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RESEARCH PAPER

The Rehabilitation Complexity Scale – extended version: detection of patients with highly complex needs

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***Purpose*: To describe the extended Rehabilitation Complexity Scale (RCS-E) and its factor structure, and to determine whether it provides added value over the RCS-version 2 to identify patients with highly complex rehabilitation needs. *Method*: A cohort analysis of prospectively-collected routine clinical data from 331 patients with complex neurological disabilities undergoing inpatient rehabilitation in a tertiary specialist neurorehabilitation unit in the UK. RCS-E and RCS-v2 scores were recorded in parallel by the multi-disciplinary team (MDT) at fortnightly intervals, alongside the Northwick Park nursing (NPDS) and therapy (NPTDA) dependency scales, capturing nursing care and therapy interventions in staff hours/week. *Results*: Very strong correlations were found between total RCS-v2 and RCS-E scores ($\rho = 0.954$); the RCS-E "Care & nursing" subscale and care/nursing hours/week ($\rho = 0.838$, $p < 0.001$); and the RCS-E "Therapy" subscale and total therapy hours/week ($p = 0.697$, $p < 0.001$). The RCS-E showed better discrimination for complex therapy needs than the RCS-v2, but not for complex care/nursing needs. The RCS-E factor structure was similar to the RCS-v2, with moderate internal consistency overall, separating into two distinct dimensions ("Nursing/medical care + Equipment" and "Therapy"). *Conclusion*: The RCS-E provides an equivalent measure of complexity to the RCS-v2, but offers added value in identifying patients with highly complex therapy and equipment needs.**

Keywords: Rehabilitation Complexity Scale – extended, complexity of rehabilitation needs, factor analysis

Implications for Rehabilitation

- Assessing complexity of rehabilitation needs presents a challenge throughout the world.
- The Rehabilitaton Complexity Scales provide a simple measure of complexity of rehabilitation needs, which take account of basic care, specialist nursing, therapy and medical interventions.
- The extended version (RCS-E) presented here may offer a more sensitive tool for detecting patients with highly complex needs for therapy and equipment in specialist rehabilitation settings.

Introduction

Assessing the complexity of rehabilitation needs presents a considerable challenge throughout the world. In the US, Canada, Australia, and many parts of Europe, classifications of rehabilitation complexity have relied on physical dependency (measured by the functional independence measure (FIM [1]) or Barthel index [2]) as a surrogate for rehabilitation needs [3,4]. Although these classifications may work reasonably well where patients are medically stable and physical independence is the main target of intervention, they do not capture needs for medical or specialist nursing care, nor do they specifically address the need for cognitive, behavioural or other psychological interventions.

The Rehabilitation Complexity Scale (RCS) was designed to provide a simple measure of the complexity of rehabilitation needs and/or interventions, which is timely to apply and takes account of basic care, specialist nursing, therapy and medical interventions. It has since undergone further development as a casemix tool in the UK. A preliminary exploration [5] of the RCS (version 1) demonstrated that it was simple and practical for routine use across a range of specialist rehabilitation services. In a multi-centre cross-sectional analysis, it showed clear differences between tertiary (or "complex specialized") and secondary (or "district specialist") rehabilitation services, on the basis of their relative proportions of complex cases (and the staffing levels to cope with them [5]). Clinicians reported favourably on utility, content and face value, and based on the feedback received, the instrument was revised

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to form the RCS version 2 (RCS-v2). Detailed psychometric analysis demonstrated that the RCS-v2 provided a reliable, valid and moderately responsive profile of rehabilitation interventions, separating into two main subscales ("Nursing/medical care" and "Therapies"). It usefully identified medical and therapy inputs not captured by the FIM and Barthel Index – tools which are commonly used to define case complexity in rehabilitation [6]. However, clinicians working in tertiary specialist neuro-rehabilitation settings, reported the following problems with the RCS-v2:

1. ceiling effects were noted for patients with very complex needs – particularly within the therapy subscales.
2. it did not identify the need for special equipment/facilities,
3. the "Care" section did not capture the "Risk" or needs for supervision of patients who were ambulant but confused, for example in cognitive behavioural rehabilitation settings.

An extended version of the Rehabilitation Complexity Scale (the RCS-E) was developed to address the deficiencies. The objectives of this article are (a) to describe the RCS-E and its factor structure and (b) to determine whether it provides added value over the RCS-v2 in the detection of patients with highly complex rehabilitation needs.

Methods

Setting

The Regional Rehabilitation Unit at Northwick Park Hospital provides a tertiary post-acute inpatient specialist rehabilitation service for younger adults with severe complex neurological disabilities – including physical, cognitive, behavioural and/or communicative problems [7]. This setting was chosen because it has a high proportion of patients with complex needs.

Design

A cohort analysis of prospectively collected routine clinical data, collated through the UK Rehabilitation Outcomes Collaborative (UKROC) Database, which is a national clinical database for recording in-patient episodes for specialist neurorehabilitation across the UK. The database is funded by a programme grantfrom the UK National Institute of Health Research [8].

Measures

The full UKROC dataset includes information on patient demographics, response and waiting times, diagnosis/procedure codes, length of stay and discharge destination. It also includes a series of tools to capture (a) complexity of rehabilitation needs, (b) the inputs provided to meet those needs and (c) outcomes.

Within the dataset, complexity of rehabilitation needs is captured by the Rehabilitation Complexity Scales. Units have the option to record either or both versions of the scale. Table I summarizes the comparative content of the RCS-v2 and RCS-E, and details of the RCS-E are freely available from the corresponding author. The RCS-E is designed simply to extend the range of the RCS-v2, so that scoring levels 0–2 are identical. For score level 3 on the RCS-v2, the RCS-E offers the option of three or four, to extend the upper end of the score range. It also includes an item addressing the need for specialist equipment or facilities.

Rehabilitation inputs are captured by the Northwick Park Dependency scales. These are used to identify the rehabilitation resources provided in relation to caseload complexity.

- The NPDS [9,10] provides an assessment of care and nursing needs and translates by way of a computerized algorithm to an estimation of nursing and care staff hours per week [11].
- The NPTDA [12] is the therapy equivalent, which collates therapy inputs from the MDT and also translates by a computerized algorithm into an estimation of therapy hours per week for each discipline (including medical staff).

Application of measures

All measures are applied by the MDT at fortnightly intervals during the routine ward round/MDT meetings. The unit is the national training centre for application in the measures, so that all staff members receive formal training in their use and are updated on a regular basis.

During a 40-month period between 6 June 2006 and 7 September 2010, the RCS-v2 and the RCS-E were recorded in parallel. Data are entered at the time of collection into dedicated software (based on Microsoft Excel) which includes automated application of the computerized algorithms. Since 2009, all data have been uploaded into the UKROC Database software.

Analysis

Data were extracted, cleaned and transferred to SPSS version 19 for analysis. Descriptive statistics included median and inter-quartile ranges, as well as the minimum and maximum score range. Even though the RCS scales provide ordinal level data, means and SD were also calculated for comparability with other literature which gives both mean and median values [6]. One sample Kolmogorov–Smirnov (K–S) tests were used to test for normality. As the null hypothesis for normality was rejected on the majority of tests, non-parametric statistical tests were applied throughout.

Table I. The comparative content of the RCS and RCS-E.

	RCS-v2	Range	RCS-E	Range
C / R	Basic care	0–3	Basic care or risk	0–4
N	Special nursing needs	0–3	Special nursing needs	0–3
T	Therapy disciplines	0–3	Therapy disciplines	0–4
	Therapy intensity	0–3	Therapy intensity	0–4
Medical	Medical needs	0–3	Medical needs	0–3
E			Equipment/facilities	0–2
	Total	**0–15**	**Total**	**0–20**

- Spearman correlations (ρ) were used to examine the relationship between the RCS-E and the RCS-v2, and between the respective components of the RCS-E and the levels of nursing and therapy intervention.
- To determine whether the RCS-E provides added discrimination at the higher end of the relevant subscale, Mann–Whitney tests were used to compare care/nursing per week (as estimated by the NPDS algorithm) between patients scoring 6 and 7 on the combined RCS-E Care & Nursing (RCS-E C + N) subscale. Similarly, total therapy hours per week were compared between patients scoring 6, 7 and 8 on the combined RCS-E Therapy subscale (i.e. RCS-E TD + TI).
- To account for multiple tests (n = 4), a Bonferroni-type correct was made (i.e. 0.05/4), so that the threshold for significance was taken as p = 0.0125.

Factor structure was examined on the start of treatment (i.e. admission) RCS-E score for the 318 cases in which this was included in the sample period (13 patients were already well into their programme by the start of the study). Internal consistency was examined using Cronbach's alpha and item-total correlations in the reliability analysis module of SPSS. Dimensionality was examined using exploratory factor analysis, involving a principal component analysis with orthogonal (Varimax) rotation. Horn's method of Parallel Analysis was used as the objective criterion for how many factors to rotate [13]. Confirmatory factor analysis (CFA) was conducted on RCS-E data collected for the same patients at discharge, where scores were available (i.e. patients had been discharged by the end of the collection period (n = 306)), using the AMOS-16 structural equation software programme within SPSS. To test the factor structure identified in the exploratory factor analysis, we used multiple fit indices as recommended by Ullman (2001 [14]) including the Comparative Fit Index (CFI), the Goodness of Fit Index (GFI), the Normed Fit Index (NFI) and the Root Mean Square Error. Ullman (2001) advises that GFI values above 0.90 and CFI values above 0.95 indicate a good model fit.

Results

A total of 2241 valid ratings were obtained from 331 patients. The demographics of the patient population are shown in Table II. Descriptive statistics for complexity and dependency scores are shown in Table III. The data represented nearly the full range of both RCS-v2 and RCS-E scores, as shown in Figure 1. The RCS-E showed greater separation of complexity levels in the upper part of the scale, compared with the RCS-v2, in a pattern approximating more closely to a Gaussian distribution (skewness −0.163 compared with −0.385 for the RCS-v2). However, Kolmogorov–Smirnov tests showed the distribution of both scores to deviate significantly from normality (p < 0.05).

Table IV shows the correlations between the different scales. As expected, there was a very strong relationship between the total RCS-v2 and RCS-E scores (ρ = 0.954). There were also very strong correlations between the RCS-E C + N subscale and the total NPDS and care/nursing hours per week (ρ = 0.872 and 0.838, respectively); and between the RCS-E Therapy subscale and the NPTDA and total therapy hours per week (ρ = 0.708 and 0.697, p < 0.001). Weaker correlations were seen between the nursing and therapy elements of the RCS-E (ρ = 0.271), which were proportionate with the weaker relationship between the nursing and

Table II. Demographics of the study population (n = 331).

Mean age	44 years (SD = 15, range 15–80)	
Male/female ratio	199 male, 132 female	
Mean length of stay	98 days (SD = 64, Range 12–469)	
Diagnosis	Number	%
Acquired brain injury	269	81
Cerebrovascular accident	163 (61%)	
Traumatic	58 (22%)	
Anoxic	18 (6%)	
Other, e.g. inflammatory	30 (11%)	
Spinal cord injury	30	9
Peripheral nerve condition (e.g. Guillain–Barre syndrome, critical illness neuropathy)	28	9
Other	4	1

Table III. Descriptive statistics for complexity and dependency ratings across all time points of the sample (n = 2241).

	Mean (SD)	Median (IQR)	Range
Rehabilitation Complexity Scores			
RCS-v2			
Care (0–3)	1.4 (0.8)	1 (1–2)	0–3
Nursing (0–3)	2.2 (0.8)	2 (2–3)	0–3
Therapy disciplines (0–3)	2.8 (0.4)	3 (3–3)	1–3
Therapy intensity (0–3)	2.4 (0.6)	2 (2–3)	0–3
Medical (0–3)	1.8 (0.7)	2 (1–2)	0–3
Total (0–15)	10.6 (2.3)	11 (9–12)	2–15
RCS-E			
Care (0–4)	1.4 (0.9)	1 (1–2)	0–4
Nursing (0–3)	2.2 (0.8)	2 (2–3)	0–3
Therapy disciplines (0–4)	3.0 (0.7)	3 (3–4)	1–4
Therapy intensity (0–4)	2.6 (0.8)	2 (2–3)	0–4
Medical (0–3)	1.8 (0.7)	2 (1–2)	0–3
Equipment (0–2)	1.5 (0.7)	2 (1–2)	0–2
Total (0–20)	12.6 (3.0)	13 (11–15)	0–20
Northwick Park Dependency Scales			
NPDS scores (Nursing and care interventions)			
Basic care needs	20.7 (15.2)	17 (8–34)	0–55
Special nursing needs	3.7 (5.1)	0 (0–5)	0–30
Total NPDS	24.4 (18.7)	19 (9–39)	0–79
Estimated care hours per week	40.6 (20.0)	40 (26–60)	0–79
NPTDA scores (Therapy interventions)			
Total NPTDA	26.6 (7.4)	26 (22–31)	2–57
Estimated total therapy hours per week	22.2 (8.3)	21 (17–26)	2–95

RCS-v2, Rehabilitation Complexity Scale (version 2), RCS-E Rehabilitation Complexity Scale – extended, NPDS, Northwick Park Nursing Dependency Scale, NPTDA, Northwick Park Therapy Dependency Assessment.

therapy interventions as measured by the NPDS. However, in view of the very large number within this study, all correlations reached statistical significance at the level of $p < 0.001$.

Figure 2a shows the distribution of care/ nursing hours per week within each level of the relevant RCS-E C + N subscale. There was a clear plateau at the upper end, and patients scoring 7 ((n = 103) on the RCS-E C + N subscale did not have significantly higher care and nursing interventions than those scoring 6 (n = 85) (Mann–Whitney z = −1.8, two-tailed p = 0.072).

In contrast, Figure 2b shows the distribution of therapy hours per week within each level of the relevant RCS-E T subscale. Patients scoring 7 (n = 383) on the RCS-E TD + TI subscale had significantly higher levels of therapy interventions than those scoring 6 (n = 551) (z = −12.1, two-tailed $p < 0.001$). Similarly, patients scoring 8 (n = 241) on the RCS-E TD + TI subscale had significantly higher levels of therapy interventions than those scoring 7 (n = 383) (z = −8.4, two-tailed $p < 0.001$).

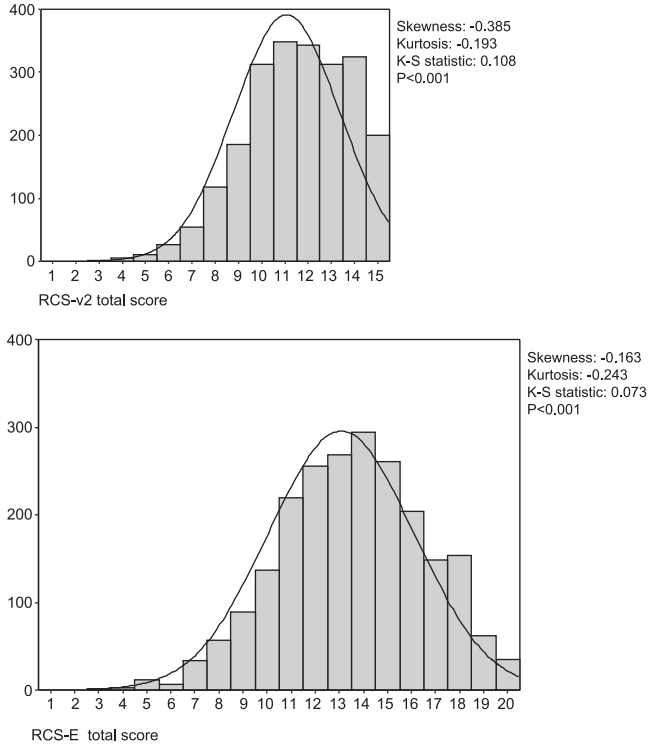


Figure 1. Distribution of total RCS and RCS-E scores.

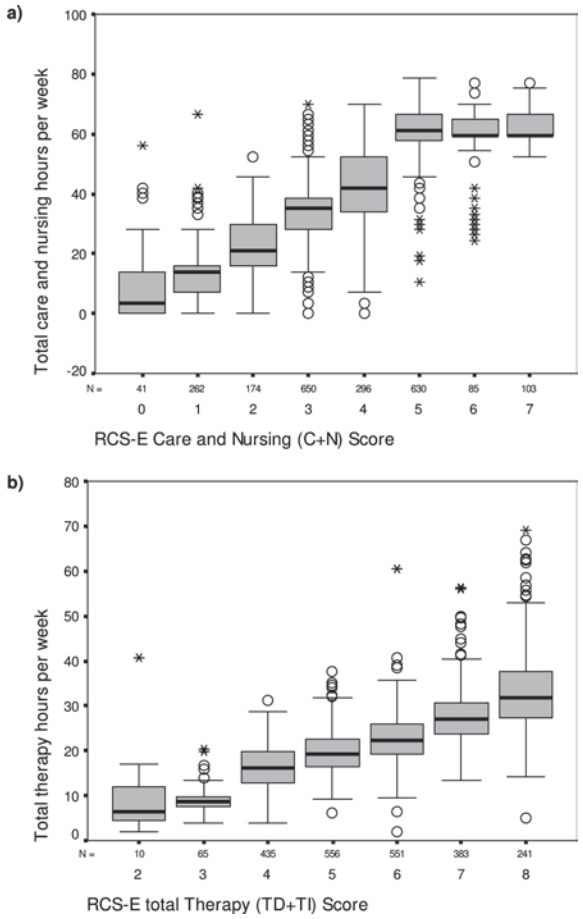


Figure 2. (a) Care hours per week within each level of the summed RCS-E Care and Nursing needs subscales. (b) Therapy hours per week within each level of the RCS-E therapy subscale (Therapy disciplines + intensity).

Table IV. Spearman correlations between the RCS-v2, the RCS-E and the Northwick Park Dependency Scale ratings (n = 2241).

	RCS version 2			RCS-Extended			NPDS		NPTDA
	C+N	TD+TI	Total	RCS-E C+N	RCS-E TD+TI	RCS-E Total	NPDS score	Care hours	NPTDA score
RCS-v2									
RCS C+N subscale									
RCS TD+TI subscale	0.215								
RCS total score	0.885	0.536							
RCS-E									
RCS-E C+N subscale	0.998	0.212	0.882						
RCS-E TD+TI subscale	0.271	0.913	0.549	0.268					
RCS-E Total score	0.834	0.592	0.954	0.833	0.662				
Northwick Park Dependency Scales									
NPDS total score	0.872	0.231	0.800	0.870	0.283	0.773			
Care/ nursing hours/week	0.838	0.201	0.752	0.836	0.248	0.727	0.916		
NPTDA total score	0.244	0.666	0.450	0.243	0.708	0.532	0.240	0.218	
Therapy hours per week	0.217	0.671	0.411	0.216	0.697	0.494	0.227	0.204	0.855

RCS-v2, Rehabilitation Complexity Scale (version 2); RCS-E: Rehabilitation Complexity Scale-Extended; C+N Care & Nursing subscale; TD+TI, Therapy Disciplines & Therapy Intensity subscale; NPDS, Northwick Park Nursing Dependency Scale; NPTDA, Northwick Park Therapy Dependency Assessment.

Table V. Results of principal components factor analysis with orthogonal rotation on the correlations of the six RCS-E items using start of treatment scores (n = 318).

	Un-rotated principal component loading		Varimax rotation orthogonal factor loading	
RCS-E item	Factor 1, Eigen value 2.2	Factor 2, Eigen value 1.4	Factor 1	Factor 2
Care (C)	0.80	−0.23	0.83	0.08
Nursing (N)	0.81	−0.22	0.83	0.09
Medical (M)	0.54	−0.26	0.60	−0.05
Therapy disciplines (TD)	0.29	0.83	−0.03	0.88
Therapy intensity (TI)	0.46	0.74	0.16	0.85
Equipment	0.58	−0.12	0.58	0.09

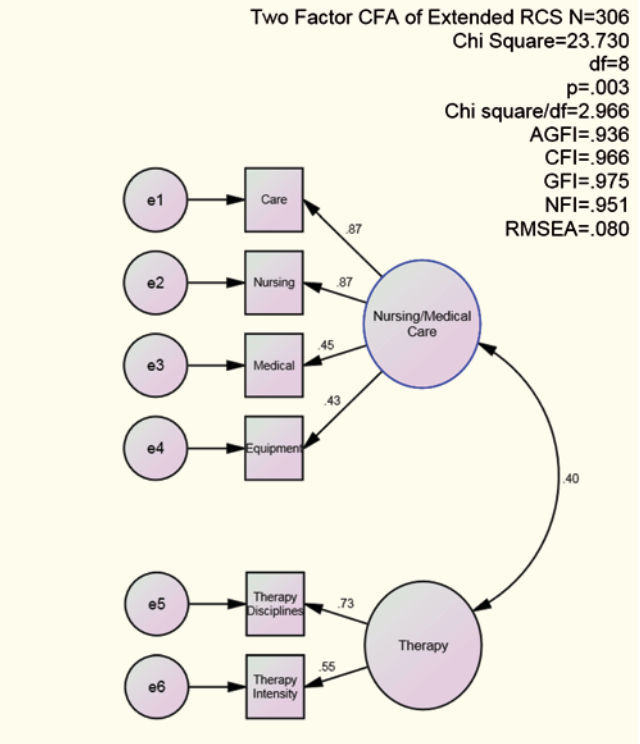
RCS-E, Rehabilitation Complexity Scale – extended.

Table V shows the results of a principal components factor analysis on the correlations of the RCS-E items. Chronbach's alpha for the total scale was 0.64. Item-total correlations ranged from p = 0.46–0.74. Only the first two components had Eigen values > 1, together accounting for 60% of the total variance in scores. Parallel analysis indicated a two factor solution, which was rotated using a Varimax procedure.

- The first factor appears to be "Nursing/medical" care, including equipment, which accounted for 37% of the variance. The C, N, M and E items all loaded high (0.58–0.83) on this factor and low (<0.1) on factor 2.
- The second factor appears to be "Therapy", accounting for 24% of the variance. The two therapy items (TD and TI) both loaded above 0.85 on this factor and low on factor 1.

Chronbach's alphas for these two subscales were 0.69 and 0.67, respectively

The results of the CFA suggested a relatively good fit to the two-factor model ($\chi^2 = 23.70$, df = 8, p = 0.003) with fit indices as follows: CFI = 0.97, GFI = 0.97, NFI = 0.95. Although the significant χ^2 value suggests a less than perfect fit, this index of fit is highly influenced by sample size. All three fit indices were well above 0.90 reflecting a good fit. The correlation between the Nursing/Medical care and Therapy factors was 0.40. These findings are summarized in Figure 3.



CFA = confirmatory factor analysis; df = degrees of freedom; AGFI = adjusted goodness of fit index; CFI = comparative fit index; GFI = goodness of fit index; NFI = normed fit index, RMSEA = root mean square error of approximation.

Figure 3. The results of a two factor confirmatory factor analysis of RCS-E scores at discharge (n = 306).

Discussion

In this cohort analysis from a tertiary specialist in-patient neuro-rehabilitation service, there was a very strong correlation between RCS-v2 and RCS-E data. The RCS-E showed better discrimination of patients with high requirements for therapy intervention above the ceiling of the RCS-v2. However, it did not provide any greater discrimination with respect to needs for staff time in relation to care and nursing. This latter finding is not entirely unexpected, because the higher scoring levels on the Nursing item for both scales relate to the level of specialist nurse experience and training, as opposed to staff time per se.

The factor structure of the RCS-E proved similar to the RCS-v2. That is, it showed moderate internal consistency, suggesting that the six subscales are broadly cumulative. Nevertheless, both exploratory and confirmatory factor analyses suggest that the scale has two distinct dimensions ("Nursing/medical care" and "Therapy"), the "Equipment" item being included within the former, rather than the latter. On the other hand, the five components each have differential impact for rehabilitation requirements and between them provide a profile of rehabilitation needs. Therefore, separate reporting of item scores (e.g. C2 N3 M2 T5 E2) is still recommended to facilitate clinical interpretation.

Containing only one item more than the RCS-v2, the RCS-E still took only 1–2 minutes to rate once the team was familiar with scoring, and was therefore feasible for use in routine clinical practice. Overall, the team preferred the RCS-E as it provided additional clinically important information with respect to therapy and equipment needs, for minimal additional rating burden.

The authors recognize a number of limitations to this study:

1. It was confined to a single centre with a particularly complex group of patients undergoing neurological rehabilitation. While it was pertinent to evaluate use of the RCS-E in a group where the RCS-v2 was shown to have ceiling effects, further work is now required to evaluate the RCS-E as a measure of rehabilitation needs across a broader range of conditions and rehabilitation settings.

2. Our CFA was undertaken on discharge scores from the same group of patients as the exploratory factor analysis. Even though the two sets of scores were demonstrated to be significantly different, the results must be interpreted with caution and further confirmatory analysis is required in different patient groups to confirm the factor structure of the RCS-E.
3. In this analysis, we have not explored the performance of the scale when "Risk" is recorded as opposed to "Care". Further evaluation is now required in cognitive behavioural rehabilitation settings, where Risk forms a more important indicator of the needs for intervention than the requirement for physical assistance.

In summary, in this first evaluation, the RCS-E was shown to offer added value over the RCS-v2 in the identification of patients with highly complex therapy and equipment needs, for minimal additional scoring burden. The findings suggest that it has the potential to offer a more sensitive evaluation of rehabilitation complexity in specialist settings carrying a highly complex caseload. Further evaluation is now warranted in other patient groups and settings, and we anticipate that data gathered through the UKROC database will provide opportunities for future multi-centre evaluations. In the meantime, this preliminary analysis will assist contributing centres to understand the differences (and similarities) between the two scales, and inform their choice of which scale to use, depending on the complexity of their caseload.

Acknowledgements

The authors gratefully acknowledge the hard work of the RRU staff in collecting the data presented in this study, and the co-operation of the patients to whom it belongs. Special thanks to Jo Clark, Sarah Harris, Hilary Rose and Aung Thu, for their roles in co-ordinating data collection. Copies of the Rehabilitation Complexity Scales (RCS-v2 and RCS-E), and indeed the NPDS and NPTDA, are available free of charge from the corresponding author. The Regional Rehabilitation Unit gathers this outcome data routinely in the course of clinical practice. Research Ethics Committee permission has been obtained to report the data retrospectively for research and audit purposes.

***Declaration of interest*:** Outcome measurement is a specific research interest of our centre. The Rehabilitation Complexity scales and Northwick Park nuring and therapy Dependency Scales were all developed through this department, but are disseminated free of charge. Professor Turner-Stokes is lead author on the papers which describe their initial development and validation. However, none of the authors has any personal financial interests in the work undertaken or the findings reported. This article presents independent research commissioned by the National Institute for Health Research (NIHR) under its Programme Grants for Applied Research funding scheme (RP-PG-0407-10185). The views expressed in this paper are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health. Financial support for the preparation of this manuscript was also provided by the Dunhill Medical Trust, the Luff Foundation.

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