to understand their metric properties. The Scientific Advisory Board of the Medical Outcomes Trust (www.outcomes-trust.org/index.html) has defined a set of attributes and review criteria against which the psychometric properties of health status and quality of life instruments may be judged, and these also form a useful framework for psychometric and clinimetric evaluation (1). Quality criteria were proposed by Terwee et al. in 2007 (2). In the present article, we use this framework to provide a comprehensive evaluation of the psychometric properties of the Northwick Park Dependency Scale (NPDS), both from the existing literature and from new data.

The NPDS is a rating scale that was developed to quantify an individual's needs for nursing care and support, particularly in highly dependent patients. First published in 1998 it is used increasingly widely in the UK (3) and has also been trialled in other countries (4–7). It has been shown to correlate well with other measures of dependency, including the Barthel Index (BI) (5, 6, 8) and the Functional Independence Measure (FIM™)¹ (4), but it also provides additional information about the needs for nursing care in clinical rehabilitation settings (5), as follows:

- It provides a direct assessment of the number of carers and time taken to complete care tasks, and is designed to be sensitive for highly dependent patients who are below the level of the BI and FIM.
- It addresses the need for input from qualified nurses as well as basic care.
- It includes assessment of need for help with cognitive functions, such as communication, behavioural management and safety awareness, which often occupy a significant proportion of nursing time in neurorehabilitation.
- It translates, by way of a validated algorithm, into: (i) a timetable of care needs (9), which may be used to directly plan care packages on discharge from hospital; and (ii) an estimate of care hours and costs, which has been used to demonstrate the cost-efficiency of rehabilitation for highly dependent patients (10).

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¹FIM™ is a trademark of the Uniform Data System for Medical Rehabilitation, a division of UB Foundation Activities, Inc, Buffalo, NY, USA.

this article is to examine the extent to which the NPDS meets the criteria of the Medical Outcomes Trust.

- The first part of this paper presents a brief systematic review of the existing literature about the NPDS, based on its psychometric performance, and summarizes these studies with respect to the criteria of the Medical Outcomes Trust for a psychometrically robust tool.
- The second part of the paper reports further analyses of a large dataset gathered prospectively from a cohort of neurorehabilitation inpatients. Several important psychometric attributes not previously examined are analysed, and the relationship between the NPDS, the BI, FIM™ and the Functional Independence and Functional Assessment measures (UK FIM+FAM) (11) is explored with respect to interaction of physical and cognitive elements of the scale.

A SYSTEMATIC REVIEW OF NPDS PSYCHOMETRIC STUDIES

Methods

To identify existing literature on psychometric evaluation of the NPDS we searched the following databases using the term "Northwick Park Dependency.mp": Medline and PubMed 1995–May 2009, Embase 1980–2009, British Nursing Index and Archive 1995–2009, Allied and Complementary Medicine (AMED) 1995–2009.

Results

Of a total of 16 articles recovered, 5 specifically examined the psychometric properties of the NPDS (4–6, 8, 12), as summarized in Table I. These studies have focused largely on inter- and intra-rater reliability and concurrent validity. They provide good support for the reliability and concurrent validity of the NPDS, although reliability for the Special Nursing Needs Subscale of the NPDS scale can be low, reflecting the dichotomous scoring structure and the quite specialized nursing needs it captures.

Three other papers (7, 13, 14) recorded the NPDS in conjunction with other parameters of nursing intervention (e.g. care needs, observed care and nursing activities, work sampling) and provide general confirmation of its content and relevance. However, we were unable to identify any published articles addressing internal consistency, dimensionality/factor structure, responsiveness to change or discriminatory power.

PSYCHOMETRIC EVALUATION IN A LARGE NEUROREHABILITATION COHORT

Participants

Participants were 569 consecutive patients admitted to a specialist post-acute neurorehabilitation unit in London, UK between November 1 1999 and May 31 2008. This is a tertiary service (catchment population in excess of 5 million) for patients with complex neurological disability whose rehabilitation needs are beyond the scope of their local services. The demographic characteristics of the cohort are shown in Table II.

Measures

Northwick Park Dependency Score. The NPDS (12) is an ordinal measure rated on a scale of 0–100, divided into two sections:

- The *Basic Care Needs (BCN)* section (range 0–65) includes a total of 16 items associated with activities of daily living, such as washing, dressing, eating and drinking, in addition to safety awareness, behaviour and communication. Each item is rated on a Likert scale of 0–3, 0–4 or 0–5.
- The *Special Nursing Needs (SNN)* section (range 0–35) contains 7 care items that would normally need to be undertaken by a qualified nurse, or a specially trained carer. These are scored on a dichotomous scale of 0 or 5 to reflect the intensity of nursing input that they represent.
- *Nursing/care hours (RCH)*: NPDS data can be entered into customized software, which applies the algorithm to derive an estimation of care hours per week (9).

In our unit, NPDS scores are routinely recorded for all patients every fortnight by the patient's named nurse, based on the average needs for care over the previous week. NPDS scores recorded for admission and discharge were chosen to correspond as closely as possible to the period over which FIM+FAM ratings were recorded (see below). Patients are routinely divided into 4 dependency groups, based on their admission NPDS scores (10).

- Low-dependency (NPDS score 0–9) patients are largely independent for self-care or require incidental help only.
- Medium-dependency (NPDS 10–24) patients generally require help from one person for most tasks.
- High-dependency (NPDS 25–40) patients generally require help from two or more people for most tasks.
- Very high-dependency (NPDS >40) profoundly disabled patients with very complex care needs.

Barthel Index and Functional Independence Measure. The UK Functional Assessment Measure (UK FIM+FAM) (11) is routinely applied on the unit within 10 working days of admission and during the last 7 days before discharge (i.e. corresponding to the start and end of treatment). It comprises 30 items, subdivided into motor scales (16 items) and cognitive scales (14 items) (15), and includes FIM™ version 4 (13 motor items and 5 cognitive items) (16). BI scores (17) were extracted from the FIM+FAM data via the automated conversion within the FIM+FAM software (18).

Psychometric analyses. Data were entered into a customized program written in Microsoft Excel. From there, they were extracted, cleaned and imported into SPSS v.15.0 for analysis. Traditional psychometric tests are generally based on parametric assumptions, but as the NPDS is an ordinal measure, we included non-parametric tests in the analysis wherever they were available.

- Internal reliability was tested by examining coefficient alpha and "corrected" item-total correlations (i.e. the item correlated with the total score excluding that item). We examined the whole scale as well as the two subscales, and expected coefficient alpha to fall between 0.7 and 0.95 (2).

Table I. Summary of published literature on psychometric properties of the Northwick Park Dependency Scale (NPDS)

Author/year	Attributes examined	Sample	Main findings
Turner-Stokes et al., 1998 (12)	Validity (Barthel Index) and Inter- and intra-rater reliability	Inpatient neurorehabilitation sample. Three nurses rated 21 patients on 3 occasions (63 paired ratings)	<i>Inter-rater reliability:</i> Total scores (Spearman's correlation): BCN 0.91, SNN 0.68, Total NPDS 0.90 ($p < 0.01$) <i>Item-by-item analysis (BCN items only):</i> Absolute agreement 38.7–92.1%; Agreement ± 1 79.0–100% <i>Intra-rater reliability:</i> Total scores (Spearman's correlation): BCN 0.95, SNN 0.81, Total NPDS 0.93 ($p < 0.01$) <i>Item by item analysis (BCN items only):</i> Absolute agreement 61.9–93.0%; Agreement ± 1 88.4–100% <i>Validity:</i> Barthel Index: rho -0.91 ($p < 0.01$)
Post et al., 2002 (5)	Construct validity (Cronbach's alpha) Validity (Barthel Index) Sensitivity to change Nurses preference	A prospective longitudinal study of stroke patients ($n = 31$) with serial measurements one month apart	<i>Validity:</i> Construct validity (Cronbach's alpha): BCN score 0.85–0.92 Barthel Index: BCN rho -0.85 to -0.95 at each measurement; SNN rho -0.28 to -0.57 ; total NPDS score -0.87 to -0.95 Strong relationship to global rating of nursing dependency (rho -0.82) and sensitivity to change Wilcoxon z 4.06 ($p < 0.001$) Nurses preference: NPDS was not significantly superior to the Barthel Index but 9/12 nurses preferred it for future use
Hatfield et al., 2003 (8)	Validity (Barthel Index and recorded nursing hours) Inter-rater reliability Utility: time to score	Inpatient neurorehabilitation sample ($n = 22$). Two raters (a doctor and a nurse)	<i>Inter-rater reliability:</i> Total scores (Spearman's correlation): BCN 0.92, SNN 0.48, Total NPDS 0.92 ($p < 0.01$) <i>Item-by-item analysis:</i> BCN items: Absolute agreement 55–95%; Agreement ± 1 82–100% SNN items: Absolute agreement 55–100%. <i>Validity:</i> Barthel Index: BCN rho -0.95 ($p < 0.01$); Total NPDS rho -0.89 ($p < 0.01$); Nursing time: BCN rho -0.88 ($p < 0.01$); Total NPDS rho -0.87 ($p < 0.01$); Mean time to score NPDS: 4–5 min
Svensson et al., 2005 (4)	Validity (FIM) and Inter- and intra-rater reliability	Patients with brain injury ($n = 40$) in 3 rehabilitation centres, rated by 2 nurses ($n = 13$) or and a nurse and an occupational therapist (OT) ($n = 27$)	<i>Inter-rater reliability:</i> Item by item analysis (BCN items only): Nurse-Nurse: absolute agreement 77–100%; unweighted kappa 0.63–1.0 Nurse-OT: absolute agreement 54–96%; unweighted kappa 0.28–0.80 <i>Intra-rater reliability:</i> Item by item analysis (BCN items only): Absolute agreement 71–100%; unweighted kappa 0.53–1.0 <i>Validity:</i> FIM: Goodman Kruskals's gamma–Nurses: -0.83 (ase 0.04); OT: -0.87 (ase 0.04)
Plantinga et al., 2006 (6)	Validity (Barthel Index and Dutch Care Dependency Score (CDS))	Mixed rehabilitation population (total $n = 154$)	<i>Validity:</i> Total Barthel Index and total NPDS: mean group correlation (rho) -0.87 ; percentage explained variance $R^2 = 0.76$. (Within each of the disease groups correlation varied from -0.93 ($R^2 = 0.86$) to -0.70 ($R^2 = 0.49$) which exceeded their criterion of rho 0.60) Total CDS and total NPDS score: rho -0.74 ($R^2 = 0.55$)

Ase: asymptotic standard error; BCN: Basic Care Needs subscale for the NPDS; SNN: Special Nursing Needs subscale of the NPDS; FIM: Functional Independence Measure.

- Dimensionality of the BCN scale was examined using a principal components analysis and Varimax rotation (19). As this was the first published factor analysis of NPDS data, we used exploratory factor analysis (2). The decision on the best number of factors to rotate was made according to Horn's method of parallel analysis using freely available software (20, 21).
- Responsiveness was examined separately for low-, medium-, high- and very high- dependency NPDS groups, as we expected

that the NPDS would be relatively more responsive in the higher dependency groups. Responsiveness was compared with the FIM and BI using Kazis's Effect Size (mean change from baseline/standard deviation (SD) baseline) (22) and interpreted according to Cohen (23). As effect size relies upon parametric assumptions Wilcoxon z values were also calculated.

- We calculated the discriminatory power of the NPDS using coefficient δ , a non-parametric statistic. This index was originally developed by Ferguson (24), and has recently

Table II. Participants' demographics (n = 569)

Clinical characteristics		
Age, years, mean (SD) [range]	44.4 (14.3) [13–77]	
Length of stay, days, mean (SD) [range]	99 (61) [14–411]	
Time since injury, days, mean (SD) [range]	154 (444) [4–9281]	
Male:female ratio, n (%)	350:219 (~ 60:40)	
Diagnosis, n (%)		
Acquired brain injury	472 (83)	
Stroke	322 (68)	
Traumatic	92 (19.5)	
Inflammatory	26 (5.5)	
Anoxic	20 (4.2)	
Other	9 (2.0)	
Spinal cord injury	53 (9.3)	
Peripheral nervous disorder	30 (5.3)	
Progressive neurological	6 (1.1)	
Other conditions	8 (1.4)	
Dependency scores, median (IQR) [range]		
	Admission	Discharge
NPDS total	18 (8–33) [78]	8.5 (2–20) [74]
BCN	16 (6–28) [57]	7 (2–18) [54]
SNN	0 (0–5) [30]	0 (0–5) [25]
Barthel Index	9 (5–14) [20]	17 (12–20) [20]
FIM Motor	48 (29–68) [78]	77 (61–85) [78]
FIM Cognitive	26 (19–31) [30]	29 (24–33) [30]

NPDS: Northwick Park Dependency Scale; BCN: Basic Care Needs subscale for the NPDS; SNN: Special Nursing Needs subscale of the NPDS; FIM: Functional Independence Measure; IQR: interquartile range; SD: standard deviation.

been adapted for polytomous items, and with the availability of relevant software provides a useful measure of a questionnaire's ability to discriminate or distinguish between individuals (25).

- Construct validity was further tested using Spearman's rank correlations to examine associations between different elements of the NPDS and the FIM/BI. We expected a close inverse relationship between the BCN scale overall and the FIM/BI, but a weaker relationship with the SNN scale. We also expected a closer relationship between the cognitive elements of the NPDS and the FIM than across the cognitive/motor divide.

RESULTS OF PSYCHOMETRIC EVALUATION OF THE NPDS

Reliability and item-total correlations

For the full 23-item NPDS scale coefficient alpha was 0.90, which fell within the desirable range of 0.7–0.95 (2). Coefficient alpha for the BCN scale was 0.93, but only 0.50 for the 7-item SNN section. Item-total correlations for the BCN scale are presented in Table III. All BCN item-total correlations were above 0.30 and 75% were above 0.50. Item-total correlations for the dichotomous SNN scale were substantially lower, ranging from 0.01 to 0.40. However, this is likely to reflect the very small number of “Yes” responses for some SNN items as follows: Tracheostomy 23 (4%), Open wound

55 (10%), Night-time interventions 123 (22%), Psychological support 109 (19%), Isolation 86 (15%), Medical surgical 41 (7%) and Specializing (i.e. one-to-one nursing) 9 (2%).

Factor analysis

Table III also presents the results of the principal component analysis of the 16 BCN items. These indicate the presence of a large general “nursing dependency” factor with 13 out of the 16 items loading high (i.e. > 0.50) on the first principal component. Only 3 items had a loading below 0.5 (*eating, drinking and behaviour*). Three components had eigenvalues > 1.0 and the parallel analysis also suggested a 3-factor solution, accounting overall for 70% of the total variance. However, the third factor appeared to reflect only the local dependency of the eating and drinking items, thus this left a 2-factor solution as shown in Table III². The first factor represents *physical care needs* (13 items) and accounted for 50% of the variance, the second factor represents *cognitive/behavioural needs* (3 items) and accounted for 12% of variance. Coefficient alphas for these factors were 0.93 for the *physical care needs* subscale and 0.68 for the *cognitive/behavioural needs* subscale.

Test discrimination and responsiveness

The ability of the BCN section to discriminate among people with different degrees of nursing dependency, as measured by coefficient δ , was high at 0.99. Table IV shows the effect sizes for the NPDS scores in comparison with the BI, FIM and FIM+FAM for the 4 different dependency groups. As expected, responsiveness was greatest for the higher dependency patient groups, at which the NPDS is targeted.

Convergent and discriminant construct validity

Table V presents the correlations between the NPDS, the BI, FIM and UK FIM+FAM (motor and cognitive scales) on admission and discharge for the rehabilitation programme. Both the BCN and SNN subscales correlate highly with the total NPDS score at 0.97 and 0.78 respectively. However, the correlation between the BCN and SNN subscales is only moderate (0.59), confirming that they are indeed measuring different aspects of nursing care.

The concurrent correlations of the different components of the NPDS with admission scores from the FIM/FAM and the BI provide further support for the validity of the measure. For example:

- the BCN score correlates with the BI, FIM Motor and FIM+FAM Motor at –0.87 to –0.88;
- the SNN score also shows significant correlations with each of these 3 measures, but the correlations are moderate (–0.50

²Local dependency refers to items with very high correlations between them due to the fact that a person cannot score high on one without also scoring high on the other. In this case people who need help drinking virtually always need help eating.

Table III. Item Means, Item-Total Correlations and Loadings for the first principal component and 3-factor Varimax rotation of NPDS 16 BCN Items¹

Item	Range ²	Mean (SD)	Item-Total Correlations	1 st Principal Component	Factor 1 Physical Care (50% variance)	Factor 2 Cognitive/ Behaviour (12% variance)	Factor 3 Eating/ Drinking (8% variance)
<i>Basic care needs</i>							
1. Mobility	0-4	1.70 (1.34)	0.77	0.82	0.77		
2. Bed Transfers	0-3	1.17 (1.15)	0.80	0.84	0.85		
3a. Toileting Assistance: bladder	0-4	1.21 (1.15)	0.54	0.60	0.54		(0.51)
3b. Urinary Incontinence	0-3	0.50 (0.89)	0.61	0.66			
4a. Toileting Assistance: bowels	0-5	2.22 (1.90)	0.85	0.89	0.88		
4b. Bowel Incontinence	0-3	0.57 (0.98)	0.65	0.69	0.61		
5. Wash/Groom	0-5	1.48 (1.20)	0.78	0.82	0.64	0.52	
6. Bath/Shower	0-5	2.30 (1.51)	0.87	0.91	0.85		
7. Dressing	0-5	2.13 (1.45)	0.88	0.91	0.86		
8a. Eating	0-3	0.67 (0.72)	0.36	0.42			(0.83)
8b. Drinking	0-3	0.51 (0.72)	0.41	0.46			(0.82)
8c. Enteral Feeding	0-4	0.65 (1.46)	0.56	0.61	0.56	0.56	
9. Skin Pressure	0-5	0.73 (1.39)	0.67	0.72	0.73		
10. Safety Awareness	0-3	0.73 (0.91)	0.68	0.72		0.76	
15. Communication	0-5	1.03 (1.48)	0.47	0.52		0.78	
16. Behaviour	0-5	0.55 (1.01)	0.34	0.39		0.64	
<i>Special nursing needs</i>							
		% positive					
Tracheostomy	0-5	4	0.24				
Wound dressings	0-5	10	0.21				
>2 Night-time interventions	0-5	22	0.40				
Psychological support	0-5	19	0.18				
Isolation for MSRA	0-5	15	0.31				
Intercurrent medical/surgical condition	0-5	7	0.24				
1:1 Specializing	0-5	2	0.01				

¹Item-factor loadings rounded to 2 decimal places and for the Varimax rotation, all loadings <0.50 removed for clarity.

²All item ranges represented the full possible range of the score.

NPDS: Northwick Park Dependency Scale; BCN: Basic Care Needs subscale for the NPDS; SD: standard deviation; MRSA: methicillin-resistant *Staphylococcus aureus*.

Table IV. Effect sizes (ES=mean change from baseline/SD baseline) and Wilcoxon signed-ranks Z for the various scales within the different dependency groups¹

Dependency (NPDS 0-9) scale	Low (NPDS 0-9)		Medium (NPDS 10-24)		High (NPDS 25-40)		Very high (NPDS 41+)	
	n=147	n=183	n=183	n=183	n=84	n=84	n=72	n=72
	ES	Z	ES	Z	ES	Z	ES	Z
<i>NPDS</i>								
BCN	0.58	-6.55	1.79	-10.70	2.19	-7.49	1.89	-6.51
SNN	0.37	-2.53	0.25	-3.03	0.57	-3.99	1.03	-6.00
Total	0.37	-4.22	1.53	-10.59	3.30	-7.26	1.98	-5.59
RCH	1.00	-9.12	1.55	-10.83	1.52	-6.34	2.41	-5.69
<i>Barthel</i>								
Index	1.12	-9.68	2.11	-11.54	2.01	-7.45	2.69	-6.06
<i>FIM</i>								
Motor	1.03	-10.25	1.91	-11.63	1.99	-7.71	2.74	-6.30
Cognitive	0.42	-7.28	0.52	-8.96	0.45	-5.89	0.59	-6.01
Total	1.04	-10.31	1.87	-11.66	1.76	-7.71	1.85	-6.83
<i>FIM+FAM</i>								
Motor	1.20	-10.43	2.09	-11.63	2.11	-7.74	2.41	-6.44
Cognitive	0.12	-1.43*	0.40	-6.80	0.36	-4.88	0.63	-6.35
Total	0.86	-9.59	1.60	-11.63	1.31	-7.54	1.31	-6.90

¹Effect sizes can be interpreted according to Cohen (i.e. 0.2=small, 0.5=moderate, 0.8=large). *Non-significant, all other Z values p<0.01. NPDS: Northwick Park Dependency Scale; BCN: Basic Care Needs subscale of the NPDS; SNN: Special Nursing Needs subscale of the NPDS, RCH: estimated nursing care hours; FIM: Functional Independence Measure; SD: standard deviation.

to -0.51) reflecting the more specialized nature of the SNN items;

- as expected, the NPDS cognitive items correlated more strongly with the FIM and FIM+FAM cognitive scales (0.74-0.77) than with the motor subscales or BI (0.49-0.53).

DISCUSSION

The findings of this study demonstrate that there is now a substantial body of evidence for the psychometric properties of the NPDS, as summarized in Table VI, measured against the criteria of the Medical Outcomes Trust. The findings of this study were generally supportive of the reliability and validity of the NPDS as a measure of nursing dependency for use in rehabilitation settings. High internal consistency and the presence of a large principal component within the BCN scale support its use as a unidimensional scale for measuring overall need for nursing support. However, factor analysis demonstrated that the BCN scale can usefully be considered as having two substantive subscales, one reflecting needs for physical care, and the other cognitive/behavioural needs. The NPDS also showed excellent discriminatory power for people with different degrees of dependency, and was responsive to change, particularly for the medium- and high-dependency groups of patients, in which the effect sizes ranged from 1.5 to 3 standard deviations.

Table V. Pearson correlations of NPDS total score, BCN and SNN sections and NPDS Cognitive items admission scores with admission and discharge scores on BI, FIM, and FIM+FAM (Spearman's rho in parentheses)*

Measure	NPDS Adm.	BCN Adm.	SNN Adm.	NPDS Cognitive Items Adm.	RCH Adm.	RCH Dis.
BCN admission	0.97 (0.97)					
SNN admission	0.78 (0.71)	0.59 (0.56)				
Total NPDS	0.81 (0.77)	0.80 (0.77)	0.60 (0.51)			
Discharge						
<i>Barthel Index</i>						
Admission	-0.83 (-0.86)	-0.87 (-0.90)	-0.50 (-0.50)	-0.49 (-0.51)	-0.85 (-0.85)	-0.73 (-0.72)
Discharge	-0.79 (-0.77)	-0.81 (-0.78)	-0.53 (-0.44)	-0.53 (-0.49)	-0.68 (-0.70)	-0.88 (-0.84)
<i>FIM Motor</i>						
Admission	-0.84 (-0.87)	-0.88 (-0.90)	-0.50 (-0.50)	-0.50 (-0.51)	-0.86 (-0.85)	-0.74 (-0.73)
Discharge	-0.81 (-0.81)	-0.82 (-0.78)	-0.53 (-0.44)	-0.54 (-0.50)	-0.68 (-0.71)	-0.88 (-0.85)
<i>FIM Cognitive</i>						
Admission	-0.60 (-0.52)	-0.63 (-0.55)	-0.35 (-0.30)	-0.77 (-0.74)	-0.45 (-0.42)	-0.52 (-0.47)
Discharge	-0.62 (-0.52)	-0.63 (-0.60)	-0.40 (-0.32)	-0.74 (-0.70)	-0.45 (-0.41)	-0.60 (-0.54)
<i>FIM+FAM Motor</i>						
Admission	-0.85 (-0.87)	-0.88 (-0.90)	-0.51 (-0.50)	-0.50 (-0.52)	-0.85 (-0.85)	-0.74 (-0.73)
Discharge	-0.82 (-0.80)	-0.83 (-0.82)	-0.54 (-0.45)	-0.55 (-0.50)	-0.70 (-0.73)	-0.89 (-0.86)
<i>FIM+FAM Cognitive</i>						
Admission	-0.67 (-0.60)	-0.70 (-0.63)	-0.40 (-0.34)	-0.77 (-0.76)	-0.53 (-0.51)	-0.58 (-0.54)
Discharge	-0.66 (-0.58)	-0.68 (-0.60)	-0.43 (-0.32)	-0.76 (-0.73)	-0.49 (-0.57)	-0.65 (-0.61)

*Note: n ranges from 490 to 565. All correlations are significant $p < 0.01$ (2-tailed).

NPDS: Northwick Park Dependency Scale; BCN: Basic Care Needs subscale for the NPDS; SNN: Special Nursing Needs subscale of the NPDS; RCH: Nursing/care hours (9); FIM: Functional Independence Measure; FIM+FAM: Functional Independence and Functional Assessment measures.

Comparison with the BI and FIM confirmed a close relationship between the 3 scales based primarily on the similarity of these other two scales with the BCN section of the NPDS. The physical and cognitive items of the BCN mapped broadly onto the motor and cognitive elements of the FIM+FAM, confirming that the NPDS provides information on cognitive or behavioural problems in addition to detailing the nursing support that is needed for physical functioning, and in this respect it has a modest advantage over the BI. High correlations between the admission NPDS and discharge FIM and BI suggest that the NPDS admission scores may also have predictive value as an indicator of outcome, in a similar fashion to the FIM (26).

One of the key differences between the NPDS and these other scales is the additional SNN section, which describes the needs for more specialized nursing support, such as tracheostomy, wound care or 1-to-1 nursing. Evidence from observational studies confirms that, when these needs arise, they have considerable impact on nursing time and skills (13), and these are important for the purposes of planning staffing provision in relation to caseload, as they are generally tasks that require input from a qualified nurse (14). We expected, and indeed found, a weaker relationship between item and total scores for this section of the scale, and with the BI and FIM, confirming that it is indeed measuring something different. Even in this large and relatively complex sample, the item frequencies were low for some items in this section (notably one:one special nursing), which will have affected the overall item total-correlations.

The SNN section is thus both conceptually and structurally different from the BCN and on a practical clinical level it is appropriate to present the scale totals separately. Our more recent work has demonstrated that it may be more appropriate to rate the SNN

items on a graded rather than a dichotomous scale (13, 14), and work is now underway to develop a Likert scaling structure for the SNN subscale. In the meantime, in view of the strong correlation between the two subscales (0.56, $p < 0.01$), it appears reasonable to sum the two sections to yield a total NPDS score as an overall indicator of how dependent the person is on nursing support.

A further point of potential added value for the NPDS is its direct translation into an assessment of care hours. The BI and FIM are both shown to correlate with care hours on a population level (13, 14), but cannot be used to measure them directly as they do not assess the number of people required to assist with the task or the time taken to complete it. Part of the potential added value of the NPDS is its algorithm to calculate the impact of reduced dependency on care hours and costs at the level of the individual. Further research is required to define the differential calculations for care hours in different settings and to evaluate them internationally in different health cultures (13, 14). However, this may be one of the reasons for the growing popularity of the NPDS in the UK.

Limitations of the study

The authors recognize a number of limitations to this study:

- The sample reflects the practice of a single rehabilitation unit, which may limit the generalizability of the results, particularly as it is a tertiary centre with a more dependent caseload than may be expected in a typical rehabilitation service.
- NPDS scores were chosen to match the period of scoring for the FIM/BI scores as closely as possible, but may not always have coincided exactly
- NPDS scores were collected by the patient's named nurse, so that very many different raters contributed to the dataset over

Table VI. Psychometric evaluation of the Northwick Park Dependency Scale (NPDS) according to the Medical Outcomes Trust framework

Attribute	Criteria	Evaluation
Conceptual and measurement model	<i>The rationale for and description of the concept and the populations that the measure is intended to assess</i>	
	Clinical content and design	A 23-item ordinal rating scale to quantify an individual's needs for nursing care and support – particularly highly dependent patients. Subscales: BCN 16 items (range 0–65) and SNN 7 items (0–35). Total score range 0–100. Translates by a computerized algorithm into an assessment of care hours, and costs of care in the community – the NPCNA (12).
	Dimensionality	Principal component analysis demonstrates a strong general “dependency” factor within the BCN subscale, with two major specific factors (“Physical Care needs” and “Cognitive/Behavioural needs”) (see Results section, this article).
Reliability	<i>The degree to which the instrument is free from random error</i>	
	Internal consistency and homogeneity	Cronbach's alpha: for the full 23-item NPDS scale (alpha=0.90); for the 16-item BCN scale (alpha=0.93) (this article). For the 7-item SNN scale alpha=0.50 (reflects lower positive score rates for these items). Item-total correlations: BCN section: 0.34–0.88; SNN section 0.18–0.31 (also reflects lower positive score rates for these items).
	Reproducibility	Inter-rater reliability: 3 studies report reliability correlations (>0.80) for the full NPDS score and the BCN scale (4, 8, 12). (See Table 1) 2 studies reported correlations for the SNN scale (0.48–0.80) (8, 12). Agreement: 3 studies reported absolute agreement for individual items (39–100%); unweighted kappa 0.63–1.0 (4, 8, 12).
Validity	<i>The degree to which the instrument measures what it purports to measure</i>	
	Content	Within developmental design – based on clinicians' expert opinion, and several rounds of observed activity analysis (13) and work sampling in a hospital setting (14).
	Criterion-related	Not testable – no accepted gold standard currently exists.
	Construct	Five studies reporting high correlations (0.83–0.95) between BCN and/or total NPDS scores with the BI (5, 6, 8, 12) (this article); and between the BCN and FIM (4). Moderate correlation in present study between SNN scale and Barthel Index (0.50).
Discrimination and Responsiveness	<i>Ability to detect change over time where real changes occur</i>	
	Change: admission to discharge	Discriminates among people with different levels of dependency (coefficient δ 0.99) (this article). Responsive to change over time, particularly in the higher dependency groups (effect –size 1.9–3.3) (see Table IV) (this article).
Interpretability	<i>The degree to which easily understood meaning can be assigned to the quantitative scores</i>	
	Clinical meaning	Nurses preferred the NPDS over the BI because it provided “better, information about the actual need for care of the patients” (5, 9).
Burden	<i>The time, effort or other demands of administering the instrument</i>	
	Time to administer	The mean time to complete the NPDS for an experienced user was under 5 min ($n=22$ patients) (8).
Alternative modes of administration		A self-report version for patients and their carers is currently undergoing testing.
Cultural and language adaptations		Swedish (4) and Dutch (6).

BCN: Basic Care Needs subscale of the NPDS; SNN: Special Nursing Needs subscale of the NPDS; FIM: Functional Independence Measure; BI: Barthel Index; NPCNA: Northwick Park Care Needs Assessment.

the years. Whilst this could have reduced the consistency of data collection it has the advantage of being reflective of real-life clinical practice.

- It is to be noted that 4 of the 5 evaluations in the literature, as well as our own, were all conducted in neurorehabilitation settings. The NPDS, like the FIM and BI, is designed to be applicable to the wider disabled population (and indeed is quite widely used in general care of the elderly settings in the UK). Further evaluation is required in these more general rehabilitation settings.

Notwithstanding these limitations the study demonstrates the NPDS to be a reliable scale that discriminates well among people with different levels of nursing dependency, and offers a broader range of information on special nursing needs (including support for cognitive and behavioural problems) than other commonly-used disability measures.

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