ASSESSMENT PROCEDURE

The Northwick Park Therapy Dependency Assessment scale: a psychometric analysis from a large multicentre neurorehabilitation dataset

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Abstract

Purpose: To assess the internal reliability, construct and concurrent validity and responsiveness of the Northwick Park Therapy Dependency Assessment (NPTDA) scale. *Method*: A cohort of 2505 neurorehabilitation patients submitted to the UK Rehabilitation Outcomes Collaborative database. Cronbach's coefficient-α was used to assess internal reliability and factor analysis (FA) to assess construct validity. We compared NPTDA scores at admission and discharge to determine responsiveness. *Results*: Coefficient-α for the whole scale was 0.74. The exploratory FA resulted in a four-factor model (*Physical*, *Psychosocial*, *Discharge planning* and *Activities*) that accounted for 43% of variance. This model was further supported by the confirmatory FA. The final model had a good fit: root-mean-square error of approximation of 0.069, comparative fit index/Tucker–Lewis index of 0.739/0.701 and the goodness of fit index of 0.909. The NPTDA scores at admission and discharge were significantly different for each of the factors. Expected correlations were seen between the admission scores for the NPTDA, the Rehabilitation Complexity Scale ($r = 0.30$, $p < 0.01$) and the Functional Independence Measure ($r = -0.25$, $p < 0.01$). *Conclusions*: The scale demonstrated acceptable internal reliability and good construct and concurrent validity. NPTDA may be used to describe and quantify changes in therapy inputs in the course of a rehabilitation programme.

➤ **Implications for Rehabilitation**

- The Northwick Park Therapy Dependency Assessment (NPTDA) is designed as a measure therapy intervention, which reflects both quantitative and qualitative aspects of the inputs provided (including staff time and the different types of intervention) during inpatient rehabilitation.
- The scale demonstrated acceptable internal reliability and good construct and concurrent validity.
- NPTDA is responsive to change in the therapy inputs provided during neurorehabilitation between admission and discharge.

Introduction

The diversity of patients' needs for therapy and rehabilitation following neurological illness or injury is well recognised, but there is a scarcity of standardised tools for collating information

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on the therapy needs of patients with complex neurological disability or the inputs provided to meet those needs. This information is important for planning services that are truly responsive to the individual patient's needs [1,2]. The most frequently studied populations are stroke and spinal cord injury rehabilitation patients, where the available tools record the inputs (activities provided), typically focussing on physical interventions, but failing to capture the full spectrum of disciplines involved in rehabilitation [3–10]. Few of the existing tools provide information at a level that can be used to quantify multidisciplinary inputs in a manner that can be used for costing services [11].

In countries such as the United States and Australia, casemix systems use the Functional Independence Measure (or FIM™ (Uniform Data Systems)) as a proxy for therapy needs [12].

However, for patients with complex neurological disabilities, physical dependency is not necessarily a good indicator of needs for therapy intervention [13]. Moreover, it is expected that therapy interventions will change over the course of a rehabilitation programme, not only in the quantity (or intensity) of input required but also in the focus for intervention. For example, in the early stages following a severe stroke or brain injury, much of the focus for intervention may be on restoring physical function, managing basic needs such as nutrition and tracheostomy weaning and working towards independence in basic self-care. Towards the end of the programme, however, the focus is expected to change towards discharge planning and community re-integration. It is pertinent therefore to have a tool that is practical to apply serially over time, which captures both the quantity and nature of therapy interventions provided by the whole multi-disciplinary team.

In England, the UK Rehabilitation Outcomes Collaborative (UK-ROC) database is a national clinical database that collates information on rehabilitation needs, inputs and outcomes for all patients admitted for in-patient specialist multidisciplinary rehabilitation programmes. Within the UK-ROC dataset, the Northwick Park Therapy Dependency Assessment (NPTDA) is used as a measure of therapy intervention [14,15]. The NPTDA records the types of intervention and staff time allocated (translated into hours per individual discipline) that form the major determinants of cost in rehabilitation. The development and initial validation of the NPTDA scale has already been described [14], but to date its scaling properties have not been fully explored.

The aim of this paper is to assess the psychometric properties of the scale in terms of factor structure, internal reliability and responsiveness in a large mixed neurorehabilitation sample. We also assess concurrent validity through exploring the relationship of the NPTDA with the UK-ROC needs and outcome scales.

Methods

Data source UK-ROC

The UK-ROC database was established in September 2009 at Northwick Park Hospital funded by a National Institute for Health Research Programme Grant [16,17]. The dataset comprises inpatient-level, socio-demographic and clinical data, as well as information on:

- Rehabilitation needs (measured by the Rehabilitation Complexity Scale (RCS) [18])
- Inputs (measured by the Northwick Park Nursing (NPDS) and Therapy (NPTDA) dependency scales) [14,19,20]
- Outcomes, measured by the UK Functional Assessment Measure (UK FIM + FAM) [21,22], which incorporates the FIM version 4 [23].

Formal data collection started from January 2010, initially on a voluntary basis. Since April 2013, data collection of the UK-ROC dataset is mandated as a requirement for commissioning for all level 1 and 2 specialist neurorehabilitation rehabilitation services in England.

Requirements for UK-ROC registration stipulate collection of RCS scores fortnightly through the course of admission. Nursing and therapy dependency scores are collected at minimum in a series of cross-sectional tranches of all patients in the unit to yield 100 data pairs per annum (i.e. in a 25 bed unit a single cross sectional tranche would yield 25 ratings, so a series of at least four would be required per year to provide a representative cross-sectional sample of the units caseload at any one time). However, many units find the dependency tools useful for clinical monitoring and record them routinely at fortnightly intervals alongside the RCS. UK FIM + FAM scores are collected on admission and discharge. There is no formal accreditation process for use of the

tools, but all registered units have received training in their application, delivered through a series of regional and centralised workshops. Contributing centres also have free access to the regular UK-ROC training courses for updating and training new users.

Measures

The NPTDA is designed as a measure therapy intervention, which reflects both quantitative and qualitative aspects of the inputs provided (including staff time and the different types of intervention) during inpatient rehabilitation. It comprises 30 items grouped into seven domains [14] to reflect the multi-dimensional nature of multidisciplinary therapy inputs.

- Domains A–E comprise 22 items each rated on a scale of 0–4, recording direct hands-on patient care.
- Domain F comprises four items recording indirect patient-related care (multi-disciplinary meetings, report writing, etc) each on a scale of 0–2.
- Domain G is a checklist only, recording use of facilities and equipment for rehabilitation.
- The total range of the score (domains A–F) is 0–100 (item 2 ''Splinting/orthotics'' is scored double being divided into 2a ''upper limb'' and 2b ''lower limb'', counting therefore for a maximum score of 8).

Each patient is rated individually on the basis of inputs provided over a one-week period. The UK-ROC software applies a computerised algorithm that translates raw NPTDA item scores into an estimation of therapy hours per week for each discipline involved. The development of the scale and the algorithm for calculation of therapy hours has been previously published [14].

Other measures used in this analysis were the RCS version 8 and the FIM component of the UK FIM + FAM. These were used to describe the population in terms of overall complexity of rehabilitation needs and levels of functional independence at admission and discharge for rehabilitation. There is no gold standard against which to determine the validity of the NPTDA, but its relationship with complexity and functional independence was used to provide an overall indicator of concurrent validity.

The RCS is a measure of rehabilitation complexity in terms of care, nursing, therapy and medical requirements [24]. It is a simple four-item scale, which is recorded on a fortnightly basis including at admission and discharge. In clinical practice, the information is used to identify the current casemix on the ward, to plan admissions and to support reimbursement based on a system that is weighted for complexity [11]. Although the RCS has subsequently been extended to versions 12 and 13 [25], version 8 can still be derived from these later versions. In this analysis, we used RCS version 8 [18] as it was common to all assessments during timeframe from which this sample was drawn. As the RCS identifies the overall complexity of rehabilitation needs, we expected to find a moderate positive correlation with the NPTDA, which measures specifically therapy input.

The UK FIM + FAM allows an assessment of a patient's functional gains during the episode of care, between admission and discharge. For the purpose of this analysis, we extracted the FIM score because this is widely used and understood by rehabilitation professionals. The FIM is 18-item scale composed of 13 motor and 5 cognitive items each rated on a seven-level scale with a total range of 18–126. We did not expect to find a close relationship with the NPTDA because, as noted above, physical dependency is not the only (or even the main) determinator of rehabilitation needs. Nevertheless, we expected to find weak–moderate negative correlations between the FIM and the NPTDA scores.

Sampling and data analysis

To assess the psychometric properties of the NPTDA scale, we extracted the consecutive cohort of all patients admitted to specialist rehabilitation services within England reporting data to UK-ROC between 1.1.10 and 30.11.12, for which an NPTDA score was available at admission and/or discharge from the hospital. The dataset comprised 2505 patients in 49 neurorehabilitation centres (representing approximately 82% of the total number of services reporting data during this study period).

As the FIM, NPDS and NPTDA, all generate ordinal data; non-parametric techniques should technically be used for comparing differences. On the other hand, factor analysis (FA) uses parametric assumptions. Given the large size of the dataset and the fact that the distribution of data was within acceptable limits of normality, parametric techniques (paired T tests) were used to describe differences between admission and discharge and p values <0.01 were considered statistically significant. Alternative analyses using non-parametric techniques gave similar results, however, and are available on request from the authors.

For the purpose of FA, we required two similar samples that spanned the range of NPTDA scores in all items. As we anticipated that admission scores would be systematically different from discharge scores, the admission and discharge ratings were pooled into one dataset, which was then randomly split into two halves using the randomisation facility within SPSS for our exploratory and confirmatory analyses.

The combined total set consisted of $N = 3921$ ratings – 2103 were recorded at admission and 1818 at discharge; 1418 patients had NPTDA ratings recorded at *both* admission *and* discharge. After cleaning to delete all records with missing information on individual NPTDA items, 3764 ratings remained in the sample (2017 admission and 1747 discharge ratings), amounting to 4.1% loss of records. This dataset was randomly split into two halves, each of $n = 1882$ NPTDA scores. To confirm successful randomisation, we used independent sample t tests to confirm that the mean total NPTDA scores for two samples were not significantly different – as indeed they were not (mean (SD), 18.7 (9.5) versus 18.4 (9.7), $p = 0.879$).

The first sample of NPTDA ratings ($n = 1882$) was used for the exploratory principal component analysis. To assess internal reliability, we calculated the corrected item-total Pearson correlations and Cronbach's coefficient-α for the whole 22-item scale. A coefficient-α between 0.70 and 0.95 is considered to reflect good internal consistency. An item correlation value above 0.2 or 0.3 indicates that the corresponding item does correlate with the scale overall [26]. We used the 22 NPTDA ordinal scale items in domains A–D for the FA. We excluded domains F and G, which are not designed to be scalable in the same way as the direct hands-on therapy items. On the assumption of a correlation between factors, we employed an oblique (i.e. Promax) rotation for the principal components [27,28]. To determine the number of factors extracted in the analysis, we used Gorsuch's criterion: i.e. a latent factor was defined by at least three items with factor loadings of 0.40 or greater [29]. We did not expect to find a high degree of homogeneity within the scale, but we were interested to know whether the intuitive division into five domains was borne out by FA.

The second sample of NPTDA ratings ($n = 1882$) was used to perform confirmatory FA using the Statistical Package for the Social Sciences AMOS (version 21.0., IBM SPSS AMOS, Armonk, NY). Goodness of fit was assessed with five indices: p value (best if chi-square/df ratio less than 2.0, $p > 0.05$), root-mean-square error of approximation (RMSEA; best if 0.05 or less, values as high as 0.08 represent reasonable fit), comparative fit index/Tucker–Lewis index (CFI/TLI) and goodness of fit index

(GFI; values range from 0.00 to 1.00 for the last three indices, best 0.90 or higher values) [30]. Due to the large sample size, the chi-square difference test was not considered a relevant fit index. All statistical analyses were carried out using IBM SPSS Statistics, (version 21.0., Armonk, NY).

Ethics

The UK-ROC programme is registered as a Payment by Results Improvement Project. It collates only de-identified data, gathered routinely in the course of clinical practice and analysed as part of service evaluation, which does not require ethics permission in the UK.

Results

Table 1 lists the characteristics of the study population ($n = 2505$ patients). It consisted of adults of predominantly working age (mean 50.9 years (SD 15.9), with a male to female ratio of 3:2 and an average length of stay 83.3 d (SD 77). Approximately, two-thirds of the population had acquired brain injury (of any cause), with the remaining third composed of progressive neurological conditions (9.7%) spinal cord injury (7.6%); peripheral neuropathies, e.g. Guillain–Barré syndrome, critical illness neuropathy, etc. (4.6%), and other conditions (6.9%). There were statistically significant differences between admission and discharge for the RCS and FIM scores ($p < 0.0001$) in the expected directions. Complexity scores reduced and independence scores increased over the course of admission. No significant difference was seen between admission and discharge in the total NPTDA score and total therapy hours, indicating that the overall quantity of therapy input was similar during the first and last weeks of the programme.

Table 2 lists the descriptive statistics for each item in the NPTDA scale based on the first randomly split sample of NPTDA ratings ($N = 1882$). Although the item-total correlations ranged from 0.15 to 0.49, with less than 50% being above 0.30, the full 26-item NPTDA scale Cronbach's coefficient-α was within the limits for acceptable internal consistency at 0.76.

Principal component analysis of the 22 NPTDA items revealed seven factors with eigenvalues >1.0. However, inspection of the Scree plot showed a break after the fourth factor suggesting that a four-factor model was the best according to Gorsuch's criteria – these accounted for 43% of the total variance. The factors have been labelled as follows: (1) *Physical* (eight items with five loading over 0.5), (2) *Psychosocial* (five items, all with loadings over 0.5), (3) *Discharge planning* (five items with three loading over 0.5) and (4) *Activities* (four items with two loading over 0.5). Although the item ''speech/language'' loaded highest onto the Activities factor, it also loaded significantly (>0.3) onto the Physical factor, and it was assigned to the latter on the basis of best clinical fit. For all 22 NPTDA items included in the exploratory analysis, coefficient-α was 0.74. The corresponding values for the four factors are 0.71 for *Physical*, 0.71 for *Psychosocial*, 0.65 for *Discharge planning* and 0.48 for *Activities*. The correlations between factors ranged from 0.33 (*Activities* and *Psychosocial*) to -0.07 (*Physical* and *Discharge planning*).

To determine the reliability of the hypothesised four-factor model yielded by exploratory FA, the second randomly selected sample of NPTDA ratings ($N = 1882$) was examined using confirmatory FA. The model was specified to estimate each of the loadings on the four-factor hypothesised model (Table 2). Inspection of the modification indices suggested model fit would be significantly improved if ''speech/language'' was allowed to load on both the Physical and Activities factors. For the final model, the RMSEA was 0.069, CFI/TLI 0.739/0.701 and the GFI was 0.909. The final model supported the four-factor hypothesised structure of the NPTDA scale.

Table 1. Characteristics of the study population ($N = 2505$).

Characteristics			
Age, years, mean (SD) [range]	50.9 (15.9) [14–91]		
Length of stay, days, mean (SD) [range]	83.3 (77) [4–945]		
Male, n (%)	1517 (60.6)		
Diagnosis, n (%)			
Acquired Brain Injury	1602 (64.0)		
Stroke	786 (49.1)		
Traumatic	435 (27.2)		
Tumour	122 (7.6)		
Anoxia	101 (6.3)		
Inflammatory	60 (3.7)		
Other	98 (6.1)		
Progressive condition	242 (9.7)		
Spinal cord injury	191 (7.6)		
Peripheral neurology	116 (4.6)		
Other	173 (6.9)		
Unknown	184 (7.2)		

	Admission	Discharge	Paired t tests t/df/p value
Rehabilitation scores, mean (SD) [range]			
NPTDA total	18.1 (9.1), [0–57]	18.5 (9.9), [0–55]	−1.77/1415/(0.077)
NPTDA therapy hours			
Total hours per week	18.9 (16.4), [0–227]	18.4 (16.2), [0–214]	1.33/1415/(0.184)
RCS	10.4 (2.0), [2–15]	7.8 (2.9), [0–15]	41.37/1885/(<0.0001)
Care + medical + nursing	5.3 (1.6), [0–9]	3.6 (2.1), [0–9]	38.18/1885/(<0.0001)
Therapy	5.1 (0.9), [0–6]	4.2 (1.4), [0–6]	28.01/1885/(<0.0001)
FIM	67.1 (30.6), [18–126]	89.5 (32.2), [18–126]	−42.46/1656/(<0.0001)
FIM motor	44.7 (24.9), [13–91]	63.1 (26.1), [13–91]	−40.58/1650/(<0.0001)
FIM cognitive	22.5 (9.8), [5–35]	26.6 (8.7), [5–35]	−28.19/1658/(<0.0001)

NPTDA, Northwick Park Therapy Dependency Assessment Scale; RCS, Rehabilitation Complexity Scale; and FIM, Functional Independence Measure.

Although we did not necessarily expect the total amount of therapy input to be different between admission and discharge, we expected, and indeed found, changes within the individual items/subscales as the emphasis of the programme changed during the course of the programme. Table 3 lists statistically significant decreases of the NPTDA scores from admission to discharge within the first three factors, i.e. (A + B) *Physical* ($p < 0.0001$), (C) *Activities* ($p = 0.001$) and (D) *Psychosocial* ($p = 0.028$). However, within these three subscales, certain individual items increased towards discharge – namely Vocational activity (leisure) ($p < 0.0001$), Domestic (community) activity ($p = 0.001$) and Family support ($p < 0.0001$). The remaining factor (E) *Discharge planning* and the indirect patient care (F) additional activities, both show a significant increase in their scores ($p < 0.0001$) between admission and discharge.

Table 4 lists, as expected, the admission scores for the NPTDA scale were significantly correlated with the RCS scores ($r = 0.304$, $p < 0.001$) and FIM scores ($r = -0.249$, $p < 0.001$) although the correlation was modest. Correlations were higher with the physical part of the NPTDA scale, i.e. $r = 0.435$, $p < 0.01$ (RCS) and $r = -0.492$, $p < 0.01$ (FIM). As expected, the physical part of the NPTDA correlated strongest with FIM Motor $r = -0.462$, $p < 0.01$, while the psychosocial part of the NPTDA scale correlated strongest with FIM Cognitive $r = -0.217$, $p < 0.01$.

Discussion

This first psychometric analysis of the NPTDA scale demonstrates that it has satisfactory psychometric properties, in terms of internal reliability, responsiveness, concurrent and construct validity, for measuring multidisciplinary therapy interventions in neurorehabilitation. The exploratory FA revealed the 22 items grouped into four latent factors (1) *Physical*, (2) *Psychosocial*, (3) *Discharge planning* and (4) *Activities*.

As noted in the methods section, we did not expect to find a homogeneous scale, but were interested to explore to what extent the domain structure developed intuitively during the scale design was borne out by FA when the scale is applied in clinical practice. In fact, the fit was remarkably good.

- The first two domains (A and B) mapped almost exactly onto the ''Physical'' factor.
- Domain C loaded onto the ''Activities'' factor.
- Domain D loaded onto the ''Psychosocial'' factor.
- Domain E loaded onto the ''Discharge planning'' factor.

One item (Speech and language therapy) loaded significantly onto two factors – ''Physical'' and ''Activities'', with a cross-loading that differed by less than 0.2. It was placed within the Physical factor on the basis of best clinical fit. The item Domestic activities had a dominant positive loading on ''Activities'' and also a (lower value) negative loading on ''Physical'' factor. This is an interesting and expected result, as patients who are extremely physically disabled (i.e. requiring two or more skilled therapy disciplines to treat at any one time – most typically for postural management, etc.) are not likely to be engaged in therapy for domestic activities such as shopping, meal preparation, etc. as they are not at that level. Similarly, these interrelations probably explain the low coefficient-α for the ''Activities'' subscale as people needing to work on personal selfcare are less likely to be working on vocational activities at the same time. The four factors mapped exactly onto the original domains. Given the correlations between factors did not exceed 0.7 (i.e. −0.072 to 0.333), we concluded that there was adequate discriminant validity of the four-factor scale, i.e. the factors measure separate aspects of the

Table 2. Exploratory factor analysis – pattern matrix loadings for the hypothesised model (direct patient care) and confirmatory factor analysis – factor loadings.

Item (domain)	Range	Mean (SD)	Item-total correlations	First principal component	Factor 1 Physical (17% variance)	Factor 2 Psychosocial (12% variance)	Factor 3 Discharge planning (8% variance)	Factor 4 Activities (6% variance)	Factor 1 Physical	Factor 2 Psychosocial	Factor 3 Discharge planning	Factor 4 Activities
1. Medical (A)	0–4	1.44 (1.09)	0.26	0.429	0.542				0.522			
2. Splinting (A)	0–8	0.70 (1.32)	0.33	0.427	0.445				0.288			
3. Seating (A)	0–4	0.99 (1.18)	0.24	0.401	0.706				0.471			
4. Physical therapy (A)	0–4	2.58 (1.27)	0.22	0.347	0.585				0.408			
5. Tracheostomy (B)	0–4	0.14 (0.60)	0.13	−0.388	0.491				0.451			
6. Swallowing (B)	0–4	0.33 (0.79)	0.26	0.447	0.570				0.551			
7. Nutrition (B)	0–4	0.51 (0.94)	0.28	0.464	0.655				0.585			
8. Communication (B)	0–4	0.39 (0.93)	0.33	0.515	0.409				0.441			
9. Speech/language (B)	0–4	0.74 (1.11)	0.38	0.543	0.348			0.498	0.452			(0.187)
10. Personal/self-care (C)	0–4	1.11 (1.21)	0.32	0.404				0.429				0.259
11. Domestic activity (C)	0–4	0.76 (1.09)	0.21	0.516	(−0.313)			0.709				0.678
12. Vocational activity (C)	0–4	0.44 (0.88)	0.32	0.485				0.687				0.586
13. Cognitive (D)	0–4	0.93 (1.28)	0.23	0.372		0.552				0.440		
14. Behavioural (D)	0–4	0.31 (0.86)	0.34	0.510		0.827				0.617		
15. Emotional/mood (D)	0–4	0.60 (0.99)	0.39	0.516		0.696				0.586		
16. Family support (D)	0–4	0.48 (0.96)	0.47	0.606		0.562				0.517		
17. Emotional – staff (D)	0–4	0.54 (0.96)	0.49	0.653		0.746				0.677		
18. Discharge (E)	0–4	1.02 (1.27)	0.27	0.570			0.679				0.627	
19. Benefits (E)	0–4	0.33 (0.77)	0.33	0.424			0.491				0.507	
20. Equipment (E)	0–4	0.48 (0.91)	0.22	0.486			0.759				0.498	
21. Community (E)	0–4	0.43 (0.99)	0.15	0.485			0.609				0.443	
22. Key working (E)	0–4	1.07 (1.09)	0.39	0.418			0.417				0.505	
23. Meetings (F)	0–2	0.83 (0.91)	0.33									
24. Reports (F)	0–2	0.69 (0.83)	0.09									
25. Groups (F)	0–2	0.49 (0.76)	0.23									
26. Clinical attendance (F)	0–2	0.12 (0.44)	0.15									

NPTDA, Northwick Park Therapy Dependency Assessment; Extraction Method, Principal Component Analysis; Rotation Method: Promax; all loadings<0.3 removed for clarity. Domains: (A) physical/handling programme, (B) basic functions, (C) activities of daily living, (D) cognitive/psychosocial/family support, (E) preparing for discharge, (F) additional activities; (G) special input not shown.

Table 3. Descriptive statistics of the 26 NPTDA items: scores on admission and discharge and change scores ($N = 1418$).

Domain/Item *Factor*	Admission Mean (SD)	Discharge Mean (SD)	Mean difference	95% CI	Paired *t* tests		
					t	df	*p* Value
Direct patient care							
(A) Physical/handling programme (range 0–16)							
1. Medical (A)	1.69 (1.11)	1.18 (1.05)	0.51	−0.45 to 0.57	17.35	1417	<0.0001
2. Splinting (A)	0.68 (1.31)	0.62 (1.19)	0.06	−0.01 to 0.13	1.84	1365	0.066
3. Seating (A)	1.25 (1.26)	0.61 (0.96)	0.64	0.58 to 0.71	19.23	1365	<0.0001
4. Physical therapy (A)	2.89 (1.13)	2.16 (1.35)	0.72	0.65 to 0.79	19.49	1365	<0.0001
(B) Basic functions (range 0–20)							
5. Tracheostomy (B)	0.19 (0.70)	0.08 (0.43)	0.11	0.07 to 0.14	6.11	1365	<0.0001
6. Swallowing (B)	0.42 (0.87)	0.18 (0.58)	0.25	0.21 to 0.29	11.02	1416	<0.0001
7. Nutrition (B)	0.57 (0.99)	0.37 (0.80)	0.19	0.15 to 0.24	8.76	1416	<0.0001
8. Communication (B)	0.44 (0.95)	0.28 (0.75)	0.16	0.11 to 0.21	7.06	1416	<0.0001
9. Speech/language (B)	0.83 (1.13)	0.55 (0.96)	0.28	0.23 to 0.34	10.32	1416	<0.0001
Physical (A + B)	*8.17 (5.75)*	*5.45 (4.43)*	*2.73*	*2.46 to 2.99*	*20.45*	*1365*	*<0.0001*
(C) Activities of daily living (range 0–12)							
10. Personal/self-care (C)	1.35 (1.25)	0.84 (1.07)	0.51	0.43 to 0.58	13.81	1416	<0.0001
11. **Domestic activity (C)**	**0.74 (1.09)**	**0.85 (1.13)**	**−0.11**	**−0.18 to −0.04**	**−3.24**	**1416**	**0.001**
12. **Vocational activity (C)**	**0.33 (0.78)**	**0.51 (0.93)**	**−0.18**	**−0.23 to −0.12**	**−6.65**	**1416**	**<0.0001**
Activities (C)	*2.41 (2.24)*	*2.18 (2.19)*	*0.22*	*0.09 to 0.35*	*3.42*	*1416*	*0.001*
(D) Cognitive/psychosocial/family support (range 0–20)							
13. Cognitive (D)	1.11 (1.34)	0.85 (1.24)	0.26	0.18 to 0.33	6.94	1416	<0.0001
14. Behavioural (D)	0.36 (0.91)	0.29 (0.77)	0.07	0.03 to 0.12	3.10	1416	0.002
15. Emotional/mood (D)	0.61 (0.98)	0.62 (0.97)	−0.01	−0.06 to 0.05	−0.21	1416	0.83
16. **Family support (D)**	**0.44 (0.90)**	**0.54 (1.01)**	**−0.11**	**−0.16 to −0.05**	**−3.89**	**1416**	**<0.0001**
17. Emotional – staff (D)	0.51 (0.91)	0.54 (0.95)	−0.03	−0.08 to 0.02	−1.34	1415	0.18
Psychosocial (D)	*3.02 (3.45)*	*2.84 (3.32)*	*0.18*	*0.02 to 0.34*	*2.20*	*1415*	*0.028*
(E) Preparing for discharge (range 0–20)							
18. **Discharge (E)**	**0.57 (1.00)**	**1.52 (1.33)**	**−0.95**	**−1.03 to −0.88**	**−24.37**	**1416**	**<0.0001**
19. **Benefits (E)**	**0.19 (0.57)**	**0.49 (0.90)**	**−0.29**	**−0.35 to −0.25**	**−12.39**	**1416**	**<0.0001**
20. **Equipment (E)**	**0.22 (0.65)**	**0.71 (1.05)**	**−0.50**	**−0.55 to −0.44**	**−16.83**	**1416**	**<0.0001**
21. **Community (E)**	**0.22 (0.72)**	**0.70 (1.24)**	**−0.48**	**−0.55 to −0.41**	**−13.27**	**1416**	**<0.0001**
22. **Key working (E)**	**0.90 (0.99)**	**1.21 (1.15)**	**−0.31**	**−0.36 to −0.26**	**−11.48**	**1416**	**<0.0001**
Discharge planning (E)	*2.09 (2.37)*	*4.63 (3.59)*	*−2.54*	*−2.72 to −2.35*	*−26.49*	*1416*	*<0.0001*
Indirect patient care							
(F) Additional activities (range 0–8)							
23. **Meetings (F)**	**0.79 (0.91)**	**0.89 (0.91)**	**−0.09**	**−0.15 to −0.04**	**−3.48**	**1416**	**0.001**
24. **Reports (F)**	**0.34 (0.63)**	**1.12 (0.81)**	**−0.78**	**−0.83 to −0.73**	**−30.53**	**1416**	**<0.0001**
25. **Groups (F)**	**0.37 (0.66)**	**0.66 (0.84)**	**−0.29**	**−0.34 to −0.25**	**−13.50**	**1416**	**<0.0001**
26. **Clinical attendance (F)**	**0.12 (0.44)**	**0.15 (0.47)**	**−0.03**	**−0.06 to −0.01**	**−2.08**	**1416**	**0.038**
Total (F)	1.62 (1.46)	2.82 (1.78)	−1.20	−1.30 to −1.11	−24.09	1416	<0.0001

NPTDA, Northwick Park Therapy Dependency Assessment.
Items for which therapy inputs increase from admission to discharge are shown in bold.
Italics are shown the total scores from admission to discharge within the four factors.

interventions in rehabilitation. Although the exploratory FA supports the construct validity of the NPTDA scale, only 43% of the total variance was accounted for which is further evidence for the somewhat heterogeneous nature of the NPTDA items.

The four-factor structure has been further supported by the confirmatory FA, and the final model showed reasonably good fit. Of note, a RMSEA value of 0.069 has been achieved, which is indicative of a good fit model. Cronbach's coefficient-α for the whole scale, as well as for the restricted scale (22 items), was within the acceptable range. The corresponding values for the hypothesised four-factor model showed modest to acceptable reliability. This is consistent with the multidimensional structure of the NPTDA subscales with less than 50% of the item-total correlations >0.30. The factor with the lowest values for coefficient-α (i.e. Activities) corresponds to the original domains that exhibit inconsistency in the direction of change from admission to discharge within the individual items, as listed in Table 4 (Domain C).

The NPTDA scale has been evaluated in a previous study using a small sample of neurological patients. The content validity was ensured through an iterative process of serial analysis and reflection of an expert multidisciplinary rehabilitation team, and the concurrent validity of the scale was assessed by systematic comparison with the (actual) activity analysis expressed by therapy hours. Within this study, using a much larger multicentre patient sample with neurological disability, we have demonstrated that the NPTDA also detects change in therapy inputs over time. Encouragingly, the nature and direction of these changes resonates with clinical experience. For example, items in which the therapy inputs increased towards discharge include vocational and domestic activities, family support and all items related to discharge planning. These are typically activities that tend to occur during the latter stages of a rehabilitation programme.

We found relationships between the NPTDA scale and the RCS and FIM scales that confirmed our expectations and further supported the concurrent validity of the scale. However, as expected, the correlations were relatively low, suggesting that the scales indeed measure different aspects of patient rehabilitation inputs. A stronger correlation between the physical domain of the NPTDA and the FIM suggests that the FIM is a better predictor of

Table 4. Pearson correlations between NPTDA direct patient care with RCS and FIM based on total and subscales scores on admission.

	NPTDA Direct patient care (A + B + C + D + E)	Subscales			
		Physical (A + B)	Activities (C)	Psychosocial (D)	Discharge planning (E)
RCS	0.304*	0.435*	−0.153*	0.173*	−0.028
Care + medical + nursing	0.226*	0.360*	−0.196*	0.149*	−0.073*
Therapy	0.290*	0.346*	0.005	0.128*	0.069*
FIM	−0.249*	−0.492*	0.275*	−0.022	0.145*
Cognitive	−0.245*	−0.359*	0.172*	−0.217*	0.106*
Motor	−0.209*	−0.462*	0.265*	0.059**	0.132*

Domains: (A) physical/handling programme, (B) basic functions, (C) activities of daily living, (D) cognitive/psychosocial/family support, (E) preparing for discharge; RCS, Rehabilitation Complexity Scale; FIM, Functional Independence Measure.
*$p < 0.01$ and **$p < 0.05$.

the physical domain of therapy input than of the whole multidisciplinary therapy input. Again this is expected as the major focus of the FIM (13/18 items) is on motor (physical) disability, but it supports the contention that the NPTDA may provide a more holistic evaluation of multi-disciplinary input than simply using the FIM as a proxy for therapy intensity [12].

The authors recognise both some strengths and weaknesses of this study.

- The analysis included a large dataset gathered from 49 specialist units representing diverse teams and patients, which supports the generalisability of the findings. However, although all units have been offered training in use of the UK-ROC tools, the analysis was carried out on data from the early stages of development of the UK-ROC database, at a time when staff in many units were still familiarising themselves with the tools, which may have led to some scoring inaccuracy.
- Although the sample size exceeded the usual standards for FA, the FAs were carried out on two subsamples that were not independent; a preferable option would have been to use an independent sample for the confirmatory FA.
- As scoring of the NPTDA is not mandated for collection on admission and discharge, NPTDA scores were only available from a proportion of the sample, which could have led to a degree of selection bias.
- Finally, in relation to its psychometric properties, in the absence of an accepted gold standard, the criterion validity of the NPTDA tool established in this study cannot be definitive.

To conclude, the NPTDA has shown acceptable internal reliability, good construct and concurrent validity for measuring multidisciplinary therapy interventions in neurorehabilitation. It is responsive to change during neurorehabilitation between admission and discharge. The findings suggest that the NPTDA scale is a rehabilitation tool that provides useful and reliable estimates of multidisciplinary therapy interventions in patients with complex disability undergoing treatment in specialist neurorehabilitation settings.

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Declaration of interest

The authors report no declarations of interest.

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