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Validation of the simplified therapeutic intervention scoring system on an independent database*

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Abstract *Objective*: To evaluate the performance of the Simplified Therapeutic Intervention Scoring System on an independent database and determine its relation with the Therapeutic Intervention Scoring System in the quantification of nursing workload in intensive care.
Design: Analysis of the database of a multicenter prospective Portuguese study.
Setting: 19 intensive care units (ICUs) in Portugal.
Patients: Data on 1094 patients consecutively admitted to the ICUs were collected during a period of 3 months.
Methods: Collection of the data necessary for the calculation of the Therapeutic Intervention Scoring System (TISS-76) and the Simplified Therapeutic Intervention Scoring System (TISS-28) during the first 24 h in the ICU. Basic demographic statistics and all the variables necessary for the computation of the Simplified Acute Physiology Score II were also collected. Vital status at discharge from the hospital was registered. Regression techniques, Pearson's correlation and paired sample *t*-test were used. Results are presented as mean ± standard deviation except when stated otherwise. Reliability was evaluated by the use of intraclass correlation coefficients in a 5 % random sample.
Measurements and results: After exclusion of all the patients with missing data, 1080 patients were analysed. The overall mean TISS-28 (29.82 ± 10.64) was significantly lower than the mean TISS-76 (31.14 ± 11.95). Both systems showed very significant differences between ICUs ($p < 0.001$). The correlation between the two was good, with TISS-28 explaining 72 % of the variation of TISS-76 ($r = 0.85$, $r^2 = 0.72$). The relation between the two systems was TISS-28 = 6.22 + 0.85 TISS-76.
In this cohort, reliability of data collection was very high, with intraclass correlation coefficients greater than 0.90 for both systems.
Conclusions: TISS-28 was validated on this independent population. The results indicate that TISS-28 can replace TISS-76 for the measurement of the nursing workload in Portuguese ICUs

Key words Therapeutic Intervention Scoring System · Simplified Therapeutic Intervention Scoring System · TISS-28 · Intensive care unit · Nursing workload

Introduction

The development in 1974 of the Therapeutic Intervention Scoring System (TISS) by Cullen et al. [1] introduced into clinical practice the measurement of nursing workload. This system was subjected to a major revision in 1983 [2] and now comprises a set of 76 selected therapeutic activities performed in intensive care units (TISS-76). Proposed initially as a method for the evaluation of the severity of illness, since the beginning of the 1980s it has been used mainly for the quantification of nursing workload and the calculation of nursing staff requirements [3–5]. Problems of reliability due to different interpretations of some of the 76 items and the amount of time required to carry it out (at least 2 to 5 minutes in experienced hands [6, 7]) precluded its regular use in many intensive care units (ICUs).

In 1996, Reis Miranda et al. proposed a simplified version of the system, the Simplified Therapeutic Intervention Scoring System (TISS-28) [7]. This was developed through advanced statistical techniques on a random sample of 10 000 records of TISS-76 items from the database of the Foundation for Research on Intensive Care in Europe and cross-validated in another sample of 10 000 TISS records randomly extracted from the same database. Later, its validity on clinical practice was assessed in 1820 valid pairs of TISS-76 and TISS-28 items in 22 Dutch ICUs. Moreover, the relation between the TISS-28 score and nursing workload was evaluated on the same sample and was demonstrated to be excellent.

The objective of this work is to evaluate the performance of the TISS-28 on an independent database, in a different European country, and determine its relation with the TISS-76 in the quantification of nursing workload in ICUs.

Material and methods

Before the study, all mixed medical-surgical ICUs in Portugal (excluding the islands of Madeira and Azores) were invited to participate in the study by mail or personal communication by the Portuguese Severity Scores Study Group. Of the 28 ICUs invited, 19 (68%) collaborated. In each of the ICUs a local co-ordinator was appointed (appendix).

Data collection took place from 15 December 1994 to 14 March 1995. During the study period, all consecutively admitted patients, 18 years or older, in participating ICUs were enrolled; 14 patients with missing data on TISS-76 and/or TISS-28 were excluded from the final analysis.

Each patient was described using a simple set of variables selected on the basis of the literature that included all the variables from the TISS-76 [2] and the TISS-28 [7] collected during the first 24 h in the ICU. Since the description of this last scoring system had not yet been published at the beginning of the study, all the operative definitions and weights were obtained directly from the authors (D. Reis Miranda, personal communication). Severity of illness was evaluated by the Simplified Acute Physiology Score (SAPS) II system [8]. All data were collected as raw data. Basic demographic characteristics, including sex, age, type of patient (medical, acute coronary, scheduled surgical, and unscheduled surgical), and principal diagnostic category of admission (using a list of 50 mutually exclusive diagnoses [9]) were also recorded.

ICUs had the choice of entering data on standardised forms or using a computer program made by the authors, available in IBM format, containing out-of-range and logical errorchecking. In both cases, data were checked for accuracy and completeness and requests for missing data returned to local co-ordinators. All people involved had access to an operative manual with the protocols and definitions. During the study period, support was provided to all participating ICUs by the co-ordinating centre.

Quality control was performed, at the end of the study, by the site co-ordinator completing a second set of forms for a 5% random sample of that ICU's patients.

Patients were followed up to hospital discharge, and their survival status was then registered.

To assess inter-observer reliability, original and quality control forms were compared, and discrepancies evaluated using intraclass correlation coefficients [10] to determine if there was a good rate of agreement. Chi-square statistics were used to test for the statistical significance of categorical variables and the *t*-test or one-way analysis of variance were used to assess continuous variables. Regression techniques, Pearson's correlation and paired sample *t*-test were used for the comparison of TISS-76 with TISS-28.

All statistical tests were two-sided, and a significance level of 0.05 was used except when otherwise stated. In the case of the length of stay in the ICU, since the distribution was highly skewed, results are presented as median (interquartile range) and the Mann-Whitney *U* test used to compare groups.

All data analysis and statistics were performed using the Statistical Package for Social Sciences, version 6.0.1.

Results

During the study period, the 19 ICUs collected data on 1094 patients. After the exclusion of patients with missing data on TISS-76 and/or TISS-28, 1080 patients were analysed (98.7% of the original sample). The mean number of patients analysed per ICU was 56.8, ranging from 16 to 168. As shown in Table 1, most patients were male (742, 68.7%), with a mean age of 55.5 ± 19.1 years. There was a clear a predominance of medical patients (71.6%). Non-operative respiratory disease was the principal diagnostic category of admission, occurring in 30.0% of the sample.

Mean SAPS II was high (40.2 ± 20.4), with a significant difference between survivors and non-survivors (33.1 ± 15.0 vs 54.8 ± 33.1, $p < 0.001$). Predicted risk of death by SAPS II was 30.8 ± 29.3 (survivors 20.6 ± 21.2, non-survivors 52.2 ± 31.5, $p < 0.001$). There were very large differences in SAPS II between ICUs, with mean ICU values ranging from 30.25 to 46.97.

The overall mortality in the ICU was 22.0% and the corresponding mortality in the hospital 35.6%. Median length of stay in the ICU was 4.1 days (interquartile

Table 1 Basic characteristics of the 1080 patients analysed (*LOS* length of stay)

	No.	%
No. of males	742	68.7
Age (years) (mean ± SD)	55.5 ± 19.1	
Type of patient		
Medical	773	71.6
Scheduled surgery	117	10.9
Unscheduled surgery	189	17.5
Diagnostic category of admission[a]		
Non-operative		
Respiratory	322	30.0
Cardiovascular	250	23.2
Trauma	68	6.3
Neurological	38	3.5
Other	17	1.6
Non-specific	75	6.9
Post-operative	307	28.5
LOS (days) (median and interquartile range)	4.1 (1.8–10.2)	
TISS-28 (mean ± SD)	29.8 ± 10.6	
TISS-76 (mean ± SD)	31.1 ± 11.9	
Interventions during first 24 h in the ICU		
Mechanical ventilation	700	64.8
Vasoactive drugs	532	49.3
Parenteral nutrition	148	13.7
Swan-Ganz catheter	55	5.1
Arterial catheter	302	28.0
Central venous catheter	768	71.1
SAPS II[b] (mean ± SD)	40.2 ± 20.4	
SAPS II predicted risk[b] (mean ± SD)	30.8 ± 29.4	
ICU mortality[a] (mean ± SD)	238	22.0
Hospital mortality (mean ± SD)	384	35.6

[a] Excluded 3 patients with missing data
[b] Excluded 98 patients because of non-applicability of SAPS II [8]

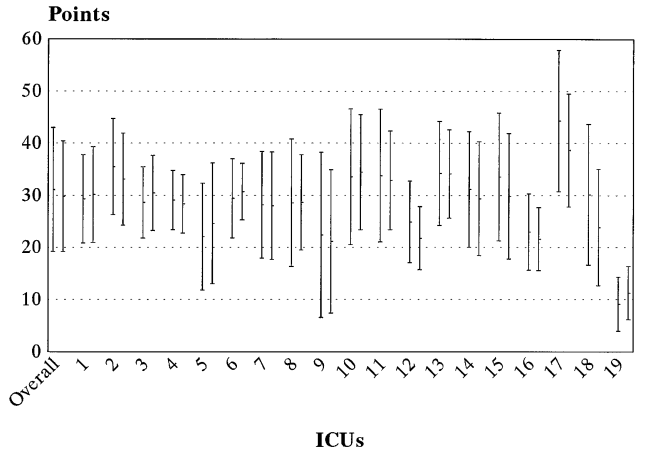

Fig. 1 TISS-76 and TISS-28 in the overall sample and among 19 ICUs. For each ICU is indicated the mean ± standard deviation for TISS-76 *left bar* and for TISS-28 *right bar*

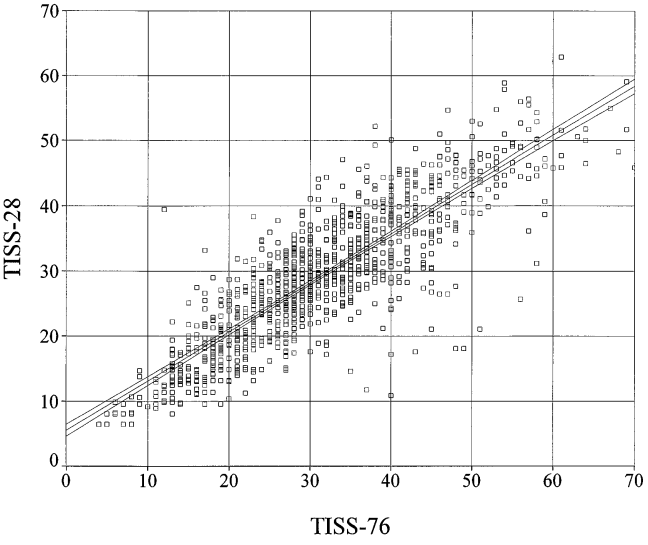

Fig. 2 Linear regression of TISS-76 versus TISS-28 in the 1080 patients analysed. The linear regression equation established is TISS-28 = 6.217 (0.475) + 0.851 (0.016) × TISS-76. Multiple $R = 0.85$, $R^2 = 0.72$

range 1.8–10.2 days) and significantly longer ($p < 0.001$) in non-survivors (median 5.6, interquartile range 1.8–14.9) than in survivors (median 3.7, interquartile range 1.8–7.8).

Most of the patients received mechanical ventilation (64.8 %) during the first 24 h in the ICU, with the frequent use of vasoactive drugs (49.3 %) and parenteral nutrition (13.7 %). Central venous catheterisation was used during the same period in 71.1 % of the patients, arterial catheterisation in 28.0 % and a pulmonary artery catheter in 5.1 % of the patients.

The reliability of both systems was very good, with a intraclass correlation coefficient of 0.93 (95 % confidence interval 0.83 to 0.98) for TISS-28 and 0.95 (95 % confidence interval 0.86 to 0.98) for TISS-76.

Mean TISS-28 was 29.8 ± 10.6 (range 7–63) and mean TISS-76 was 31.1 ± 11.9 (range 4–70), with large variations among ICUs (Fig. 1). At ICU level, mean values ranged from 11.3 ± 5.1 to 38.7 ± 10.8 for TISS-28 and from 9.1 ± 8.2 to 44.3 ± 13.6 for TISS-76. Overall, TISS-28 underestimated TISS-76 (mean difference 1.3 points, $p < 0.001$).

In the comparison of the two systems, a linear regression equation was established (Fig. 2) as TISS-28 = 6.217 (0.475) + 0.851 (0.016) × TISS-76. Values within brackets are standard errors.

Discussion

The quantification of nursing workload represents an obligatory part of the evaluation of intensive care. This

measurement makes possible the precise evaluation of the utilisation of ICU facilities [2], the appropriateness of the number of ICU beds [3, 11] and the definition of the level of care at which ICUs operate [5, 12]. As cost constraints increase, these measurements become more and more important. TISS-28 has been shown previously to allow a precise quantification of the nursing workload in intensive care [6, 7]. It is easy to perform; the main criticism that can be raised against it is the absence of studies that demonstrate its validity outside the Dutch setting.

In this study, we evaluated the performance of TISS-28 on a database that was completely independent from the one used to develop and validate the system. This step in the use of a new instrument on another population of patients is important. In recent years, several instruments developed and validated in one population [13] failed later to confirm their original performance when used in different settings [14]. Although there is some debate about why this occurs, differences in patient mix and in local practices can account for most of the discrepancies [15].

We demonstrated that TISS-28 can be computed in a reliable way (intraclass correlation coefficient 0.93) and similarly to TISS-76 (intraclass correlation coefficient 0.93), although all of the people involved in this study had much more experience of the definitions and collection of data necessary for the computation of TISS-76 than of the new method. When compared with the original database [7], TISS-28 explained less variability (72 vs 86 %) and showed a small but significant trend to underestimate TISS-76 (mean difference 1.3 points).

In the Portuguese study population, the number of TISS points scored on the admission day by each patient was higher than in the Dutch study used to validate the system. It should be noted that the difference between mean TISS-76 and mean TISS-28 was smaller in Portugal (mean difference 1.3 points) than in The Netherlands (mean difference 4.6 points); moreover, the trend to overestimation of the TISS-76 described was not found in our results. This seems to suggest a better correspondence between the values of TISS-76 and TISS-28 than in the original validation study, although it explained less variability (72 vs 86 %) of the TISS-76. However, we did not study the patients during the entire stay in the ICU and we admit that the differences between the two systems will increase as the therapeutic intensity diminishes, since the smaller number of items on TISS-28 could lead to a less smooth decrease of scores over the stay in the ICU.

We did not address in this study two of the most usual criticisms of TISS-76: the amount of time needed to score it and the imprecision of some of the definitions. However, it seems logical to assume that the replacement of 76 by 28 items, and the more precise definition of all the variables involved, should reduce these problems.

Our results demonstrate that, at least in this population, this new system can replace TISS-76 in the evaluation of nursing workload in intensive care.

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