

THE DEVELOPMENT, VALIDITY AND RELIABILITY OF THE HOSPITAL IN THE HOME DEPENDENCY SCALE (HDS)

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ABSTRACT

The aim of this study was to develop and investigate the validity and reliability of the Hospital-in-the-Home (HITH) Dependency Scale (HDS). The HDS is a new instrument designed to measure the dependency of HITH patients. It calculates an overall dependency level by rating four dimensions of the provision of HITH nursing care. Specifically, these dimensions are the complexity of assessment, complexity of treatment, time taken to provide the treatment, and the frequency of treatment. The results of testing the HDS suggest that it is valid in measuring adult medical and surgical HITH patient dependency. The scale demonstrated strong stability over time in test retest procedures over a one month period ($r = 0.80$, $p < 0.01$) and internal consistency (Cronbach's $\alpha = 0.72$). We conclude that the HDS is a valid, reliable instrument that is quick and easy to use in the HITH setting.

INTRODUCTION

For many years the measurement of patient acuity and dependency has been undertaken in the hospital setting utilising a variety of instruments. The needs for such measurements stem from various clinical and administrative sources including; the prediction of the chances of survival of a critically ill patient; the determination of nurse staffing requirements; resource allocation and the assessment of appropriateness of care. More recently the advent of new treatment options, such as hospital in the home (HITH) programs, has highlighted the need for new instruments to objectively capture the acuity and dependency of patients treated in such programs. When existing measures, such as the Appropriateness Evaluation Protocol (Gertman and Restuccia 1981) are applied to HITH patients, they have been found to lack the necessary sensitivity required to accurately capture the characteristics of these patients and unique elements of their care in the home setting.

LITERATURE REVIEW

Endacott and Chellel (1996) describe nursing dependency as the total patient need for nursing attention, including education, rehabilitation and psychological care. A number of other studies focus alternatively on patient dependency that involves the patient's ability to care for him or herself or the extrapolation of costs based on degree of resource utilisation as a function of patient care needs (Walker and Whyne 1990; Stillwell and Haley 1993).

A range of instruments have been developed to assess nursing dependency in specific conditions, such as, the cardiac illness dependency instrument (Riegel et al 1997) and in various settings including: the Therapeutic Intervention Scoring System (Cullen et al 1974) in the intensive care unit. The *Excelcare* system (Mason 1991) has been developed for the acute in-patient setting, the Northwick Park Dependency Score (Turner-Stokes et al 1998) in the rehabilitation setting and the Omaha problem classification system in the community setting (Helberg 1994). Each of these instruments has limitations when applied to the HITH setting. Further more, a number of studies have highlighted limitations of instruments such as the Appropriateness Evaluation Protocol (AEP) in the evaluation of ambulatory care nursing dependency (Lang et al 1999; Mozes et al 1996). Some studies have undertaken the development of alternative measures of nursing dependency which may be applicable for use in a home care environment, (Corless et al 1994; Halloran and Corless 1994; Carr-Hill and Jenkins-Clarke, 1995) however, few of these measures have undergone rigorous reliability and validity assessment.

Riegel et al (1997) conducted a factor analysis of a 25-item instrument used to measure cardiac illness dependency. On the basis of this factor analysis, the 25 items were divided into four primary areas – attention, reassurance, concern and assistance. These four factors accounted for 57.4% of the variance in scores.

Carr-Hill et al (1995) reported the findings of a comparison of four nursing workload measurement systems used in the acute care setting in the United Kingdom. The systems investigated included *Criteria for Care and South East Nursing System* which adopted a dependency level approach; the *Financial Information Project* which is based on a task orientated approach; and *Excelcare* which uses a care planning approach based on units of care. A simple comparison of the nursing workload measurement systems with the actual shift hours worked showed wide variations and, although there were quite high correlations between the estimates of over/understaffing from each of the systems and per capita hours worked, there was no obvious pattern. The authors concluded that dependency, as measured by these four systems, was a poor predictor of actual hours worked.

A study conducted by Turner-Stokes et al (1998) provides an evaluation of the Northwick Park Dependency Score (NPDS), a tool used in the rehabilitation setting at Northwick Park Hospital to assess impact on nursing time. Following a series of pilot tests, the NPDS was subjected to inter-rater and intra-rater reliability through an analysis of 21 patients by three senior nurses. Scores on the NPDS were collected on days one, three and seven. These reliability measures were calculated using a Spearman rank correlation. Inter-rater reliability provided a correlation of 0.9 ($p < 0.1$). Intra-rater reliability, assessed through a comparison of scores on day one and day three, was 0.93 ($p < 0.1$), indicating statistically significant reliability of the NPDS.

Helberg (1994) assessed the impact of nursing dependency on resource use by elderly home care patients. Nursing care requirements were measured through the use of the nursing classification index for home health care. This index identified 25 care activities and was scored by summing the total number of activities. A significant correlation was determined between measures of nursing dependency and duration and frequency of nursing visits ($p < 0.02$). However, nursing dependency was only found to account for 7% and 5% of the variation in number of nursing visits and days of nursing service respectively (both measures statistically significant, $p < 0.02$). Given the variables used to measure nursing dependency – mental status, physical activities of daily living, instrumental activities of daily living and coping ability – it appears that Helberg's definition of nursing dependency is more closely aligned with that of patient dependency.

Freeman et al (1999) reported on a nurse dependency tool developed in Wolverhampton, which aimed to provide an explanation of the caseload for individuals and teams working in district nursing services. This tool, which reflected the product of time per visit and frequency of visits, improved on the author's previous dependency measurement that was based on frequency of visits only. However, while this tool provided a total number of hours per patient, it did not differentiate the complexity of care being delivered.

As is indicated by the aforementioned studies, few reliable or valid instruments exist which measure patient dependency on nursing care in the ambulatory setting (Mozes et al 1996). While a number of studies focus on general nursing dependency (Freeman et al 1999; Carr-Hill and Jenkins-Clarke 1995; Helberg 1994), these typically tend to centre on the impact of nursing dependency on caseload or on the cost of care and have associated limitations when applied in the HITH environment.

Conceptual and measurement dimensions of the HDS

A recent review of 168 patients from six Victorian HITH programs conducted by the Victorian Centre for

Ambulatory Care Innovation revealed that using biological measures of acuity similar to those employed in the AEP resulted in HITH patients recording little or no abnormality. The problem in measuring HITH patient acuity using traditional methods is that while that patient may have a variable degree of dependency on care, they may not have measurable biological abnormality present on commonly measured parameters. An example of this situation is a patient with cellulitis who is being treated with intravenous antibiotics may not have an elevated temperature or abnormal blood chemistry, and consequently will register a negligible acuity score. However, this patient does have a discernible dependency level evidenced by the need for assessment and treatment. The difficulty with measuring patient acuity presents HITH programs with the problem of not having objective evidence to support the government requirement that HITH care provide a substitution for in-hospital care.

Because of the previously identified problems regarding the measurement of acuity in HITH patients, we decided to focus our efforts on developing a scale to measure patient dependency in the home setting. We believed that dependency could be successfully and reliably measured in both the in-patient and HITH settings, thereby providing the ability to directly compare in-patients with HITH patients. The challenge was to develop a measurement system that was valid, reliable, sensitive to changes in the patient as well as being relatively easy and quick to use for the treating nurse.

The HDS approaches the measurement of dependency in a unique manner because it utilises biometric, psychometric and temporal parameters to infer the final dependency level of the patient. Underpinning the HDS methodology are a number of assumptions regarding patient dependency. Firstly, that dependency level is the most appropriate measure of patient needs in the HITH setting due to the lack of meaningful acuity data. Secondly, that dependency can be measured in an objective, valid and reliable manner by examining the complexity of assessment and treatment required by a patient. Thirdly, that the frequency and duration of each treatment episode are meaningful indicators of dependency.

The HDS is designed to measure patient dependency on nursing care by calculating the sum of four major elements of HITH nursing care. These comprise the complexity of assessment, complexity of treatment, frequency of treatment and time taken to deliver treatment. The sum of these sub-scales produces a total dependency value for the patient.

Each of the two complexity sub-scales for assessment and treatment use a three-point scoring range i.e. 1=Low, 2=Moderate and 3=High. The complexity sub-scales rate complexity from the perspective of the behavioural demands of the tasks to be performed by the HITH nurse. This can be thought of in terms of the tasks having

cognitive, affective and psychomotor components. Therefore, the assessment and treatment tasks require the nurse to hold and apply a particular body of knowledge (cognitive), attitudes (affective) and physical skills (psychomotor) to the care of the patient.

From a practical perspective, this conceptualisation of determining overall complexity can be exemplified in the case of the HITH nurse who is administering a dose of an anticoagulant such as a low molecular weight heparin (LMWH) to a patient who has a deep vein thrombosis (DVT). The procedure of administering the drug is relatively simple and would be allocated a 'Low' (1) score, however the assessment task is much more complex due to the cognitive load and is allocated a 'High' (3) score. The nurse needs to understand the patient's current and past illness history, the physiological processes in the clotting mechanism, the role of the drug in that mechanism and the complications associated with the drug. The nurse also needs to determine the psychosocial and educational needs of the patient and family, as well as how to conduct the assessment process and how to elicit the data from the patient. Based on this example the complexity for this patient would be scored as Moderate to High (1 + 3 = 4 out of a possible score of 6).

The frequency and time sub-scale are relatively straightforward to score. Each range is divided into four steps. Frequency scores may range from daily or less (1), bd (2), tds (3) or qid (4). The time to provide treatment scale divides time as follows: 30 minutes or less (1), >30 minutes to ≤60 minutes (2), >60 minutes to ≤90 minutes (3) and >90 minutes (4).

The sum of the HDS sub-scale scores may range from 4 to 14 points. This dependency value is then used to allocate a final dependency classification to the patient in the following way: 4 = Low, 5-6 = Low/Moderate, 7-8 = Moderate, 9-11 = Moderate/High, 12-14 = High.

The overall definition of dependency encompassed in the HDS approach can therefore be represented by the following formula:

$$\text{Dependency} = \text{Assessment complexity} + \text{Treatment complexity} + \text{Frequency of treatment} + \text{Duration of treatment}$$

METHODS

Multiple methods were used to develop and trial the HDS. These included; the use of a consensus expert panel; the review of a normative sample of HITH patients; and an examination of the concordance between HDS values and those of HITH nurses to typical patient scenarios. Test-retest procedure, calculation of item to total correlation coefficients and a calculation of Cronbach's alpha were also employed in the testing process.

Validity development and testing

Validity refers to the degree to which an instrument measures what it purports to measure (Dawson-Saunders and Trapp 1994). In the case of the HDS, the construct of interest was that of patient dependency on nursing care. The first stage in the HDS development comprised convening an expert panel of HITH nurses. The nurses were all HITH coordinators from metropolitan and regional Victorian Hospitals. Their task was to advise and help define the levels of HITH patient dependency commonly encountered in practice. The deliberations of the panel resulted in a decision to view dependency level as the composite of four dimensions of HITH nursing practice. These dimensions were the complexity of assessment, complexity of treatment, time taken to provide the treatment and the frequency of the treatment. The panel then developed two lists of HITH nursing interventions, one representing assessment and one treatment. Each list grouped the interventions according to one of three levels of complexity, low, moderate or high.

The next stage in establishing the validity of the HDS was to use the intervention lists developed by the expert panel, and to compare the levels of assessment and treatment complexity to that of a normative sample of 129 adult medical and surgical HITH patient records from seven Melbourne metropolitan HITH programs. This process produced a data matrix of 704 individual patient observations that were used to refine the initial intervention lists. These patient data were believed to be representative of the majority of adult HITH patients in Victoria.

The final stage was to investigate the construct validity of the HDS. This was approached by the authors developing six patient scenarios based on the complexity interventions (see tables 1 and 2) and the characteristics of the HITH patient normative sample. The six patient scenarios were constructed so that there were two scenarios for each complexity level of the HDS assessment and treatment sub-scales. A group of 20 nurses drawn from five Victorian HITH programs were asked to allocate one of three possible complexity levels to the assessment and treatment interventions required in each scenario as defined by the expert panel. The goal of the process was to investigate the validity of the dependency complexity levels by observing the concordance between the expected levels and the determinations of the HITH nurses.

Reliability testing

The reliability of an instrument relates to the accuracy and consistency of the instrument in measuring a particular characteristic or construct (Tabachnick and Fidell 1989). In the case of the HDS, this property relates to its accuracy and consistency in measuring assessment and treatment complexity and subsequent dependency

level. The process we employed involved using the same six patient scenarios that were developed for the validity testing. We asked a further group of 20 HITH nurses to score the scenarios on two separate occasions with a time interval of one month between scoring. This technique enabled us to hold the patient characteristics constant while calculating the test-retest correlation coefficients of reliability of the HDS scores for each patient. Item to total correlation coefficients were also calculated for each HDS scenario and a value for Cronbach's alpha was derived for the total HDS instrument and for the effect on the alpha value of removing individual items from the scale.

Analysis

All statistical tests were carried out with SPSS V9 computer program. Test-retest results were explored using Pearson's product moment correlation coefficient. Scale reliability was tested by calculating item to total correlation coefficients and Cronbach's alpha for the overall scale. Alpha was also calculated for the scale if the individual items were removed. In all cases the significance level was set at 0.05.

RESULTS

Validity

Tables 1 and 2 present the findings of the expert panel of 10 HITH coordinators after adjustment based on the review of a normative sample of 129 HITH patients.

Table 1: HITH Assessment complexity

High	Moderate	Low
1. comorbidities > 1	comorbidities X 1	no comorbidities
2. highly complex needs social psych educational	complex needs social psych educational	stable needs social psych educational
3. IV drugs > 2	IV drugs X 2	IV drugs X 1
4. IV pumps	IV pump	no pumps
5. complex wounds >1	complex wound	Simple wound
6. complex drainage system	drainage system	no drains
7. complex physical assess	physical assessment	vital signs only
8. central venous access devices		peripheral venous access device

Table 2: HITH Treatment complexity

High	Moderate	Low
central venous access	cannulation	peripheral IV bung
devices CVC, PICC, Hickmans, Portacath chemotherapy IV bolus, IV infusion	total parenteral nutrition	insitu
titration of IV drugs		IMI or SC injection
sliding scale insulin	enteral feeds	O ₂ administration
multiple IV pumps	single IV pump	bronchodilators
complex specimen collection		simple specimen collection
highly complex support Social Psych Educational	complex support social psych educational	simple support social psych educational
complex interdisciplinary communication	interdisciplinary communication	hygiene
complex wound care > 1	complex wound care	simple wound care

Assessment and treatment interventions have been grouped under three complexity levels according to the composite of cognitive, affective and psychomotor load required to perform each intervention.

Table 3 presents the characteristics of the normative sample of 129 adult medical and surgical HITH patients drawn from seven Melbourne hospital HITH programs used to refine the complexity sub-scales.

Table 3: Normative sample patient characteristics (N=129)

mean age (range)	52.4(18-83)
male/female ratio	48/81
treatment by type	
IV antibiotics	41
anticoagulation	29
wound care	25
IV drugs	8
SC injection	4
IV blood product	1
enteral nutrition	1
post-op care	1
other	19
total	129

Table 4 reports the results of the construct validity testing using a group of 20 HITH nurses. The table presents the expected sub-scale complexity mean scores for each of six patient scenarios and compares them to the actual means recorded by the HITH nurses. The difference and the direction of the difference for each scenario are expressed as a fraction and percentage.

Table 4: Expected vs actual means for HITH patient scenarios

Scenario	Expected Mean	Actual Mean (SD†)	Difference (%)
1. assessment	1	1.31 (0.47)	+0.31 (23.7)
1. treatment	1	1.57 (0.50)	+0.57 (36.4)
2. assessment	3	2.42 (0.60)	-0.58 (19.4)
2. treatment	2	2.31 (0.47)	+0.31 (13.5)
3. assessment	2	1.89 (0.56)	-0.11 (5.5)
3. treatment	2	1.52 (0.51)	-0.48 (24)
4. assessment	1	1.31 (0.58)	+0.31 (24.7)
4. treatment	1	1.42 (0.50)	+0.42 (29)
5. assessment	2	1.84 (0.37)	-0.16 (8.6)
5. treatment	2	2.26 (0.56)	+0.26 (11)
6. assessment	3	2.05 (0.52)	-0.95 (32)
6. treatment	2	1.94 (0.52)	-0.06 (3.0)
total	22	21.84 (3.03)	-0.16 (0.7)

† Standard deviation

Reliability

Table 5 reveals that the test-retest reliability of the HDS with a one-month interval between scores produced a correlation coefficient of 0.809, $P < 0.01$. Cronbach's alpha for the HDS and the effect on the alpha value of removing individual items on the scale is also reported.

Table 5: Corrected item to total correlations and alpha values

Scenarios	Corrected item to total correlation	Alpha if item removed
1. assessment	0.29	0.70
1. treatment	0.17	0.71
2. assessment	0.56	0.68
2. treatment	0.37	0.70
3. assessment	0.47	0.69
3. treatment	0.47	0.69
4. assessment	0.08	0.72
4. treatment	0.31	0.70
5. assessment	0.52	0.69
5. treatment	0.76	0.67
6. assessment	0.61	0.68
6. treatment	0.37	0.70
HDS Alpha		0.72

DISCUSSION

Validity

The testing of construct validity presented in Table 4 reveals the HITH nurses generally scored the two lowest complexity patient scenarios (1 and 4) as having higher complexity than expected. The medium complexity scenarios (3 and 5) were predominantly scored as being slightly lower than predicted. These scenarios also demonstrated the lowest total degree of variance. Scenarios at the highest level of complexity (2 and 6) were mainly scored lower than expected. Overall, the HDS scenario mean score was only 0.16 (0.7%) below the expected mean. The degree of concordance between the expected and actual scores demonstrates a degree of statistical regression towards the mid-point of the scale, that is that lower complexity scenarios were scored higher and conversely high complexity scenarios were scored lower. We believe that the extremely close overall means support the general construct validity of the HDS. It should be noted that the HDS scenarios had no other information regarding how to score the complexity apart from the instruction to allocate one of three possible scores to each. Because no definitions of complexity or lists of interventions such as those presented in Tables 1 and 2 were given to the HITH nurses, we conclude that the HDS has relatively strong construct validity.

Reliability

We believe that the findings of the reliability testing support the performance of the HDS. The test-retest correlation coefficient value of 0.80 ($p < 0.01$) indicates that when patient characteristics were held constant, the HDS demonstrated stability over a period of one month. Similarly the internal consistency of the HDS was supported by the strong value calculated for Cronbach's alpha of 0.72. The corrected item to total correlation coefficients presented in Table 5 should be interpreted with caution because the scenarios were designed to have differential values. The consequence is that they cannot be used in the usual manner to judge the value of either rejecting or retaining an individual item on the scale. The individual alpha values provide a more meaningful measure of the internal consistency of the scale and consequently the relative performance of individual items. Overall, we believe that the findings demonstrate that the HDS is internally consistent and stable.

Limitations

The study is limited by the relatively small normative sample used to refine the assessment and treatment complexity sub-scales. Ideally, the normative sample should be larger given the volume of HITH care provided in Australia. The current form of the HDS is specifically

designed for adult acute medical or surgical HITH patients therefore we make no claims regarding its performance with other patient groups.

Future development and research

We believe that the HDS presents a number of development opportunities. Specific versions could be developed in areas such as midwifery and paediatrics. The HDS could be suitable for conversion to a computerised form, ideally designed to operate on hand held computers that are becoming increasingly popular in community settings. The performance of the HDS should be investigated with specific HITH patient groups. It is possible that the HDS could perform differently with some patient groups. It would also be interesting to investigate the relationship between dependency levels measured by the HDS and the cost of care for a range of diagnostic categories.

CONCLUSION

The HDS is at a relatively early stage of development, however we believe that its performance to date is encouraging. The HDS is unique in the HITH practice setting because it uses the assessment and treatment complexity, frequency and duration of care provided by HITH nurses to infer patient dependency. We believe that with further refinement and testing the HDS will provide HITH clinicians and managers with a valuable instrument to monitor patient dependency levels, resource utilisation and to provide objective evidence of the comparability of HITH patients to in-patient populations.

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