ARTICLE

Validity and reliability of the simplified Therapeutic Intervention Scoring System in intensive care units of a public sector hospital in Johannesburg

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Purpose. To introduce the simplified Therapeutic Intervention Scoring System (TISS-28) and to employ the original Therapeutic Intervention Scoring System (TISS-76) and Simplified Acute Physiological Score (SAPS) version II in critically ill adult patients in order to describe the validity and reliability of TISS-28 as a suitable measure of quantifying nursing workload in the adult intensive care units (ICUs) of a public sector hospital in Johannesburg.

Objectives. To describe the profile of patient admissions to the ICUs, to investigate the impact of the patients' profile on the requirements for nursing workload, and to validate the use of the TISS-28 as a measure for quantifying nursing workload in this setting.

Design. A non-experimental, comparative, correlation and prospective two-staged design was utilised to meet the study objectives. Stage I involved face and content validation of TISS-28 by a panel of 6 ICU nurse experts. Stage II involved assessment of concurrent and construct validity as well as inter-rater reliability of TISS-28 using 105 participants drawn from trauma, cardiothoracic and multidisciplinary ICUs. Data necessary for the calculation of TISS-28, TISS-76 and SAPS II were recorded for each patient in the ICU at 24 and 48 hours after admission and in the wards after discharge within 24 - 48 hours. Descriptive and inferential statistics were used to analyse data.

Results. A content validity index (CVI) of 0.93 was found for TISS-28. A significant positive correlation was found between TISS-28 and TISS-76 scores (r=0.7857, p=0.0001). Although the correlation between TISS-28 and SAPS II was significant (p=0.0317), it was small (r=0.2098). A significant intra-class correlation (ICC) was found for the data collected from a sample of patients by the researcher and expert assistant researcher (ICC=0.99; p=0.0001).

Conclusions. The findings support the validity and reliability of TISS-28 and hence its feasibility for use in South African ICUs. Recommendations for nursing education, practice, management and research are proposed.

In intensive care the requirement for nursing has traditionally always been associated with severity of illness of the critically ill patients. As a result, Cullen *et al.*[1] made the earliest attempt to quantify severity of illness in 1974 when they devised the Therapeutic Intervention Scoring System (TISS).[2] However, the use of TISS as an indicator of severity of illness was limited owing to the appearance of more sophisticated scoring systems for measuring severity of illness, such as the Acute Physiological and Chronic Health Evaluation (APACHE).[3] Since then TISS has more commonly been used as a measure of nursing workload in the ICU.[4] The original TISS was intervention based and therefore subject to variability due to practice differences between institutions and changes in practice over time.

Over the years, TISS has been updated[5] from the initial 57 to 76 therapeutic activities, which are more representative of commonly performed activities in the ICU. TISS remains the most widely used scoring system worldwide and is evident in numerous studies[4,6,7] that rely on therapeutic, diagnostic and nursing activities. TISS is currently used to determine nurse-to-patient ratios and assess current bed utilisation and need.[8]

However, the application of TISS was not without criticism, as pointed out by Miranda *et al.*,[4] and this led to development of TISS-28.

TISS-28, based on advanced statistical methods, was published by Miranda *et al.*[4] Its therapeutic items were reduced from 76 to 28 following four steps: item selection, item clustering, item reduction and cross-validation. Miranda *et al.*[4] state that one TISS-28 point corresponds to 10.6 minutes of nursing time spent on direct patient care, thus permitting a more accurate estimation of nursing workload in an intensive care unit (ICU). This is an added advantage over and above the previous versions. TISS-28 has been widely tested in numerous multi-centre and single-centre studies on independent populations in first-world countries. Recently, the instrument was tested in two studies in Hong Kong[9] and Brazil,[10] both of which have cost constraint issues similar to those in South Africa.

Currently it is estimated that only 25.6% of all nurses working in South African ICUs are intensive care trained, and 21.4% are drawn from the ranks of sub-professional nurses.[11] Using nurses without additional ICU qualification carries the risk of dilution of highly specialised practices, which could threaten the safety of care provided by ICU nurses.[12] Moreover, as there is no nationally prescribed ratio for the requirements of nursing staff in ICUs,[11] a consensus-based method of one nurse to one patient is no guarantee that quality care is provided and therefore is not cost effective.

The literature has indicated that there is a shortage of intensive care-trained nurses in South Africa.[11,13,14] For this reason highly skilled and experienced intensive care nurses no longer feel that they are involved in patient care because they are increasingly required to supervise nurses without additional ICU qualification. While this raises a concern that intensive care nurses may engage in activities that are not commensurate with their level of training and skills, it also carries a risk of dilution of highly specialist nursing care as a result of increasing placement of generalist nurses and sub-professional nurses, which will ultimately impact on patient outcomes.

The use of a scoring system based on patient illness severity, such as the TISS-score, provides an objective measurement of the requirements for nursing care and use of resources.[15] To date, no studies have been found that objectively quantify nursing workload in the intensive care setting in South Africa. However, there appears to be a suggestion in management circles, in part as a result of cost constraints, that any nurse may be capable of providing a substitute for the skills of an intensive care-trained nurse. As this is clearly not the case, this study proposed to investigate the use of an objective measurement to determine the requirements for nursing care in the intensive care setting. It is however, anticipated that the findings of this study could be used to inform further future studies in the ICUs.

The purpose of this study was to introduce the simplified therapeutic intervention scoring system (TISS-28), the original therapeutic intervention scoring system (TISS-76) and the Simplified Acute Physiological Score (SAPS) version II in critically ill adult patients, in order to describe the validity and reliability of TISS-28 as a suitable measure of quantifying nursing workload in the adult ICUs of a public sector hospital in Johannesburg. The objective of the study was to validate the use of TISS-28 as a means of quantifying nursing workload in this setting.

Methods

Study design

A non-experimental, comparative, correlation and prospective two-staged design was utilised to meet the study objectives.

Study setting, population, sampling and sample size

The research was conducted in three adult ICUs at a public sector tertiary-level hospital in Johannesburg. These ICUs included trauma, cardiothoracic and multidisciplinary units.

The population from which the ICU experts were selected in stage I consisted of registered nurses who were currently working in the ICUs and had extensive experience of daily nursing activities performed in the ICUs, and specialists in nursing education. In stage II, the target population comprised all critically ill patients admitted to the three ICUs.

A non-probability purposive sampling method was used in stage I to select experts to assess the face and content validity of TISS-28. Six nurses specialising in ICU and/or nursing education were invited to participate in the validation process. Inclusion criteria for the expert group were that they were registered with an additional qualification in ICU nursing, had more than 5 years of experience in specialised practice and/or education, were working in a trauma, cardiothoracic or multidisciplinary ICU, and provided written consent to participate.

A simple random sampling method was used in stage II to select the sample of patients in the ICU (*N*=105).

In order to ensure that each patient had an equal opportunity of being selected, the ICU register was used as the sampling frame. The inclusion criteria for the patient sample were critically ill patients on admission to any of the three ICUs who were 18 years and older, had an anticipated admission period >24 hours, and provided written consent to participate.

Data collection procedures

In stage I, ICU nurse experts who met the inclusion criteria were invited to participate in the study. The content validity index (CVI) was derived following steps discussed in the results section. In stage II, data were collected from a sample of patients who agreed to participate in this study from June to August 2008. Data necessary for the calculation of TISS-28, TISS-76 and SAPS II were recorded for each patient in the ICU at 24 and 48 hours after admission. Information was obtained from ICU charts, medical and nursing notes, laboratory test results, admission records and ward discharge notes. An additional final measurement of the TISS-28 score was obtained from the same participants within 24 - 48 hours of discharge from ICU to the ward.

Ethical considerations

Ethical approval was obtained from relevant university and hospital authorities. Written informed consent was obtained from all participants. Participants had a right to withdraw from this study at any time. Research codes were used instead of participants' real names to ensure their anonymity and confidentiality.

Instruments

Three instruments identified in the literature and previously published studies were used to achieve the study objectives, as discussed below:

TISS-28 (Miranda *et al.*[4]) comprises 28 therapeutic items. Each item is awarded from 1 to 8 points depending on the item chosen. The total score ranges from 0 to 70 points. A total TISS-28 score is calculated by summing the scores for selected activities and reflects the provided level of care for the past 24-hour period after admission. The higher the score, the more the nursing time and effort required to care for the patient, and vice versa.[16]

TISS-76 (Keene and Cullen[5]) comprises 76 therapeutic items. Each item is awarded from 1 to 4 points depending on the item chosen. The scores range from 0 to 174 points. A total TISS-76 score is calculated by summing the scores for selected activities and reflects the level of care for the past 24-hour period after admission. The higher the score, the more the nursing time and effort required to care for the patient, and vice versa.[16]

SAPS II (Le Gall *et al.*[17]) comprises 15 items. Each item is awarded between 0 and 26 points depending on the item chosen. The SAPS II score records the worst value of the selected items during the first 24 hours of admission. The range of scores is 0 - 160 points, and the higher the score obtained, the greater the patient's severity of illness and vice versa.

Methods of data analysis

Descriptive and inferential statistics were utilised in this study. A significance level of 0.05 was decided upon for all statistical tests. The Pearson product moment correlation coefficient test was used to determine the strength of the relationship between TISS-28 and TISS-76 as well as between TISS-28 and SAPS II. A two-sample *t*-test was used to test for the difference between the TISS-28 mean score of ICU and ward patients. Intra-class correlation was used to assess the reliability of TISS-28 in the hands of two raters.

Results

Demographic information

In stage I, 3 of the experts were aged 50 - 59 years, 2 were aged 30 - 39 years and 1 was aged 40 - 49 years. Four had obtained a diploma in intensive care nursing. One had a diploma plus a higher degree in intensive care nursing, and 1 had a higher degree. Three were clinical instructors and 3 were ICU nurse/shift leaders, with only 1 of them being an ICU manager. Their years of ICU experience ranged from 5 to 25 years (mean 16 years).

In stage II of the study, 105 participants took part. Their ages ranged from 18 to 88 years with a mean (SD) of 43 (17.67); 62 (59.05%) of the study participants were male and 43 (40.95%) were female; 40 (38.10%) of the study participants were admitted for medical reasons, 38 (36.19%) were admitted for scheduled surgery and 27 (25.71%) were admitted for unscheduled surgery. The length of ICU stay for the study participants ranged from 1.5 to 37 days (mean 6.58 (6.68)). Of the 105 participants, 2 (1.90%) died after 24 hours and before 48 hours of ICU admission. In total, 20 participants (19.05%) died in the ICU more than 48 hours after being admitted, leaving only 85 participants discharged to the ward.

Descriptive statistics: SAPS II, TISS-28 and TISS-76 scores

SAPS II scores obtained from 105 participants within 24 hours of ICU admission ranged from 8 to 97 points (mean 40.88 (9.18)). TISS-28 scores obtained from 105 participants 24 hours after admission ranged from 14 to 47 points (mean 29.43 (6.06)). TISS-28 scores obtained 48 hours after admission from 103 participants ranged from 9 to 43 points (mean 26.47 (6.45)). TISS-76 scores

obtained from 103 participants 24 hours after admission ranged from 12 to 53 points (mean 29.80 (9.71)). TISS-76 scores obtained after 48 hours of admission from 103 participants ranged from 6 to 49 points (mean 25.19 (9.00)). TISS-28 scores obtained from 85 participants in the ward 24 - 48 hours after discharge from the ICU ranged from 3 to -24 points (mean 10.05 (4.51)).

TISS-28 scores

Table I summarises how the participants were distributed over the four different TISS-28 categories after grouping based on their TISS-28 scores. These categories were used as per a study conducted by Miranda *et al.*[4] which guides in detecting different time-spending patterns during the care of ICU patients. The majority of participants in the ICU (80.95%) scored between 21 and 35 (mean 28.41 (3.73)), while 14.29% of the participants had scores between 36 and 60 (mean 39.60 (2.85)). Only a few participants (4.76%) had scores ranging from 0 to 20 (mean 16.20 (2.05)). The majority of participants in the ward (96.47%) had scores between 0 and 20 (mean 9.60 (3.91)), while 3.53% of the participants had scores between 21 and 35 (mean 22.33 (1.53)).

Descriptive statistics for each of the TISS-28 items after the first 24 hours of ICU admission and between 24 and 48 hours after discharge to the ward are presented in Table II. Virtually all patients (99.05%) were on standard monitoring, all ICU patients (100%) required laboratory investigations, 92.38% were on multiple intravenous medications, 97.14% had a central venous line and 93.33% required quantitative urine output measuring. In the ward 90.59% of patients required laboratory investigations, 70.59% had a central venous line, 68.24% required supplemental ventilatory support, 92.94% required treatment to improve lung function and 78.82% required quantitative urine output measuring. The scores obtained from ICU participants were more varied than the scores from ward participants.

Table III indicates that the patients admitted to the ICU required basic activities the most, as reflected by a mean of 9.93 (SD 1.71). This requirement is closely followed by the need for ventilatory support (mean 8.94 (3.35)). The need for cardiovascular support (mean 5.39 (2.09)) comes after ventilatory support, followed by the need for renal support (mean 2.44 (1.16)). A minority of the patients admitted required both metabolic support and specific interventions (mean 1.15 (1.29) and mean 1.50 (2.16), respectively). None of them required neurological support. A few patients in the ward required basic activities, cardiovascular support, renal support and ventilatory support, with the least requirement being for metabolic support, as indicated in Table III. Comparison of SDs for ICU and ward participants in Table III shows that ICU patients had more diverse requirements than ward patients.

TISS-28 item content validity

Content validity is the determination of the content representativeness of the items of an instrument (Lynn[18]). This was assessed by a panel of 6 ICU nurse experts who were invited to identify and comment on the daily nursing activities performed in the ICU to ensure that the items represented critical attributes of issues of nursing workload in ICUs. The statistical method advocated by Lynn[18] was used to determine content validity of each item and the entire instrument. The CVI was calculated by taking the proportion of experts who judged the content of an item as valid with a score of 3 or 4. A 4-point Likert scale was used to rate all items independently, where 1 = not relevant; 2 = unable to assess relevance without item revision or item is in need of such revision that it would no longer be relevant; 3 = relevant but needing minor alteration; and 4 = very relevant and succinct.[18]

The methodology advocated by Lynn[18] was used to determine content validity of each item and the entire instrument. According to this method, 4 of the 6 respondents in this stage had to rate each item as either a 3 or a 4 to ensure that the item was content-valid. Two items were rated as not content-valid by 5 of the 6 experts, giving an 83% agreement rate. All the remaining items were rated as content-valid by all the experts (i.e. rated as either 3 or 4 on the rating scale).

Instrument's (TISS-28) content validity

The content validity of the whole instrument was the percentage or proportion of items judged as valid by

Table I. Summary of participants' TISS-28 scores 24 hours after ICU admission and 24 - 48 hours after ward admission by TISS-28 score category

TISS-28 score category	TISS-28 scores in ICU (*N*=105)			TISS-28 scores in ward (*N*=85)		
	Frequency (%)	Mean	SD	Frequency (%)	Mean	SD
0 - 20	5 (4.76)	16.20	2.05	82 (96.47)	9.60	3.91
21 - 35	85 (80.95)	28.41	3.73	3 (3.53)	22.33	1.53
36 - 60	15 (14.29)	39.60	2.85	0	0	0

Table II. Frequency distributions of participants' TISS-28 scores for each TISS-28 item in ICU and after discharge to the ward

	ICU (*N*=105)			Ward care (*N*=85)		
Items	**Frequency (%)**	**Mean**	**SD**	**Frequency (%)**	**Mean**	**SD**
Basic activities						
Standard monitoring	104 (99.05)	4.95	0.49	15 (17.65)	0.88	1.92
Laboratory investigations	105 (100.0)	1.00	0	77 (90.59)	0.91	0.29
Single medication	0	0	0	5 (5.88)	0.12	0.47
Multiple intravenous medications	97 (92.38)	2.77	0.80	31 (36.47)	1.09	1.45
Routine dressing change	12 (11.43)	0.11	0.32	28 (32.94)	0.33	0.47
Frequent dressing changes	0	0	0	1 (1.18)	0.01	0.11
Care of drains	40 (38.10)	1.14	1.46	12 (14.12)	1.10	2.06
Cardiovascular support						
Single vaso-active medication	25 (23.81)	0.71	1.28	1 (1.18)	0.04	0.33
Multiple vaso-active medications	26 (24.76)	0.99	1.73	0	0	0
Intravenous replacement of large fluid losses	11 (10.48)	0.42	1.23	0	0	0
Peripheral arterial catheter	94 (89.52)	4.48	1.54	3 (3.53)	0.18	0.93
Left atrial monitoring	3 (2.86)	0.23	1.34	0	0	0
Central venous line	102 (97.14)	1.94	0.33	60 (70.59)	1.41	0.92
Cardiopulmonary resuscitation after cardiac arrest	6 (5.71)	0.17	0.70	0	0.02	0.22
Ventilatory support						
Mechanical ventilation	69 (65.71)	3.29	2.38	1 (1.18)	0.06	0.54
Supplemental ventilatory support	33 (31.43)	0.63	0.93	58 (68.24)	1.36	0.94
Care of artificial tube	71 (67.62)	0.68	0.47	14 (16.47)	0.16	0.37
Treatment to improve lung function	84 (80.00)	0.80	0.40	79 (92.94)	0.93	0.26
Renal support						
Dialysis	13 (12.38)	0.37	0.99	7 (8.24)	0.25	0.83
Quantitative urine output Measurement	98 (93.33)	1.87	0.50	67 (78.82)	1.58	0.82
Active diuresis	7 (6.67)	0.20	0.75	0	0	0
Neurological support						
Measurement of intracranial pressure	0	0	0	0	0	0
Metabolic support						
Treatment of complicated metabolic acidosis/alkalosis	3 (2.86)	0.11	0.67	0	0	0
Intravenous hyperalimentation	5 (4.76)	0.14	0.64	2 (2.35)	0.07	0.46
Enteral feeding	47 (44.76)	0.90	1.00	8 (9.41)	0.19	0.59
Specific interventions						
Single interventions in ICU	35 (33.33)	1.02	1.42	0	0	0
Multiple specific interventions	2 (1.90)	0.10	0.69	0	0	0
Specific interventions outside ICU	8 (7.62)	0.38	1.33	0	0	0

the experts. Out of 28 items, 26 were rated as content-valid. According to Polit and Beck,[19] an instrument should have a minimum content validity index of 0.90. The content validity of the entire instrument was 0.93, slightly exceeding the minimum level of 0.90. The experts in the quantification stage therefore rated the whole instrument as being content-valid.

Concurrent validity of TISS-28

Concurrent criterion-related validity is the ability to detect a positive or negative statistical relationship between two instruments simultaneously measuring the same concept at the same time.[20,21] This was accomplished by comparing the relationship between the patients' scores obtained from TISS-28 and TISS-76 as well as TISS-28 and SAPS II. The TISS-76 was

Table III. **Description of therapeutic intervention groups of participants' TISS-28 scores in ICU and after discharge to the ward**

Therapeutic intervention groups	ICU (*N*=105)		Ward (*N*=85)	
	Mean	SD	Mean	SD
Basic activities (7 items)	9.93	1.71	3.76	2.90
Ventilatory support (4 items)	8.94	3.35	1.65	1.57
Cardiovascular support (7 items)	5.39	2.09	2.52	1.29
Renal support (3 items)	2.44	1.16	1.82	1.26
Neurologic support (1 item)	0	0	0	0
Metabolic support (3 items)	1.15	1.29	0.26	0.73
Specific interventions (3 items)	1.50	2.16	0	0

chosen because its specificity and conceptualisation was similar to the TISS-28. SAPS II is a severity of illness scoring system for risk prediction of hospital mortality for ICU patients. Because TISS-28 presumes that a patient's severity of illness reflects the nursing workload required, SAPS II was used as another criterion in ascertaining the concurrent validity of the TISS-28.[9]

Fig. 1 shows that there was a significant, but weak, positive correlation between TISS-28 scores 24 hours after ICU admission and SAPS II scores within the first 24 hours of ICU admission (r=0.2098, p=0.0317).

Fig. 2 indicates that there was a significant strong positive correlation between TISS-28 scores after 24 hours of ICU admission and TISS-76 scores after 24 hours of ICU admission (r=0.7857, p=0.0001).

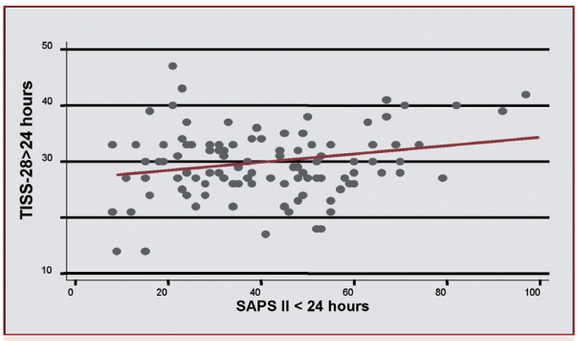

Fig. 1. Relationship between TISS-28 >24 hours and SAPS II <24 hours.

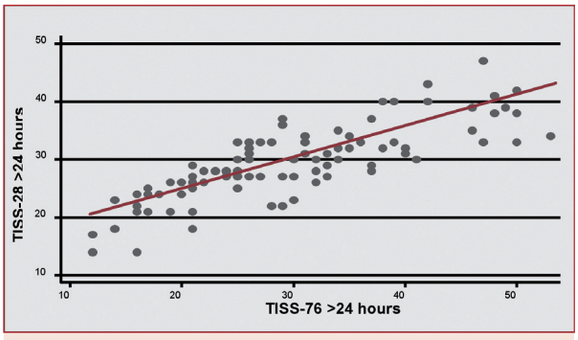

Fig. 2. Relationship between TISS-28 >24 hours and TISS-76 >24 hours.

Construct validity of TISS-28

Construct validity as outlined by De Von *et al.*[21] is the degree to which an instrument measures the construct it is supposed to measure. This was tested by comparing TISS-28 scores obtained in ICU and the scores obtained in the ward after discharge. Patients in the ward were assumed not to need the therapeutic interventions likely to be required by ICU patients.

Table IV indicates that a significant difference was found between the TISS-28 scores among patients in the ICU and the same participants discharged to the ward from the ICU (p=0.0001).

Inter-rater reliability of TISS-28

Inter-rater reliability is the degree of agreement among raters – it scores consensus in the ratings by different raters.[22] The scores were then assessed for consistency. To assess this, the researcher and an experienced assistant researcher both independently scored the same patients in a sample of 15 patients.

A significant intra-class correlation was found between the data collected by the two researchers at both 24 and 48 hours, with an intra-class correlation coefficient of 0.99 and a p-value of 0.0001, as shown in Table V.

Discussion

The majority of ICU patients had TISS-28 score categories falling between 21 and 35, as shown in Table I. These results indicate that most of the participants in this study scored relatively high TISS-28 points and hence needed much more complex care and nursing time. Categorising patients in this manner assists in working out the nurse-to-patient ratio. A study conducted by Padilha *et al.*[10] indicates that patients with more than 22 points require a nurse-to-patient ratio of 1:1, and that a 1:2 ratio would be possible in ICUs with lower average TISS-28 scores.

A study by Miranda *et al.*[4] indicates that one TISS-28 point equates to 10.6 minutes of nursing time spent on patient care. An average nurse in this study was able to deliver care equal to a maximum of 47 TISS-28

Table IV. Comparison of TISS-28 scores among patients in the ICU and the same participants discharged to the ward from the ICU

TISS-28 scores	Mean	SD	*p*-value	95% CI Lower	95% CI Upper
In ICU >24 hours (*N*=105)	28.93	5.97	0.0001	27.64	30.22
In ICU >48 hours (*N*=103)	25.19	5.86	0.0001	23.92	26.45
In ward 24 - 48 hours (*N*=85)	10.05	4.51	0.0001	9.07	11.02

CI = confidence interval.

Table V. Comparison of data collected by the researcher and assistant expert researcher using TISS-28 in the ICU

TISS-28 scores (>24 hours)				TISS-28 scores (>48 hours)			
Intra-rater reliability	*p*-value	95% CI Lower	95% CI Upper	Intra-class correlation	*p*-value	95% CI Lower	95% CI Upper
0.99	0.0001	0.995	1.000	0.99	0.0001	0.994	1.000

CI = confidence interval.

points, equivalent to 8 hours 30 minutes, in a 12-hour shift. It is important to point out that the times include only TISS activities and other direct and indirect patient care activities, but not personal activities.[4]

In addition, this study revealed that virtually all patients (99.05%) were on standard monitoring, all ICU patients (100%) required laboratory investigations, 92.38% were on multiple intravenous medications, 97.14% had a central venous line and 93.33% required quantitative urine output measuring. It was also found that basic activities are the priority needs for ICU patients. The need for ventilatory support comes next, followed by the need for cardiovascular support. The need for renal support comes after ventilatory support, and this is followed by the need for specific interventions and metabolic support. These findings are summarised in Tables II and III. These findings correspond with the findings from a study in Hong Kong by Kwok *et al.*,[9] whose ICU patients had similar needs to the patients in our study. This shows that the needs and the profile of patients admitted to ICUs in different countries can be similar. Shulman *et al.*[23] indicate that the volume of documented clinical information per patient per day in this manner is a marker of patient-related workload.

During the assessment of face and content validity of TISS-28, the ICU nurse experts indicated that some of the items in TISS-28, such as multiple dressing changes, needed much higher scores than had been awarded. This issue needs to be considered in future studies. Despite this, the TISS-28 items and the entire instrument were found to have good content validity, with an 83% agreement rate for 2 items and a 100% agreement rate for the remaining 26 items. A CVI of 0.93 was found for the entire instrument. This finding is in agreement with content validity acceptability by Lynn[18] and Polit and Beck,[22] who advocate a CVI of more than 0.9.

Concurrent validity of TISS-28 determined by examining the correlations between TISS-28 and SAPS II (r=0.2098, p=0.0317) as well as TISS-28 and TISS-76 (r=0.7857, p=0.0001) was good**.** These findings were in agreement with the findings by Kwok *et al.*[9] The good correlation between TISS-28 and SAPS II supports the notion that the severity of patients' illness is significantly related to nursing workload and type and number of therapeutic interventions in the ICU.[10]

A significant difference was found between the TISS-28 mean scores among ICU patients and ward patients. Patients in the ICU had higher scores than ward patients (t=25.59, p=0.0001; t=21.48, p=0.0001, respectively). According to Kwok *et al.*,[9] patients in the ward are not expected to demonstrate high TISS-28 scores, as the instrument was specifically designed for use in the ICUs. In this case TISS-28 had good construct validity since its therapeutic activities were more applicable mostly to ICU patients. This is supported by findings by Kwok *et al.*,[9] who found higher scores in ICU patients and lower scores in rehabilitation patients.

A statistically significant correlation was found between the data collected by the researcher and the expert assistant researcher. An intra-class correlation coefficient of 0.99 and a p-value of 0.0001 were found.

This suggests that the instrument can always be relied upon owing to its stability.

The study findings supported validity and reliability of TISS-28 in South African ICU setting. Now that an objective instrument for measuring nursing workload has been found, allocation of nursing staff based on their skills in relation to patients' needs and demands in the ICU is possible. Hospital management could take this into consideration during deployment of nursing staff. Allocation per shift based on nursing workload could also be worked out with the aid of TISS-28, given that 1 TISS-28 point equals 10.6 minutes.

The study was done in a level III tertiary hospital in three adult ICUs within a short period on a small sample size (*N*=105), so study findings from this study can only be generalised to other ICUs in level III tertiary hospitals in South Africa. It may be necessary for testing of the instrument to be conducted in other levels of ICUs in the South African context using a larger sample size. Other recommendations for future research include: TISS-28 could be used to quantify nursing workload now that its validity and reliability has been tested in a South African setting; more detailed analysis of nursing workload at each ICU could be worked out; and revision of the TISS-28 items may be necessary, since some of the items have been found to require much higher scores in our setting than were originally awarded.

Conclusion

This research study supported validity and reliability of TISS-28 as a scientific objective instrument of the requirements for nursing care and use of resources. This instrument can be used to quantify nursing workload the South African ICUs given the current shortage of critical care nurses and increasing complexity of patients' illness and needs.

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