Simplified Therapeutic Intervention Scoring System: The TISS-28 items—Results from a multicenter study

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Objectives: To validate a simplified version of the Therapeutic Intervention Scoring System, the TISS-28, and to determine the association of TISS-28 with the time spent on scored and nonscored nursing activities.

Design: Prospective, multicenter study.

Setting: Twenty-two adult medical, surgical, and general Dutch intensive care units (ICUs).

Patients: A total of 903 patients consecutively admitted to the ICUs.

Interventions: TISS-28 was constructed from a random sample of 10,000 records of TISS-76 items. The respective weights were calculated using multivariable regression analysis through the origin; TISS-76 scores were used as predicted values. Cross validation was performed in another random sample of 10,000 records and the scores of TISS-76 were compared with those scores obtained with TISS-28 ($r = .96$, $r^2 = .93$).

Nursing activities in the ICU were inventoried and divided into six categories: a) activities in TISS-28; b) patient care activities not in TISS-28; c) indirect patient care (activities related to but not in direct contact with the patient, such as contact with family, maintaining supplies); d) organizational activities (e.g., meetings, trainee supervision, research); e) personal activities (for the nurse him/herself, such as taking a break, going to the bathroom); f) other.

During a 1-month period, TISS-76 and TISS-28 scores were determined daily from the patient's records by independent raters. During a 1-wk period, all of the nurses on duty scored their activities using a method called "work sampling."

Measurements and Main Results: The analysis of validation included 1,820 valid pairs of TISS-76 and TISS-28 records. The mean value of TISS-28 (28.8 ± 11.1) was higher ($p < .00$) than that value of TISS-76 (24.2 ± 10.2). TISS-28 explained 86% of the variation in TISS-76 ($r = .93$, $r^2 = .86$).

"Work sampling" generated 10,079 registrations of nursing activities, of which 5,530 could be matched with TISS-28 records. Samples were taken from medical (19.3%), surgical (19.1%), and general (61.6%) ICUs. Of these samples, 51.1% originated from university hospitals, 35.8% from hospitals with >500 beds, 7.1% from hospitals with 300 to 500 beds, and 5.8% from hospitals with <300 beds. Samples were scored in the morning (43.0%), evening (32.9%), and night shifts (24.1%). This sample of work activities was divided into four groups, according to their matched TISS scores (0 to 20, 20 to 35, 35 to 60, and >60 points). In the successive groups of TISS scores, there was a significant increase in the proportion of time spent on the activities scored with TISS-28. In the lower TISS score group (0 to 20 points), there was a significantly larger proportion of time allocated to patient care activities not in TISS-28. There was no significant difference in the proportion of time spent when associating indirect patient care and organizational activities with the level of TISS score. There was a significant decrease in the proportion of time spent on personal activities in the successive groups of TISS scores. The mean time spent per shift with personal activities varied between 1 hr and 40 mins (group 0 to 20 points TISS), and 1 hr and 16 mins (group >60 points TISS). Significantly more time was used for patient care activities during the evening shift than during the day or the night shift. Conversely, nurses spent significantly less time on activities regarding their personal care during the evening shift. The time consumed for the activities of indirect patient care did not differ significantly among the three shifts.

A typical nurse was capable of delivering work equal to 46.35 TISS-28 points per shift (one TISS-28 point equals 10.6 mins of each nurse's shift).

Conclusions: The simplified TISS-28 explains 86% of the variation in TISS-76 and can therefore replace the original version in the clinical practice in the ICU.

Per shift, a typical nurse is capable of delivering nursing activities equal to 46 TISS-28 points. This information, together with the information concerning the association of TISS score with the time spent in the various nursing activities within the ICU, is relevant to the management of nursing manpower in the ICU. (Crit Care Med 1996; 24:64–73)

KEY WORDS: nursing workload; nursing staff; critical illness; patient outcome assessment; intensive care unit; Therapeutic Intervention Scoring System; severity of illness index

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The Therapeutic Intervention Scoring System (TISS) developed by Cullen et al. (1) is a set of 76 selected therapeutic activities among the many activities performed in intensive care units (ICUs). The score has proven to be a reliable indicator of the use of nursing manpower in the care of patients. It was assumed that 40 to 50 TISS points per day correspond to the work of three nurses, or to that of one nurse per 8-hr shift (1). The TISS score was also developed initially to stratify severity of illness. However, although TISS correlates fairly well with the severity of illness of patients, its use for this purpose was abandoned after the appearance of more specific scoring systems (2–5). The instrument was revised and modernized by the authors in 1983, remaining basically unchanged after the replacement of some items by others (6).

Since 1974, the original TISS-76 has been recognized and used worldwide

to compare the use of nursing manpower between groups of patients. Because of its importance for nursing management purposes, TISS has become a tool for both the staff of the ICU and the administrative staff involved in ICU policy-making concerns. It is therefore possible that in some ICUs, the nursing staff is confronted with the daily task of screening the activities scored in TISS for administrative purposes, without a direct relation to the organization of their tasks at patient care level In such circumstances, scoring becomes a necessity mandated by others, which is perhaps the basis for the criticisms made regarding TISS, and may also be the basis for the frequently observed interrater scoring differences.

Four major criticisms are often made regarding the original TISS-76: a) It is time consuming. Depending upon the experience of the user, the scoring takes about 3 to 5 mins. b) The use of the instrument is rather cumbersome and perhaps even boring. The instrument screens many items that address similar nursing activities at different weights. c) The items listed do not always adequately reflect the patient care activities of nurses in the ICU. d) Since it exclusively scores direct patient care activities, TISS does not reflect several other daily activities of the nursing staff that are equally important to the professionals and to the organization and management of the ICU. The first two criticisms are not addressed in this study.

The Foundation for Research on Intensive Care in Europe, created 10 yrs ago for stimulating and guiding research on the organization and management of ICUs, is building up a large database that includes information from various ICUs across Europe.

The first objective of the current study was to construct a simplified TISS, with the same objectives of application as the TISS-76, that would take into consideration the criticisms pointed out above. Moreover, the final score obtained with the new TISS version should be easy to compare with that of the original version. Thus, ICUs using the TISS-76 and wishing to use the new system should be enabled to do so without losing the full value of the previous information. On the other hand, given that other ICUs continue to use the original version, and because TISS is an excellent tool for managerial comparisons between ICUs, the new system should stimulate, not impair, these comparisons. The 37,000 TISS records in the database of the Foundation for Research on Intensive Care in Europe were used for this purpose.

The second objective of the study was to establish an association between the TISS score and the distribution of time among the full range of nursing activities in the ICU. This association will allow for the estimation of the proportion of time that is spent on TISS activities.

MATERIALS AND METHODS

Construction of the TISS-28. TISS records (n = 10,000) were randomly extracted from the database of the Foundation for Research on Intensive Care in Europe. Selection of the items to be excluded from the original TISS of 76 items was performed in four steps: item selection, item clustering, item reduction, and cross validation.

Item Selection. The 10,000 selected records were divided into four groups based on total TISS score: 1 to 14 points (23% of the records); 14 to 24 points (36%); 25 to 34 points (26%); and >35 points (15%). A percentage frequency distribution of the 76 TISS items among these four groups was computed to determine the relative impact of each item on the total score per group. Based on clinical assessment, those items that were seldom applied (e.g., phlebotomy for volume overload), and those items that were not frequently applied and in which distribution of frequencies did not contribute to discrimination between the four groups (e.g., cardioversion for arrhythmia) were eliminated.

Item Clustering. A principal components factor analysis of all 76 TISS items identified 34 factors with an Eigen value of ≥ 1.00 (see Statistical Analysis). These 34 factors were responsible for 57% of the total variance. The first factor included 26 items (responsible for 7.6% of the variance) and was mainly composed of cardiovascular and respiratory items. The association of items in the various factors was meaningful from a clinical point of view (e.g., respiratory support, cardiovascular support, metabolic support). Factor loadings of <0.4 were eliminated (e.g., intra-aortic balloon assist).

Item Reduction. After eliminating ten items following the criteria expressed above, the remaining number of items was reduced to 28 items (Table 1). The items eliminated included balloon tamponade of varices, continuous arterial infusion, G-suit (special suit to increase external pressure), platelet transfusion, blind intratracheal suctioning, hypothermia blanket, phlebotomy for volume overload, complicated orthopedic traction, and one and two peripheral intravenous catheters. The reduction was obtained by merging items that described similar activities (Table 2).

Cross Validation. Using multivariable regression analysis through the origin, weights were attributed to the 28 items, using the original TISS score per record as the predicted score value. The attributed weights are presented in Table 1. These weights were crossvalidated in another sample of 10,000 TISS records randomly extracted from the database. The score of TISS-76 items was then compared with that score obtained with TISS-28 items ($r = .96$, $r^2 = .93$).

A principal components factor analysis of the 28 items identified 11 factors that were responsible for 61.7% of total variance. The first factor of these 11 items responsible for 14.3% of the total variance was composed of items related to respiratory care and feeding. The second factor (7.5% of variance) was composed of items of support of the cardiovascular system. The third factor (5.9%) was composed of items of the basic activities (Table 3). The association between cardiopulmonary resuscitation and dialytic techniques and forced diuresis (factor 5, 4.7%), between intracranial pressure monitoring and specific interventions outside the ICU (factor 8, 3.8%), and between single and multiple specific interventions in the ICU (factor 9, 3.7%) were noteworthy.

Clinical Validation of TISS-28. Although the internal validation of the TISS-28 items was tested during the second randomly extracted sample of 10,000 records, it was necessary to validate its use in clinical practice, since some items were new (merged) and a new, nontested description was given to the majority of the other selected items.

Table 1. Therapeutic Intervention Scoring System-28

	Points
Basic Activities	
Standard monitoring Hourly vital signs, regular registration and calculation of fluid balance	5
Laboratory. Biochemical and microbiological investigations	1
Single medication. Intravenously, intramuscularly, subcutaneously, and/or orally (e.g., gastric tube)	2
Multiple intravenous medication More than one drug, single shots, or continuously	3
Routine dressing changes. Care and prevention of decubitus and daily dressing change	1
Frequent dressing changes. Frequent dressing change (at least one time per each nursing shift) and/or extensive wound care	1
Care of drains All (except gastric tube)	3
Ventilatory Support	
Mechanical ventilation. Any form of mechanical ventilation/assisted ventilation with or without positive end-expiratory pressure, with or without muscle relaxants, spontaneous breathing with positive end-expiratory pressure	5
Supplementary ventilatory support Breathing spontaneously through endotracheal tube without positive end-expiratory pressure; supplementary oxygen by any method, except if mechanical ventilation parameters apply	2
Care of artificial airways. Endotracheal tube or tracheostoma	1
Treatment for improving lung function. Thorax physiotherapy, incentive spirometry, inhalation therapy, intratracheal suctioning	1
Cardiovascular Support	
Single vasoactive medication. Any vasoactive drug	3
Multiple vasoactive medication. More than one vasoactive drug, disregard type and doses	4
Intravenous replacement of large fluid losses. Fluid administration >3 L/m²/day, disregard type of fluid administered	4
Peripheral arterial catheter	5
Left atrium monitoring Pulmonary artery flotation catheter with or without cardiac output measurement	8
Central venous line	2
Cardiopulmonary resuscitation after arrest; in the past 24 hrs (single precordial percussion not included)	3
Renal Support	
Hemofiltration techniques. Dialytic techniques	3
Quantitative urine output measurement (e.g., by urinary catheter à demeure)	2
Active diuresis (e.g , furosemide >0 5 mg/kg/day for overload)	3
Neurologic Support	
Measurement of intracranial pressure	4
Metabolic Support	
Treatment of complicated metabolic acidosis/alkalosis	4
Intravenous hyperalimentation	3
Enteral feeding. Through gastric tube or other gastrointestinal route (e.g., jejunostomy)	2
Specific Interventions	
Single specific intervention in the intensive care unit. Naso- or orotracheal intubation, introduction of pacemaker, cardioversion, endoscopies, emergency surgery in the past 24 hrs, gastric lavage. Routine interventions without direct consequences to the clinical condition of the patient, such as radiographs, echography, electrocardiogram, dressings, or introduction of venous or arterial catheters, are not included	3
Multiple specific interventions in the intensive care unit. More than one, as described above	5
Specific interventions outside the intensive care unit Surgery or diagnostic procedures	5

Criteria of exclusion are applied in four conditions: "Multiple intravenous medication" excludes "single medication", "mechanical ventilation" excludes "supplementary ventilatory support", multiple vasoactive medication" excludes "single vasoactive medication", "multiple specific interventions in the intensive care unit" excludes "single specific interventions in the intensive care unit "

Twenty-two Dutch ICUs participated in the clinical validation study (Appendix). The selection of the ICUs followed three criteria: a) the scores collected should come from both medical and surgical ICUs; b) the scores collected should come from ICUs with different levels of organization, such as university and nonuniversity, different sized hospitals; and c) the participating ICUs should be acquainted with the use of TISS-76. The characteristics of the ICUs are presented in Table 4. The coordinators of the study in each ICU, usually acquainted with the scoring of TISS-76, received specific training on the scoring of TISS-28.

During a 4-wk period, all consecutive admitted patients were enrolled in the study. The first week was dedicated to the training of the nurses on the floor with the scoring of TISS-28, which was scored once per shift per patient. During the remaining 3 wks, TISS-28 and TISS-76 were simultaneously scored once per day per patient, regarding the previous 24 hrs in the ICU. TISS-28 was scored by the nurse responsible for that patient on the third shift of that 24-hr period, TISS-76 was independently scored for all patients present each day, by the

Table 2. Reduction of 34 Therapeutic Intervention Scoring System (TISS)-76 items into 13 TISS-28 items

1	Standard monitoring Hourly vital signs Electrocardiographic monitoring Routine 24-hr fluid balance and hourly neurologic checks
2	Laboratory Multiple arterial blood gases and biochemistry studies
3.	Single medication and multiple intravenous medication Intravenous antibiotics Parenteral chemotherapy Intermittent intravenous medication (scheduled/unscheduled) Concentrated potassium infusion via central catheter Acute digitalization Anticoagulation
4.	Routine dressings Multiple dressing changes and extensive wound treatment
5	Mechanical ventilation Controlled ventilation with or without positive end-expiratory pressure Controlled ventilation with muscle relaxation Intermittent mandatory or assisted ventilation Continuous positive airway pressure
6	Supplementary ventilatory care Supplemental oxygen Spontaneous respiration via endotracheal tube
7.	Care of artificial airways Fresh tracheostomy and tracheostomy care
8	Infusion of one or more vasoactive drugs Vasoactive drugs Continuous antiarrhythmia drugs Pitressin infusion
9.	Fluid replacement Frequent infusions of blood Replacement of excessive fluid loss
10	Left heart monitoring Pulmonary artery flotation catheter Cardiac output measurement
11.	Dialytic techniques Hemodialysis (stable/unstable) Peritoneal dialysis
12.	Single and multiple interventions in the intensive care unit Pacemaker (atrial/ventricular/standby) Nasotracheal or orotracheal intubation Emergency endoscopy or bronchoscopy Cardioversion Lavage of acute gastrointestinal bleeding
13.	Specific interventions outside the intensive care unit Emergency operative procedures Diagnostic procedures outside the intensive care unit

study coordinator or his/her deputy. Interrater reliability was not addressed by the study. The two blinded scores, provided with the code number of the patient, were filed separately in the ICU and sent to the University Hospital of Groningen when the patient was discharged from the ICU.

Relation of TISS-28 Score With Nursing Activities in the ICU. The various nursing activities in the ICU were inventoried before the validation study. One of the authors (A.dR.) led a panel of nurses in the detailed inventory of all possible tasks and activities developed by the nursing staff of an ICU. A provisional list of activities was submitted for the independent consideration of other nursing staff members. The final list of activities is shown in Table 5. The activities were categorized into six groups: a) patient care activities consigned to TISS-28; b) patient care activities not indicated in TISS-28; c) activities which, although related to the presence of a given patient in the ICU and necessary to patient care, are not interventions in direct contact with the patient; d) organizational activities related to the nursing profession and/or general organizational aspects of the ICU, but not related to any specific patient; e) personal activities of the nursing staff; f) miscellaneous activities that could not be classified in one of the other five categories.

During the last week of the study, the nurses on duty were asked to note on a special form which activity they were occupied with at that particular moment and to check off the appropriate category (Table 5). The preselected moments at which this registration in each ICU should take place were randomly generated by a computer program capable of determining 20 random moments from 0000 to 2400 hrs. Accordingly, the nurses on duty would be asked to register their activities on appropriate forms about seven times during each 8-hr shift. Each ICU chose its own method of indicating each register moment to all nurses (bell, alarm clock, etc). The code number of the patient whose care was attributed to the responding nurse was noted on the appropriate form. This method of work analysis is called *work sampling*. The basic principle of work sampling is that by taking instantaneous samples of the relevant work-related activities of individuals, the time spent on each activity can be estimated. By subsequently summing up these observations into particular categories, the so-called *time spending pattern* is obtained. This pattern reflects the distribution of time across these particular categories. For more details, the reader is referred to references 8–10.

According to the second objective of this study, we assumed that in association with different levels of TISS, different time spending patterns could be detected. For each nurse, the TISS-28 score of his or her patient(s) was computed, and these records were grouped into four categories. 1 to 20 points, 20 to 35 points, 35 to 60 points, and >60 points. The mean TISS scores for each of these categories were

Table 3. Factor analysis of Therapeutic Intervention Scoring System-28 items

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10	Factor 11
Standard monitoring				52							
Laboratory				.69							
Single medication		.97									
Multiple intravenous medication		.95							.76		
Routine dressing changes					.68						
Frequent dressing changes					.70						
Care of drains											
Mechanical ventilation	.80										
Supplementary ventilatory support											
Care of artificial airways	.86										
Treatment for improving lung function	64										
Single vasoactive medication								.82			
Multiple vasoactive medication			76								
IV replacement of large fluid losses						.52					
Peripheral arterial catheter				.58							
Left atrium monitoring			.66								
Central venous catheter					.42						
Cardiopulmonary resuscitation after arrest						.41					
Hemofiltration techniques							.76				
Quantitative urine output measurement				.53							
Active diuresis			54								
Intracranial pressure measurement											.88
Treatment of complicated metabolic acidosis/alkalosis						.52					
Intravenous hyperalimentation							.47				
Enteral feeding	68										
Single specific intervention in the ICU						.70					
Multiple specific interventions in the ICU										.89	
Specific interventions outside the ICU						41					

IV, intravenous; ICU, intensive care unit.

Table 4. Participating intensive care units (ICUs)

	Hospitals				
ICUs	<300 Beds	300–500 Beds	>500 Beds	University Hospitals	Total
Medical	1	1	2	1	5
	110	79	184	140	513
Surgical	—	—	—	4	4
	—	—	—	272	272
General	1	2	4	3	10
	33	169	455	378	1035
Total	2	3	6	8	19
	143	248	639	790	1820

Per each item, the first figure indicates the number of ICUs and the second figure indicates the number of valid pairs of Therapeutic Intervention Scoring System records

related to the work sampling data of the nurses, whereby the patient number was the key variable to link both data sets.

The Institutional Review Board of the participating hospitals approved the study and waived informed consent.

Statistical Analysis. The TISS-28 sample mean values, between continuous variables, were analyzed using the Student's two-sample *t*-test. Values were mean ± SD. A $p < .05$ was considered statistically significant. Correlation between variable values was evaluated with the

Table 5. List of nursing activities in the intensive care unit

Category I
Nursing activities relating directly to the patient and part of Therapeutic Intervention Scoring System (TISS)-28 (see Fig. 1)

Category II
Activities relating directly to the patient and not included in TISS-28
- Support Helping the patient to understand and accept his/her clinical condition
- Communication Communication with the patient, e.g., informing, observation and maintenance of the psychic condition; taking measures to maintain or improve the capacity of communication (e g., working with character board)
- Safety. Ensuring the safety of the patient, e.g , isolation, restraints
- Comfort. Ensuring the physical comfort and rest of the patient
- Hygiene. Ensuring the physical hygiene of the patient
- Activate Encouraging passive movements, changing position, mobilizing
- Lifting. Lifting the patient, weighing the patient, placing patient in chair
- Assisting Assisting others in direct care activities, such as inserting a catheter, washing, thorax radiography, echography

Category III
Activities that are not performed for, or in direct contact with the patients, but that are necessary for the continuity of the personal care of the patient
- Family. Contact with and support of the family
- Other disciplines. Contact with other disciplines, such as technical service, physiotherapy, laboratory, radiology, for the patient or equipment of one patient
- Coordinating tasks Coordinating tasks, such as consultation with the team, reporting, work council, consultation with doctors
- Paperwork Paperwork, such as reporting, registration and administrative tasks (not the standard monitoring at TISS)
- Equipment Taking care of equipment, such as maintenance, cleaning, gauging
- Domestic activities Cleaning waste according to instruction
- Supply maintenance. Refilling the supplies for a patient
- Other activities. Activities not planned/intended, such as looking for property of the patient (e g , glasses) or equipment (e.g., balance)

Category IV
Activities not relating directly to a patient and not medical These activities ensure that everything fits together as it should
- Meetings dealing with organizational issues
- Making duty-rosters
- General refilling of supplies for the whole team
- Trainee supervision
- Research activities
- Following professional training in time of service
- Contact with the general hospital services

Category V
For the nurse him/herself. Taking a break, going to the toilet, waiting, chatting

Category VI
Everything which does not possibly fit in one of the above-mentioned categories

Pearson's correlation test. Correlations were considered for $r > .4$ and $p < .05$.

Explorative factor analysis was used to study meaningful interrelations among the variables scored in TISS. The factor analysis is a multivariable analysis exclusively with an explorative value, aiming to analyze the interrelations among a set of variables. However, in opposition to other multivariable analysis techniques (in which dependent and predictor variables are considered), factor analysis is an interdependence technique in which all the variables are considered simultaneously. Thus, the underlying patterns or relationships among variables become apparent in several groups of more or less interdependent variables, also called "factors" or "dimensions." The dependence, or correlation of each variable with the respective factor is called the factor loading of the variable. Squared factor loadings indicate what percentage of the variance in each original variable is explained by the respective factor. The sum of squares for a factor, representing the amount of variance accounted for by the factor, is called the Eigen value of the factor. When using the orthogonal rotation, as used in the analysis, the identified factors tend to be independent among them. Factor loadings were accepted when r was >.4.

Since work sampling is a statistical procedure that involves the estimation of the proportion of time spent on particular activities, the accuracy of the resulting time spending pattern depends on the size of the sample, the magnitude of the proportions of time, and the chosen level of significance (.05 in this study). Since time spending patterns have to be compared for each level of TISS, the accuracy of each pattern was assessed first. Accuracy is a measure of "relative unreliability" to compare the reliability of the different time spending patterns It is calculated by dividing the reliability interval of the largest proportion of that particular time spending pattern (that row) by the magnitude of the proportion. The largest proportion has the largest unreliability, hence, all other proportions in that pattern have higher reliabilities. For accurate estimates, the accuracy must be <10% (7, 11). Second, within each particular category, the chi-square statistic was computed to compare the proportion of time between the different groups of TISS scores. If the level of significance of the computed chi-square is <.05, the proportions differ significantly.

The statistical calculations in the study, including randomizations, were performed using the Statistical Package for Social Sciences, SPSS-X (version 3.0, The Universities of Groningen and Nijmegen).

RESULTS

Validation of TISS-28. Twenty-two Dutch ICUs participated in the study. As can be seen in Table 4, five of the ICUs were medical, four were surgical (all at university hospitals), and ten were medical/surgical or general ICUs. One of the surgical ICUs was a thoracic surgery ICU. The data of 19 ICUs were used for the validation of the TISS-28. Three ICUs were excluded because they used a TISS-76 score with a slightly different composition of items.

The study generated 3,484 TISS-76 and 2,432 TISS-28 records. The difference is due to the different scoring pattern during the first week of the study, during which TISS-28 was scored every 8 hrs instead of every day. After eliminating those records that a) scored a period of time ≤12 hrs (491 TISS-76 and 560 TISS-28 records); b) had a score of 0 (163 TISS-76 and 106 TISS-28 records); c) were incompletely filled regarding date and/or code number (717 TISS-76 and 80 TISS-28 records), there were 2,113 TISS-76 and 2,432 TISS-28 valid records obtained. Of these records, 1,820 valid pairs could be matched for analysis.

The mean value of the TISS-28 records (28.8 ± 11.1) was significantly ($p < .00$) higher than that value of TISS-76 (24.2 ± 10.2). Figure 1 shows the correlation between TISS-28 and TISS-76 scores ($r = .93$, $r^2 = .86$). TISS-28 can explain 86% of the variation in TISS-76. The regression equation is TISS-28 = 3.33 + 0.97 × TISS-76. Accordingly, the TISS-28 and the TISS-76 are nearly identical.

Relation of TISS-28 Score to Nursing Activities in the ICU. A sample of 10,079 registrations of nursing activities were generated during the study. The TISS scores were converted from the patient level (which applied for 24 hrs) to the nurse level (which applied for one shift). (TISS scores nursing activities during 24 hrs/patient. One nurse works an 8-hr shift. Thus, each patient receives care during three nursing shifts each day.) By computing the TISS-28 scores of each nurse's patient(s), 676 TISS-28 records were converted into 798 TISS scores per nurse per shift, which covers 909 nursing shifts. After matching the registrations of nursing activities with the corresponding TISS data, 5,530 registrations were valid for analyses. The elimination of 4,449 registrations was due to the following three factors: a) the absence of TISS-28 scores to match to these registrations (1,925 registrations). Of these records, not all of the nurses who registered their activities had responsibility for patient care on that particular moment. Therefore, their activities could only be among those activities in categories 4, 5, or 6 (808 records). Furthermore, patients often left the ICU before TISS could be scored on the day of discharge (1,117 records). b) The mismatch between registered activities data and data on TISS-28 (e.g., date, code number) (1,826 records). c) More than one nurse caring for a patient (698 records).

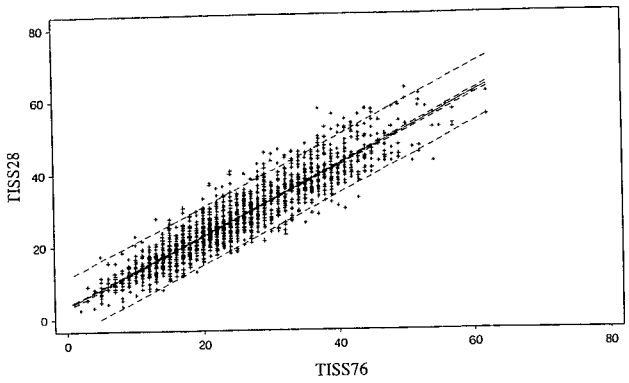

Figure 1. Simple regression plot and 95% confidence interval of Therapeutic Intervention Scoring System (*TISS*)-76 items vs TISS-28 items in 10,000 records TISS-28 = 3 33 + 0.97 x TISS-76

Of the samples taken, 19.3% were from medical ICUs, 19.1% from surgical ICUs, and 61.6% from general ICUs. Regarding the type of hospital, 51.1% of the sample originated from university hospitals, 35.8% from nonuniversity hospitals with >500 beds, 7.1% from nonuniversity hospitals with 300 to 500 beds, and 5.8% from nonuniversity hospitals with <300 beds.

Additionally, 43.0% of the sample was from nurses on the day shift, 32.9% from nurses on the evening shift, and 24.1% from nurses on the night shift. Almost half (47.7%) of the sample was from nurses with one patient; 45.1% was from nurses with two patients, and the remainder (7.2%) was from nurses with more than two patients.

Table 6 presents the proportions of time spent on each category matched with the TISS-28 score divided into four groups. The proportions in the first column are not homogeneous ($p < .00$), since there is an increase of time spent on activities scored in category 1 in the successive groups of TISS scores. In the lower TISS score group (0 to 20 points), there is a significantly larger percentage of time allocated to patient care activities not scored in TISS-28. There is no significant difference in the time spent on categories 3 and 4 between the different groups of TISS scores. There is a significant decrease of time spent on personal care (category 5) in the successive groups of TISS scores. The mean time spent on personal care, with a mean shift of 8 hrs and 10 mins, was 1 hr 40 mins in the group with 0 to 20 TISS points, 1 hr 30 mins in the group with 20 to 35 points, 1 hr 19 mins in the group with 35 to 60 points, and 1 hr 16 mins in the group with >60 TISS points.

Table 7 demonstrates the mean time spent per nurse in each activity category per daily shift. Significantly more time is used for patient care activities during the evening shift than during the day or the night shift. Conversely, nurses spend less time on activities regarding their personal care during the evening shift. The time consumed with the activities in category 3 does not differ significantly among the three shifts.

An average nurse was capable of delivering care equal to 46.35 TISS-28 points per shift. Therefore, 1 TISS-28

point equals 10.6 mins of the 490.20 mins in each nurse's shift.

Separate analysis was done regarding nurses with more than one patient (mainly two patients). The results of this analysis showed that the time spending pattern of those nurses is similar to the pattern of nurses with one patient with a high (35 to 60) TISS score. Nurses with two patients scored 57.2 ± 13.4 TISS points, and nurses with three patients scored 66.4 ± 15.9 TISS points; their time spending patterns did not differ across the TISS categories.

DISCUSSION

This study revisited the TISS developed by Cullen et al. (1) 20 yrs ago to evaluate the use of nursing manpower for intensive care patients. Using a large database of records, a simplified scoring system, the TISS-28 items, was proposed and validated. Moreover, using work sampling, the time spent on various nursing activities was estimated and related to the level of TISS score. Also, the time consumed by 1 TISS point was estimated.

TISS-28. The selection of the 76 activities in the original TISS-76 items was exclusively based on clinical grounds, and the respective attribution of weights by a panel of experts followed two criteria: a) The *inventory criterion* through which similar activities receive equal weights, e.g., hourly vital signs (1 point), electrocardiographic monitoring (1 point). The "inventory criterion" mainly reduced the chance of obtaining scores that could be disproportionately low in relation to the overall nursing workload, therefore avoiding a situation whereby

Table 6. Distribution of time per nursing activity in relation to Therapeutic Intervention Scoring System (TISS)-28 score

TISS Points	Categories of Nursing Activities[a]							
	1	2	3	4	5	6	Total[b]	Accuracy
0–20	32.0	20 2	19.2	4.4	20.9	3.4	5.4 297	.169
20–35	40 0	12 0	20 8	5.3	18.8	3 2	24.5 1354	.067
35–60	45.1	12 8	21.3	2.8	16 5	1.5	45.8 2530	.044
>60	45.6	12.7	22.9	2.2	15.8	0.8	24.4 1349	.059
Total	43 3 2392	12.9 716	21.4 1186	3.3 185	17.1 947	1.9 104	100 5530	031
Sign column	.000	.001	.085	.495	.000	.090	.000	

[a]Category 1, activities involving patient care as scored in TISS; category 2, activities involving patient care not scored in TISS; category 3, "indirect" patient care, category 4, organizational tasks; category 5, work breaks, category 6, other activities (see Table 5); sign column, overall significance per column; [b]total per category. The first figure indicates overall percentage of time per category The second figure is the total number of "work sampling" registrations made in the category

Per nursing activity category in each TISS points interval class, time is expressed as a percentage of a mean of 490 mins per nurse shift.

Table 7. Distribution of time per nursing activity in relation to work shifts

Shift	Categories of Nursing Activities[a]							
	1	2	3	4	5	6	Total[b]	Accuracy
Morning	40.0	14.8	21.3	4 6	17.8	1.6 2378	43.0	050
Evening	51.1	11.9	20.2	1.8	13.1	1.9 1821	32.9	.047
Night	38.3	11.1	23 4	3.3	21.5	2.4 1331	24 1	069
Total	43.3 2392	12.9 716	21.4 1186	3.3 185	17.1 947	1.9 104	100 5530	.031
Sign column	.000	.004	.147	.000	000	.229	.000	

[a]Category 1, activities involving patient care as scored in Therapeutic Intervention Scoring System (TISS), category 2, activities involving patient care not scored in TISS; category 3, "indirect" patient care; category 4, organizational tasks; category 5, work breaks, category 6, other activities (see Table 5); sign column, overall significance per column; [b]total per category. The first figure indicates overall percentage of time per category. The second figure is the total number of "work sampling" registrations made in the category.

Per nursing activity category in each shift, time is expressed as a percentage of a mean of 490 mins per nurse shift.

several activities performed could not be found among the few listed. b) The *representation criterion*, through which one activity may receive a higher weight than a similar one, e.g., controlled mechanical ventilation (4 points), intermittent mandatory ventilation (3 points). In this case, the different weights associate the scored items with severity of illness, and the higher score also scores for the performance of other nonmeasured activities. Other examples could be: the infusion of one vasoactive drug (3 points) and more than one vasoactive drug (4 points), often administered together in the same infusion; the acute digitalization (3 points) and the administration of antibiotics intravenously (1 point), which are similar activities implying similar workload.

In the last 20 yrs, however, the admission criteria and the standards of care in ICUs have changed substantially. Today, for example, the standard monitoring of intensive care patients is broader, including many activities that 20 yrs ago were more selectively performed. In addition, the majority of the admitted patients require the frequent estimation of various vital biochemistry variables and, frequently, the administration of diverse medications. These monitoring and/or therapeutic activities are not always clearly associated with the severity of illness of the patients. Therefore, many of the items listed on the TISS-76 may have lost much of their discriminative power and have been clustered according to types of activity in the new 28 items version of TISS (e.g., Basic Activities, Table 1).

A similar criterion was followed when reducing the number of items related to the support of the function of organs and systems. The ventilatory support mode used, for example, is today more dependent on the policy in use in the ICU than on the severity of illness of the patient. Therefore, all ventilatory modes were brought under one item, mechanical ventilation (Table 1).

Besides being a much shorter list, the items listed in the TISS-28 could be grouped into seven main headings. These meaningful clinical headings focus on the treatment of the critically ill, listing some representative items in each of them, without claiming to be an exhaustive description of activities.

The validation of the TISS-28 was done at 22 Dutch ICUs. Table 4 shows that the total number of valid TISS pairs collected (second row in each cell), in relation to the type and size of the hospital where the ICUs were operating, was proportionately lower than the ICUs of smaller hospitals. This difference was caused by a larger number of patients staying $\leq$12 hrs (in relation to the moment of scoring) in the ICUs of these hospitals. With the exception of thoracic surgery, ICUs that admitted specific types of patients (e.g., neurology/neurosurgery, coronary care units, pediatric, burns) were not included in the study. One of the criticisms often heard from the clinical field regarding TISS is that it cannot measure the nursing activities of many specific ICUs. The answer to these criticisms was not addressed in the study.

The TISS-28 was exclusively validated in Dutch ICUs. Because of possible differences of patterns of work of the nurses and even differences of the contents of their jobs across countries, it may be necessary to validate TISS-28 in a multinational group of ICUs.

TISS and Other Nursing Activities. This study demonstrates that the value scored with TISS predicts the use of time dedicated to the nursing activities, particularly those activities related to direct patient care and those activities related to rest and other activities to the benefit of the nursing staff members. The time spent on the performance of the activities grouped in categories 3 and 4 was not related to the level of TISS score. More time was spent on patient care (categories 1 and 2), and less time was left to personal activities (category 5), suggesting that the higher the nursing workload, the less time there is to perform personal care. Since "personal care" includes "activities" such as breaks, which are important for the nurse's recuperation, spending too little time in this category (particularly marked in the evening shift) could increase a nurse's stress levels. The results shown in Table 7 suggest that the distribution of the nursing staff by the three daily shifts should perhaps be reconsidered, admitting that the tasks attributed to the shifts are necessary and not liable to be changed. In the evening shift, the time spent on patient care is significantly higher compared with both other shifts, and the nurses have only 1 hr left for their own personal care. Moreover, 71% of the registrations of nursing activities in the evening shift were from nurses with two patients. Taking care of more than one patient resulted in a higher average TISS score. However, no differences were found in the time spending pattern of the nurses involved. Therefore, the TISS category for range of points is a valuable indicator of the nurse's activities, irrespective of the number of patients he or she is caring for.

TISS and Manpower Consumption. This study confirmed earlier observations (1) indicating that 40 to 50 TISS points represent the daily nursing activities. The value found in our study was 46.35 TISS points. One TISS point therefore represents about 10 of the total 480 mins in each nursing shift. This information is useful for planning the allocation of nursing manpower for the various patients in the ICU, and for direct accounting procedures regarding the cost of providing nursing care to patients or groups of patients.

Category 6 (other, nonspecified activities) scored low in all analyses, suggesting that the activities listed give a fair representation of the activities of the nurses in the ICU.

The TISS was reduced from 76 to 28 items and validated. TISS-28 explains 86% of the variation in TISS-76.

An average nurse is capable of delivering work equal to 46 TISS-28 points per shift, with one TISS-28 point equaling ~10 mins of each nurse's shift.

The TISS-28 is able to distinguish between different levels of the nurse's workload, with more time spent on patient care and less on personal care when TISS scores increase. The time spent on personal care was found to vary between 70 and 100 mins during each nurse's 8-hr shift. The average duration of "rest" was significantly shorter during the evening shift than during the other shifts.

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Appendix. Participating intensive care units (ICUs)

ICU	Location
ICU	
Medisch Centrum Alkmaar	Alkmaar
Scheperziekenhuis	Emmen
Academisch Ziekenhuis Maastricht	Maastricht
H35 - 403 Academisch Ziekenhuis Nijmegen	Nijmegen
H20 - 420 Academisch Ziekenhuis Nijmegen	Nijmegen
Maria Ziekenhuis	Tilburg
Diaconessenhuis Voorburg	Den Haag
Ziekenhuiscentrum Apeldoorn	Apeldoorn
St. Sophia Ziekenhuis	Zwolle
Medical ICU	
St. Chr. Ziekenhuis "Refaja"	Stadskanaal
Ziekenhuis Leijenburg	Den Haag
Martini Ziekenhuis	Van Swieten, Groningen
Martini Ziekenhuis	Van Ketwich, Groningen
Ziekenhuis Bethesda	Hoogeveen
St. Elisabeth Ziekenhuis	Amersfoort
Surgical ICU	
Academisch Ziekenhuis Rotterdam	Rotterdam
Academisch Ziekenhuis Rotterdam (isolation)	Rotterdam
Academisch Ziekenhuis Utrecht	Utrecht
Academisch Ziekenhuis Groningen	Groningen
ICU/Coronary Care	
Drechtsteden Ziekenhuis	Refaja, Dordrecht
Pediatric ICU	
Academisch Ziekenhuis Maastricht	Maastricht
High Care	
Academisch Ziekenhuis Rotterdam	Rotterdam