

An assessment of the staffing level required for a high-dependency unit

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Summary

High-dependency units are increasing in number and becoming an ever more important part of a hospital's facilities. The optimum staffing ratio is unknown, but the Department of Health and the Intensive Care Society recommend a level of one nurse to two patients. We recorded Therapeutic Intervention Scoring System-28 scores and Nurse Dependency Scores for all admissions to our adult, general high-dependency unit over 7 months. We found a weak correlation between the nurse dependency score and the Therapeutic Intervention Scoring System-28 score. The median Therapeutic Intervention Scoring System-28 score was 23 points (interquartile range 19–26), and the median Nurse Dependency Score was 1.0. These results are approximately two-thirds of those for European intensive care units. We conclude that a nurse-to-patient ratio of 1 : 2 may be insufficient for an adult general high-dependency unit, and would recommend a nurse-to-patient ratio of 2 : 3.

Keywords *Staffing; high-dependency unit.*

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High-dependency units (HDUs) are becoming an increasingly important part of a hospital's facilities, allowing elective surgical work to continue despite rising intensive care unit (ICU) bed occupancy [1], earlier discharge of patients from the ICU [2] and reducing ICU readmission rates [3]. Provision of HDU care for high-risk medical and surgical patients may also reduce the need for ICU admission and improve patient outcome [4]. In the UK, the number of HDUs is increasing, as shown in Table 1 [5–8], but there remain several controversies surrounding their organisation, one of which is the nurse-to-patient ratio required to care for these moderately ill but unstable patients. A survey performed in the old Anglia Region in 1995 showed that the nursing establishment on the general medical and surgical wards was approximately three-quarters of a nurse per bed, whereas that on the ICUs was between six and seven nurses per bed [9]. The staffing level for an HDU must be considerably higher than the former

and somewhat less than the latter, but the optimum level is currently unknown.

Two recent reports have attempted to address this matter. The Department of Health working party [10] and the Intensive Care Society standards subcommittee [11] both recommend that the nurse-to-patient ratio for an HDU should be one nurse to every two patients. There are, however, few published data to support this recommendation. In this prospective study we aimed to assess the nursing and therapeutic dependency of HDU patients, and hence the nurse-to-patient ratio required to care for them.

Methods

All consecutive patients admitted to our adult, general HDU between May and November 1998 (7 months) were enrolled into the study. We recorded basic data concerning age, sex, type of admission (planned or unplanned), source

Table 1 The number of HDUs in the UK as reported over the last 8 years

Year	Denominator	No. of HDUs	% of hospitals with an HDU	Type of HDU	Reference
1991	435 acute hospitals	55	12.6	Unspecified	5
1992/3	256 hospitals with ICUs	39	15.2	Unspecified	6
1993	169 hospitals with ICUs (England)	34	20.1	Unspecified	7
1997	190 hospitals with ICUs (England)	50	26.3	Unspecified	8
1998	420 acute hospitals	43	10.2	Adult general	Unpublished results

of admission, APACHE II diagnostic category [12], length of stay and unit outcome, as well as the physiological data necessary for the calculation of the APACHE II score [12]. Every patient had a Therapeutic Intervention Scoring System-28 (TISS-28) score performed at midnight on the day of admission and then every 24 h, as described by Miranda *et al.* [13] and shown in Appendix A. If a patient stayed on the HDU for less than 12 h on the day of discharge, then the TISS-28 score for that day was not calculated. All data collection forms were checked on a regular basis by one of the investigators (R.J.) and any omissions were corrected by reference to the patient's records.

Every patient also had a nursing dependency score (NDS) calculated for each shift, as is the normal practice in our unit (Appendix B). The NDS attempts to quantify the qualitative description of nurse dependency given by the Intensive Care Society's guidelines [14]. This is expressed as the number of nurses between 0.5 and 2 required to care for the patient, increasing in 0.5 nurse increments. In our experience, complex ICU patients will have an NDS of 1.5 or occasionally even 2.

Statistical analysis of non-normally distributed continuous data was carried out using the Wilcoxon rank sum test. Correlation between the TISS-28 and NDS was assessed using Spearman rank correlation. A *p*-value of <0.05 was

considered to be statistically significant. All statistical analysis was performed using the Statistics Package for the Social Sciences (SPSS, version 8.0).

Results

A total of 407 admissions occurred during the study period, representing 787 patient days of complete data. The details are shown in Table 2. Most admissions (78.9%) were categorised as 'operative' under the APACHE II system [12]. The diagnostic classification for all admissions is shown in Table 3.

The overall median (interquartile range [range]) daily TISS-28 score was 23 (19–26 [5–46]), and the median daily NDS was 1.0 (1.0–1.0 [0.5–2.0]). There was weak correlation between the median daily NDS and the TISS-28 score ($\rho = 0.33$; $p < 0.01$; Fig. 1).

Discussion

The TISS-28 score is a simplified version of the original 76-item TISS score as developed by Cullen *et al.* [15], and the two have been shown to correlate well [13, 16]. The intermediate TISS, which was developed specifically for intermediate care units, was not used because it has been shown to perform rather poorly in surgical patients [17].

Table 2 Details of patients admitted to the high-dependency unit and their length of stay and APACHE II scores. Values are mean (SD), median (interquartile range [range]) or number (proportion) unless stated otherwise

Variable	Value (n = 407)
Age; years	63.7 (18.4)
Male: female (%)	60:40
ICU step-down*	90 (22.1%)
APACHE II Score	9 (6–12[0–30])
Length of stay; days	0.94 (0.72–1.65[0.04–16.14])
Survivors	390 (95.8%)

* Patients admitted to the HDU from the ICU.

Table 3 Admissions to the HDU, classified by diagnostic category. Values are number (proportion)

Diagnostic category	Operative admissions (n = 321)	Non-operative admissions (n = 86)
Cardiovascular	151 (47.0%)	18 (20.9%)
Respiratory	57 (17.8%)	27 (31.4%)
Gastrointestinal	84 (26.2%)	11 (12.8%)
Metabolic/renal*	15 (4.7%)	18 (20.9%)
Neurological	0	3 (3.5%)
Trauma	14 (4.3%)	9 (10.5%)

* Including drug overdoses.

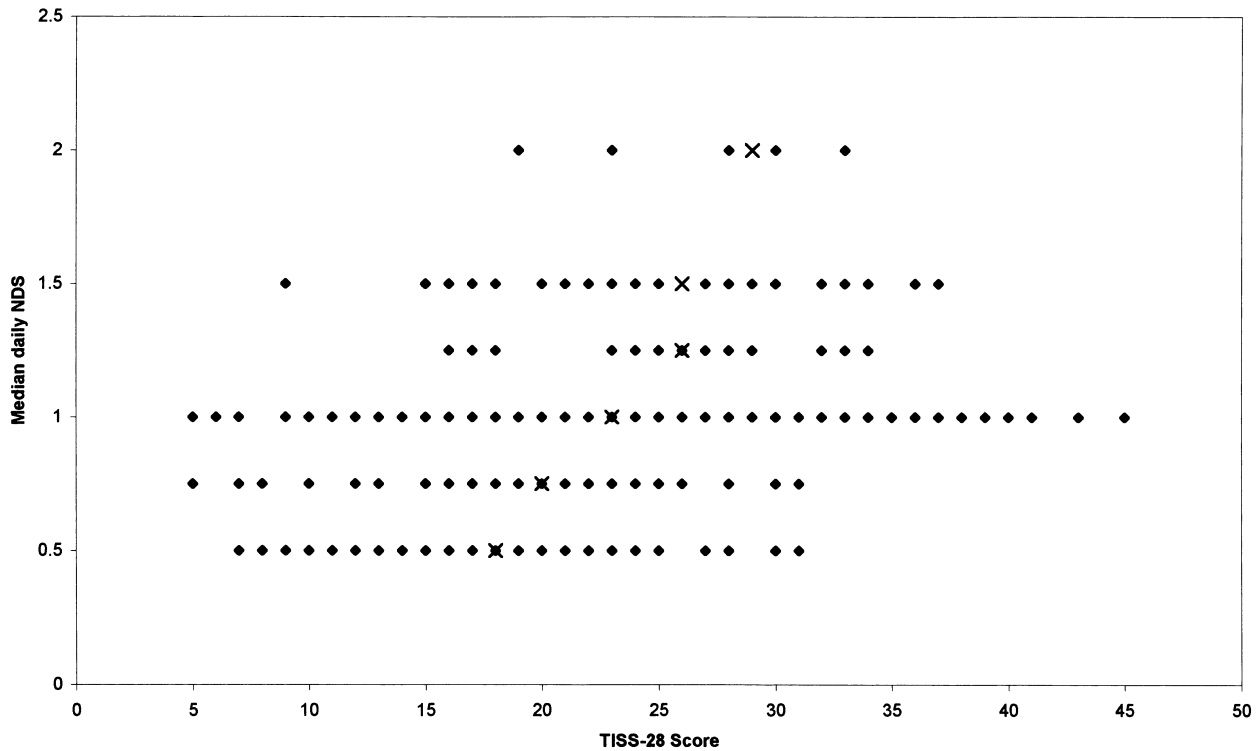


Figure 1 Relationship between median daily NDS and TISS-28 score. Diamonds: individual data points, crosses: group median scores. Some points shown may represent several data points.

We have shown that there is weak correlation between the therapeutic dependency of the patients, as measured by the TISS-28 score, and the nursing dependency, as measured by the NDS (which includes a range of activities, both measured and unmeasured by TISS-28). There are inconsistencies, however, between the scores obtained by the two systems. For example, the patients with the highest TISS-28 scores have a NDS of 1.0, as do the patients with the lowest TISS-28 scores. Similarly, the TISS-28 scores for a quarter of the patients with a NDS of 2.0 are less than 23 points, the median score for the whole population. These differences may be due to several factors.

The first is the number of patient days in each NDS group. For example, the NDS 1.0 group reflects 573 days of data, while the NDS 2.0 group reflects only six. The patients in the NDS 2.0 group may have had particularly low scores for their group, and so may have skewed the results. The two systems also weight interventions differently, as they have been designed to perform different functions. For example, the TISS-28 system allocates three points for haemofiltration at any time during the previous 24 h. This is a relatively low score, equivalent to having two or more intravenous drugs per day. The NDS allocates four points for haemofiltration in progress, recognising the extra nursing time required, but then adds two points for

each time that the haemofilter is set up, as this takes up even more nursing time. These patients thus have moderately low TISS-28 scores, but high NDS. An opposite example is the pulmonary artery catheter. Some patients returned from theatre following major vascular surgery with a pulmonary artery catheter *in situ*. This scores eight points in TISS-28, the highest possible score. The only nursing care required, however, was observation of the pulmonary artery pressure trace to detect inadvertent wedging and occasional measurement of the pulmonary artery occlusion pressure. The presence of a pulmonary artery catheter *per se* does not lead to a high NDS. Some of the patients may therefore have obtained high TISS-28 scores but had lower levels of nursing dependency.

There has been much discussion as to how appropriate TISS scoring is as a method of measuring nursing workload [18]. The work of critical care nurses consists of more than merely delivering the therapeutic interventions measured by the TISS score. The amount of this unmeasured work is, however, likely to be related to the patient's severity of illness and TISS score. Miranda *et al.* [13] conducted an in-depth analysis of nursing workload as part of their TISS-28 evaluation, involving recording each nurse's activities at random intervals throughout the shift, a method known as work sampling. They showed that the

Table 4 TISS-28 and APACHE II scores as reported by European ICUs

Author	Country of origin	No. of patients	Mean TISS-28 score	APACHE II score	Reference
Reis Miranda <i>et al.</i>	Netherlands	1820	28.8	Unspecified	13
Moreno <i>et al.</i>	Portugal	1080	29.8	19.6	16
Capuzzo <i>et al.</i>	Italy	405	22.7–28.6 (median)*	Unspecified	20
Reis Miranda <i>et al.</i>	Netherlands	2000	26.2	Unspecified	21
Reis Miranda <i>et al.</i>	Netherlands	369	27.6	Unspecified	21
Lefering <i>et al.</i>	Germany	929	34.6*	12.8	22
GIRTI‡	Italy	2710	32.3*	12.0†	23

* TISS score given in the original paper. The TISS-28 score was calculated by using the regression equation given by Miranda *et al.* [21].

† Simplified acute physiology score (SAPS) II. ‡ Multicentre Italian Group of Research in Intensive Therapy.

amount of time spent on activities not measured by TISS-28 correlated well with the TISS-28 score, and concluded that TISS-28 was a useful, indirect measure of nursing workload. Malstam & Lind [19] successfully used TISS to measure workload in their ICU.

We were unable to find any published TISS results from HDUs in the UK, using the standard search methods (Medline and EMBASE searches, and hand searching of *Intensive Care Medicine*, *Critical Care Medicine*, *Anaesthesia*, *British Journal of Anaesthesia* and *Anaesthesia and Intensive Care* for the past 5 years). We were also unable to find any evidence of TISS results from HDUs elsewhere in the world. We did manage, however, to find a reasonable amount of TISS data from ICUs in both North America and Europe. We have chosen to focus on the data from the European ICUs as European critical care practice may be more likely to reflect UK practice than that from North America. These data are summarised in Table 4.

As can be seen from these data, the TISS-28 score for our HDU patients is only marginally lower than the scores reported for the European ICU patients (23 compared with 26–34). Our patients' median TISS-28 score of 23 is identical to that which Malstam & Lind used to distinguish 'true ICU' patients from 'postoperative patients' [19]. The severity of illness scores, where given, show our HDU patients to be less unwell than the ICU patients, as would be expected, but not by a large amount. The median APACHE II score for patients on our ICU is 12, comparable with some of the European ICUs, and the median score for our HDU patients is 9. Our HDU patients therefore receive a moderate amount of therapeutic intervention and they also appear to be moderately unwell. These results may reflect the fact that ICU patients in the UK may be more unwell than those in Europe, and hence the HDU patients are also sicker. The increased dependency of our HDU patients can also be inferred by the relatively high NDS of 1.0 compared with ≈ 1.5 for our ICU patients.

Our HDU patients are therefore approximately three-quarters as unwell as our ICU patients and those reported in some of the European ICUs. Their level of therapeutic intervention is $\approx 75\%$, and their level of dependency, as measured by the NDS, is approximately two-thirds of that of the ICU patients. We therefore conclude that our HDU patients need more than half the number of nurses to look after them than the ICU patients, and so, for our patients on an adult general HDU, the recommendation of one nurse to two patients would seem to be too low. A level of two nurses to three patients may be more appropriate for an adult, general HDU with an admission profile similar to ours.

More research needs to be performed in this important area, because the efficient running of an HDU is intimately related to the staffing levels; too few staff may result in both patient care and staff morale suffering, but too many staff will lead to excessive consumption of resources in these times of increasing demand for efficiency savings.

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Activity	Points
Appendix A	
The TISS-28 scoring system	
Basic activities:	
Standard monitoring (hourly vital signs and fluid balance)	5
Laboratory, biochemical and microbiological investigations	1
Single medication by any route	2
Multiple iv medications (more than one drug or continuously)	3
Routine dressing changes (daily) and care of pressure areas	1
Frequent dressing changes (once per shift) or extensive wound care	1
Care of drains (all except nasogastric tube)	3
Cardiovascular support:	
Single vasoactive medication (any)	3
Multiple vasoactive medications regardless of type or dose	4
Replacement of large fluid losses ($> 3 \text{ l/m}^2 \cdot \text{day}^{-1}$)	4
Peripheral arterial catheter	5
Pulmonary artery catheter \pm cardiac output measurement	8
Central venous line	2
Cardiopulmonary resuscitation after arrest in past 24 h	3
Metabolic support:	
Treatment of complicated metabolic acidosis/alkalosis	4
iv hyperalimentation	3
Enteral feeding by any route	2
Neurologic support:	
Measurement of intracranial pressure	4
Ventilatory support:	
Mechanical ventilation including spontaneous breathing with positive end-expiratory pressure	5
Supplementary ventilatory support. Oxygen by any method except if mechanical ventilation parameters apply. Breathing spontaneously through tracheal tube without positive end-expiratory pressure	2
Care of artificial airways (tracheal tube or tracheostomy)	1
Thorax physiotherapy/tracheal suctioning/inhalation therapy	1
Renal support:	
Haemofiltration or haemodialysis techniques	3
Quantitative urine output measurement	2
Active diuresis (furosemide $> 0.5 \text{ mg} \cdot \text{kg}^{-1} \cdot \text{day}^{-1}$ for overload)	3
Specific interventions:	
Single specific intervention in the high-dependency unit, e.g. tracheal intubation, pacemaker insertion, endoscopy, emergency operation in preceding 24 h, gastric lavage (excluding radiographs, echocardiography and insertion of lines, etc.)	3
Multiple specific interventions in the unit as above	5
Specific interventions outside the unit – surgery or diagnostic procedures	5

Appendix B

The Nursing Dependency Scoring (NDS) system

Score	Respiratory	Cardiovascular	Renal	Neurological state	Nursing care	Relatives	Special events
1	Spontaneous ventilation ± oxygen Routine physiotherapy No suction	Routine monitoring	Catheterised Monitoring urine output	Awake Orientated Co-operative	Basic 2-hourly Bedpan Bottle	Tel. enquiries Few relatives	
2	Tracheostomy Mini-tracheostomy Endotracheal tube spontaneous ventilation Occasional suction Regular blood gases	Central venous pressure ≥ hourly Complicated drug regimens Low-dose inotropes	Bladder washout Diabetes insipidus	Sedated/unconscious Neurological observations ≥ hourly	Bed bath Hair wash In/out of bed	Multiple relatives visiting	Theatre visit
3	Continuous positive airways pressure Ventilated Frequent suction	Cardioversion Pacing Pulmonary artery	Bladder irrigation Haemodialysis	Confused Restless	Incontinent Fluid loss Isolation	Interview with doctors Multiple relatives	Admission Discharge CT scan/ angiogram Other dept
4	Frequent blood gases Respiratory arrest Borderline ventilation	Inotrope-dependent shock (all types) Cardiac arrest	Continuous venovenous haemofiltration	Unable to leave patients Aggressive	Constant intervention Complex dressings/ burns	Requiring constant Support	Transfer to other hospital Death

Add 2 points for invasive/complicated procedures, e.g. intubation/extubation, tracheostomy change, insertion of central venous/pulmonary artery/haemofiltration catheters, set up haemofiltration, set up continuous positive airway pressure/noninvasive ventilator.

Score	1–6	7–13	13–20	21–28
NDS	0.5	1.0	1.5	2.0