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ORIGINAL ARTICLE

Nursing Activities Score in the intensive care unit: Analysis of the related factors

Katia Grillo Padilha[a,*], Regina Márcia Cardoso de Sousa[a], Alda Ferreira Queijo[a], Ana Márcia Mendes[a], Dinis Reis Miranda[b]

[a] *School of Nursing, University of São Paulo, Av. Dr. Eneas de Carvalho Aguiar 419, CEP 05403-000, São Paulo SP, Brazil*
[b] *Health Services Research Unit, Hanzenplein 1 Postbus 30001, 9700 RB, Groningen, The Netherlands*

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Summary
Background: High costs of intensive care as well as quality of care and patient safety demand measurement of nursing workload in order to determine nursing staff requirements. It is also important to be aware of the factors related to high patient care demands in order to help forecast staff requirements in intensive care units (ICUs).
Objectives: To describe nursing workload using the Nursing Activities Score (NAS); to explore the association between NAS and patients variables, i.e. gender, age, length of stay (LOS), ICU discharge, treatment in the ICU, Simplified Acute Physiology Score II (SAPS II) and Therapeutic Interventions Scoring System-28 (TISS-28).
Methods: NAS, demographic data, SAPS II and TISS-28 were analysed among 200 patients from four different ICUs in a private hospital in São Paulo, Brazil.
Results: NAS median were 66.4%. High NAS scores (>66.4%) were associated with death (p-value 0.006) and LOS (p-value 0.015). Logistic regression analysis demonstrated that TISS-28 scores above 23 and SAPS II scores above 46.5 points, classified as high, increased 5.45 and 2.78 times, respectively, the possibility of a high workload as compared to lower values of the same indexes.
Conclusion: This study shows that the highest NAS scores were associated with increased mortality, LOS, severity of the patient illness (SAPS II), and particularly to TISS-28 in the ICU.

* Corresponding author.
E-mail addresses: kgpadilh@usp.br (K.G. Padilha), vian@usp.br (R.M.C. de Sousa), afqueijo@ig.com.br (A.F. Queijo), Nanagiaradia@hotmail.com (A.M. Mendes), drm@skynet.be (D.R. Miranda).

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Introduction

High costs of intensive care as well as quality of care and patient safety demand measurement of nursing workload in order to determine nursing staff requirements adequately.

The identification of the nursing staff requirements in an intensive care unit (ICU) environment is relevant not only for nursing care planning but also for appropriate management of human resources. Under such circumstances, it is also important to be aware of the factors related to high patient care demands in order to help forecast staff requirements. This study aims to describe the nursing workload in ICUs using the Nursing Activities Score (NAS) and explore the association between NAS and patients variables, namely gender, age, length of stay (LOS), ICU discharge, treatment in the ICU, Simplified Acute Physiology Score II (SAPS II) and Therapeutic Intervention Scoring System-28 (TISS-28).

Literature review

For over 30 years in an attempt to demonstrate the cost—benefit ratio of the intensive care unit (ICU) a variety of tools have been developed to measure not only the severity of illness of the patient but also capture the true cost of the nursing workload (Jakob and Rothen, 1997; Guccione et al., 2004; Carayon and Gürses, 2005). One tool that has been used to measure nursing workload is the NAS (Table 1).

Proposed by Miranda et al. (2003) the score obtained on the basis of the 23 NAS items shows the percentage time that is devoted by a nurse to the direct care of the critically ill patient during 24 h in the ICU. Therefore, a total score of 100.0% indicates the work of one nurse over a 24 h period. The sum of the 23 items ranges between 0 and 177%.

NAS was validated in a study of 99 ICUs in 15 countries and the results indicated that it explains 81% of the nursing time. Due to its scope to measure nursing workload in ICUs and the fact that its use is free of charge NAS can be considered an important tool in a clinical setting.

Despite the relevant investigation focused on identifying nursing workload in ICUs, little is known about this matter with the use of NAS as well as the factors associated with the workload. The following might be included among these factors: age and sex; admission information such as origin, type of admission, LOS, ICU discharge; and clinical data such as severity of illness and therapeutic interventions.

With regards to the effect of socio-demographic data on nursing workload in ICUs, few studies have focused on such analysis. However, two investigations carried out with NAS at a university hospital adult ICU in Brazil have shown that there is no significant difference between age and nursing workload (Ciampone et al., 2006; Gonçalves et al., 2006). Results from a Finnish study carried out with 1737 patients with the Oulu Patient Classification (OPC) found a weak statistical correlation between nursing intensity and age, as well as gender (Lundgrén-Laine and Suominen, 2007). As far as origin is concerned, another study performed at a Brazilian ICU showed no association between this variable and nursing workload (Gonçalves et al., 2006).

A weak co-relation was observed between LOS and workload in a study carried out in Finland (Lundgrén-Laine and Suominen, 2007). Brazilian research work (Gonçalves et al., 2006; Gonçalves, 2006; Silva, 2007) using NAS found significant difference between those variables, with progressive increase of index average score as LOS rose. However, a study relating LOS in ICU with required care hours showed that a decrease in the time of stay caused the nursing team's care hours to rise (Shamin et al., 1994).

A study performed at a UK university hospital (Viney et al., 1997) showed that the severity of illness measured by the Acute Physiologic and Chronic Health Evaluation (APACHE II) could hardly measure patients' dependency, thus being unable to predict nursing workload.

In relation to nursing workload between survivors and non-survivors in ICU, research carried out among 249 patients showed a higher demand for workload among non-survivors (Byrick and Caskenette, 1992). This was supported by studies carried out in Brazil (Nascimento, 2002; Silva and Sousa, 2002; Ducci et al., 2004; Balsanelli et al., 2006; Gonçalves et al., 2006) and in other countries (Miranda et al., 1998; Gómez Ferrero et al., 1999; Castillo-Lorente et al., 2000), thus drawing the conclusion that non-surviving patients required higher nursing workload.

The aforementioned Finnish study observed a great co-relation between TISS and nursing workload. Nevertheless, the authors found that TISS scores in their study could only account for 32% of the patients average nursing intensity during the period of treatment (Lundgrén-Laine and Suominen, 2007). While studying NAS validation, it was also observed that TISS-28 was only able to cover around 42% of the ICU nursing workload

Table 1 Nursing activities score (NAS)

Basic activities	Score
1. Monitoring and titration	
1a. Hourly vital signs, regular registration and calculation of fluid balance	4.5
1b. Present at bedside and continuous observation or active for 2 h or more in any shift, for reasons of safety, severity or therapy, such as: non-invasive mechanical ventilation, weaning procedures, restlessness, mental disorientation, prone position, donation procedures, preparation and administration of fluids and/or medication, assisting specific procedures	12.1
1c. Present at bedside and active for 4 h or more in any shift for reasons of safety, severity or therapy, such as those examples above (1b)	19.6
2. Laboratory: biochemical and microbiological investigations	4.3
3. Medication: vasoactive drugs excluded	5.6
4. Hygiene procedures	
4a. Performing hygiene procedures such as: dressing of wounds and intravascularcatheters, changing linen, washing patient, incontinence, vomiting, burns, leaking wounds, complex surgical dressing with irrigation, special procedures (e.g., barrier nursing, cross-infection related, room cleaning following infections, staff hygiene), etc.	4.1
4b. The performance of hygiene procedures took more than 2 h in any shift	16.5
4c. The performance of hygiene procedures took more than 4 h in any shift	20.0
5. Care of drains all: except gastric tube	1.8
6. Mobilization and positioning, including procedures such as: turning the patient; mobilization of the patient; moving from bed to chair; team lifting (e.g., immobile patient, traction, prone position)	
6a. Performing procedure(s) up to three times per 24 h.	5.5
6b. Performing procedures(s) more frequently than three times per 24 h, or with two nurses (any frequency)	12.4
6c. Performing procedure with three or more nurses (any frequency)	17.0
7. Support and care of relatives and patient, including procedures such as telephone calls, interviews, counseling. Often, the support and care of either relatives or patient allow staff to continue with other nursing activities (e.g., communication with patients during hygiene procedures, communication with relatives whilst present at bedside and observing patient)	
7a. Support and care of either relatives or patient requiring full dedication for about 1 h in any shift such as: to explain clinical condition, dealing with pain and distress, difficult family circumstances	4.0
8. Administrative and managerial tasks	
8a. Performing routine tasks such as: processing of clinical data, ordering examinations, professional exchange of information (e.g., ward rounds)	4.2
8b. Performing administrative and managerial tasks requiring full dedication for about 2 h in any shift such as: research activities, protocols in use, admission and discharge procedures	23.2
8c. Performing administrative and managerial tasks requiring full dedication for about 4 h or more of the time in any shift such as: death and organ donation procedures, co-ordination with other disciplines	30.0
Ventilatory support	
9. Respiratory support, 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 (e.g., CPAP or BiPAP), with or without endotracheal tube; supplementary oxygen by any method	1.4
10. Care of artificial airways. Endotracheal tube or tracheostomy cannula	1.8
11. Treatment for improving lung function. Thorax physiotherapy, incentive spirometry, inhalation therapy, intratracheal suctioning	4.4
Cardiovascular support	
12. Vasoactive medication, disregard type and dose	1.2

Table 1 (*Continued*)

Basic activities	Score
13. Intravenous replacement of large fluid losses. Fluid administration >3 L/m2/day, irrespective of type of fluid administered	2.5
14. Left atrium monitoring. Pulmonary artery catheter with or without cardiac output measurement	1.7
15. Cardiopulmonary resuscitation after arrest; in the past period of 24 h (single precordial thump not included)	7.1
Renal support	
16. Hemofiltration tecniques. Dialysis techniques	7.7
17. Quantitative urine output measurement (e.g., by indwelling urinary catheter)	7.0
Neurological support	
18. Measurement of intracranial pressure	1.6
Metabolic support	
19. Treatment of complicated metabolic acidosis/alkalosis	1.3
20. Intravenous hyperalimentation	2.8
21. Enteral feeding. Through gastric tube or other gastrointestinal route (e.g., jejunostomy).	1.3
Specific interventions	
22. Specific intervention(s) in the intensive care unit. Endotracheal intubation, insertion of pacemaker, cardioversion, endoscopies, emergency surgery in the past period of 24 h, gastric lavage. Routine interventions without direct consequences to the clinical condition of the patient, such as: X-rays, echografhy, eletrocardiogram, dressing, or insertion of venous or arterial catheters, are not included	2.8
23. Specific interventions outside the intensive care unit. Surgery or diagnostic procedures	1.9

The sub-items of item 1,4,6—8, are mutually exclusive.

(Miranda et al., 2003). It seems that TISS is not sensitive enough to measure the real intensive care nursing workload.

Since, research has provided no conclusive results about the factors associated to an increased ICU nursing workload, many studies on this issue are currently being carried out.

Methods

An exploratory, descriptive, prospective study was carried out on 200 consecutive patients admitted to four ICUs at a private tertiary hospital with 1700 beds in São Paulo, Brazil, over a 1 month period in 2002. Two of the ICUs were general units (with 28 and eight beds, respectively) and two were specialised (neurological ICUs), with nine and eleven beds, respectively, which is equivalent to 26.4% of all ICU beds.

Participant inclusion criteria included age equal to or above 16 years and minimal LOS of 24 h in the ICU.

Factors related to nursing workload, the relation of such variables as gender, age, LOS, treatment, discharge from the ICU, severity of illness and interventions were collected and analysed. Severity of illness, therapeutic interventions and nursing workload were measured by SAPS II, TISS-28 and NAS, respectively.

The project was approved by the hospital's ethics and research committee. Written authorisation was obtained from families or patients included in the study. Medical records were used to collect demographic data, LOS, and SAPS II, TISS-28 and NAS indexes. Data were completed with information provided by nurses whenever necessary. All the indexes were collected on the first 24 h in the ICU.

Statistical analysis

Data were analysed using the Statistical Package for the Social Sciences (SPSS) 13.0 software. The study sample was characterised through descriptive analysis of collected data. Variables were analysed according to absolute and relative frequencies. The average, the standard deviation, the median and the range were calculated for age and LOS variables. NAS, TISS-28 and SAPS II values were classified as either high or low. High values were above the median, while low values were equal to or below the median. The factors related to the high nursing workload were analysed through univariate analysis with the Mann—Whitney and the chi-square

Table 2 Univariate analysis, according to the nursing workload

Variables	NAS		*p*-Value
	Low values (≤66.4%)	High values (>66.4%)	
Gender			
Female	52.0%	39.0%	0.065[a]
Male	48.0%	61.0%	
Age			
Mean ± S.D.	59.0 ± 20.4	56.3 ± 18.8	0.296[b]
Range	16.0—97.0	16.0—99	
LOS (ICU)			
Mean ± S.D.	3.8 ± 3.6	5.5 ± 6.0	0.015[b]
Range	1.0—19.0	1.0—37.0	
ICU discharge			
Survival	89.9%	74.7%	0.006[a]
Death	10.1%	25.3%	
Treatment			
Medical	56.0%	58.0%	0.775[a]
Surgical	44.0%	42.0%	

[a] Chi-square test.
[b] Mann—Whitney test.

tests. Multiple logistic linear regression analyses were performed in order to determine which of the independent variables would work as predictors of higher ICU nursing workload. The initial multivariable analysis was performed without the variables TISS-28 and SAPS II. These variables were later included in the second multivariate analysis. A forward stepwise multiple regression analysis was then performed using the variables found to be of significance in the univariate analysis.

Results

From the total of 200 patients studied, 144 (72.0%) were from general ICUs and 56 (28.0%) from neurological ICUs. Patients' age ranged between 16 and 99 years (mean ± S.D. 57.7 ± 19.6; median: 58); 54.5% were male. In terms of type of treatment, 43.0% of the patients had undergone surgery, while the remaining 57.0% had been hospitalised for medical treatment. The average LOS in the ICUs was 4.6 ± 5 days (ranging between 1 and 37 days), and the median was 3.0 days. Of the 190 patients whose discharge was known, 35 (17.5%) died during their ICU stay and 165 (82.5%) survived.

The SAPS II had an average value of 48.3 ± 16.6 during the first 24 h of admission in the ICU (range 14—119), and the median was 46.5. The NAS presented an average of 67.2% (range 54.3—107.2%), with a median of 66.4%. The TISS-28 average was 24.2 ± 7.6 (range 12—57), and the median was 23.

Only the LOS ($p = 0.015$) and discharge ($p = 0.006$) were significantly associated to NAS in the univariate analysis (Table 2). Patients that obtained a higher NAS remained on average longer in the ICU (5.5 days) as compared with patients with low NAS (3.8 days). Similarly, highest mortality was found among patients that obtained the highest NAS. The relation between LOS and discharge was also analysed by means of a logistic regression analysis and both variables remained within the final model (Table 3).

Table 3 shows that patients who remained longer in the unit had 1.07 times (7.0%) more probability of increasing the NAS, for each extra ICU-day. For patients who died the probability of higher NAS rose to 2.65 times in comparison to those who survived.

Table 3 Results from the multivariate analysis of factors related to the high nursing workload in ICUs

Variable	Coefficient	Descriptive level (*p*-value)	Odds ratio (Exp(coeff.))	Range
LOS (ICU)	0.07	0.093	1.07	0.99—1.15
Death	0.98	0.0298	2.65	1.11—6.34

Table 4 shows results following introduction of SAPS II to TISS-28 in the logistic regression model. A high TISS-28, i.e. above 23 points, increased 5.45 times the possibility of high NAS as compared to lower values. It was also observed that high SAPS II scores (>46.5) increased 2.78 times the possibility of a high NAS comparatively to SAPS II scores equal to or below 46.5 points.

The results of this study pointed out a high NAS in the ICU (average of 67.2%) was associated with the variables LOS, ICU discharge, severity of illness and therapeutic interventions.

Discussion

In this study, the demographic and clinical data were similar to those usually addressed in ICU studies: the same distribution of gender and age were also found elsewhere (Bastos et al., 1996; Castillo-Lorente et al., 2000; Lefering et al., 2000; Silva and Sousa, 2002; Rocker et al., 2004; Gonçalves et al., 2006). The mortality rate was comparable with the rate found in other countries (Miranda et al., 1998; Metnitz et al., 1999). The SAPS II mean (48.3) was close to some European countries (Miranda et al., 1998; Kvale and Flaatten, 2002), and higher than that reported by others studies, between 26 and 33.6 (Metnitz et al., 1999; Graf et al., 2002; Nascimento, 2002; Beck et al., 2003; Iapichino et al., 2003; Metnitz et al., 2003). The average of TISS-28 (24.2) was similar to the results quoted in the literature (between 25.4 and 26.9) (Miranda et al., 1996; Nogueira, 2002; Padilha et al., 2007).

The average NAS in this study was 67.2%, similar to other Brazilian studies. A study carried out in an ICU from an university hospital, found a NAS average of 69.3%, ranging between 47.6 and 125.8% (Gonçalves et al., 2006). Similar results were verified in a sample of patients from a private hospital of tertiary level with a NAS average of 65.5%, minimum of 22.3% and maximum of 127.9% (Conishi, 2005). Additionally, a study carried out in six ICUs of four Brazilian hospitals to analyse the nursing workload within a sample of 500 patients found a similar NAS average, i.e. 62.13% (Silva, 2007).

In an attempt to identify the factors related to NAS by using demographic and clinical variables, this study has shown that the highest NAS scores were associated to mortality, LOS, severity of the patient illness, and especially the therapeutic interventions in the ICU.

In the initial analysis, mortality and LOS in the ICU were variables that showed significance in relation to NAS. Patients who died or remained longer in ICUs probably were those presented in a more unstable condition, required more monitoring and aggressive treatment and, as consequence, a higher NAS.

These results support literature that demonstrates non-surving patients demand increased nurse working time (Byrick and Caskenette, 1992; Miranda et al., 1998; Gómez Ferrero et al., 1999; Castillo-Lorente et al., 2000; Nascimento, 2002; Silva and Sousa, 2002; Ducci et al., 2004; Balsanelli et al., 2006; Gonçalves et al., 2006). Although the association between NAS and LOS in the literature is conflicting (Shamin et al., 1994; Gonçalves et al., 2006; Gonçalves, 2006; Lundgrén-Laine and Suominen, 2007; Silva, 2007), studies carried out in Brazilian ICUs where NAS was applied showed that the more LOS increases, the greater NAS eventually becomes (Gonçalves et al., 2006; Gonçalves, 2006; Silva, 2007).

The multi-varied analysis showed that NAS was associated with severity of illness and therapeutic interventions. Nevertheless, the most important variable identified in this analysis was therapeutic interventions. Results showed that high TISS-28 score increased 5.45 times the risk for higher NAS. This result may be related to the inter-dependence of medical and nursing activities, which is inherent in the multidisciplinary nature of ICU work.

Limitations of the study

An important issue when performing this type of study is whether the results produced by the participating ICUs will be meaningful to other units. Due to the fact that this study is an exploratory descriptive study, futher research is needed to investigate

Table 4 Results of the multivariate analysis of factors related to the high nursing workload in ICUs adding TISS-28 and SAPS II

Variable	Coefficient	Descriptive level (*p*-value)	Odds ratio (Exp(coeff.))	Range
TISS-28 high[a]	1.69	0.000	5.45	2.850—10.426
SAPS II high[b]	1.02	0.002	2.78	1.455—5.316

[a] TISS-28 > 23
[b] SAPS II > 46.5.

other variables, such as type of ICU (general and specialised), morbidity and nursing care dependence so that a better understanding of the factors related to nursing workload can be obtained. Other limitations include the convenience sample and the performance of the study in a sole Brazilian hospital. Besides, considering that NAS is a new instrument to measure nursing workload in the ICU, there are no studies in the international literature that allow comparison.

Conclusion

The study was carried out with a view to describing the nursing workload according to the NAS in a clinical setting and also exploring the association between NAS and patient variables (gender, age, LOS, treatment, ICU discharge, SAPS II and TISS-28). By identifying the risk factors for high nursing workload demand, one should be able to meet staff requirements to actual care demands within particular patient groups.

The results of this study showed a high nursing workload as measured by NAS to be similar to other Brazilian studies. According to the related factors, it was found that adding such variables as severity of illness, therapeutic interventions, LOS, and mortality to workload measurement may contribute to enhance nursing human resource forecasts with a view to improving service quality and decreasing ICU costs.

Among the factors related to nursing workload, it was observed that therapeutic interventions, more than severity of illness, played a leading role in determining ICU nursing workload.

To this extent, results demonstrated that the units where patients undergo more aggressive treatment with a greater number of interventions are prone to elicit a higher nursing workload demand and therefore require a higher number of nurses.

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