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ORIGINAL ARTICLE

# Nursing workload and staff allocation in an intensive care unit: A pilot study according to Nursing Activities Score (NAS)

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**KEYWORDS**
Intensive care units;
Workload;
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**Summary**
*Objectives:* The objectives of the study were to identify the daily nursing workload in an intensive care unit (ICU) and to analyse the adequacy of nursing staff in a six hour shift according to the Nursing Activities Score (NAS).
*Method:* The sample consisted of 68 patients from a general 25-bed adult ICU in a private hospital with 250 beds in São Paulo, Brazil. The nursing workload of all patients admitted in the ICU over a one month period in 2004 were measured daily according to the NAS. For the analysis of nursing staff it was considered the number of nurses available in a six hour shift. Data were submitted to descriptive analyses.
*Results:* Most patients were elderly and remained on average 12 (±16.4) days in the ICU. The mean NAS was 63.7 (±2.4%) and remained above 58.5% throughout the month. Apart from the 16th day of data collection there was an excess of nursing professionals in a six hour shift during the study period (range from 0.8 to 4.8 professionals).
*Conclusions:* The study results show the importance of nursing staff adequacy to workload fluctuations for reducing ICU costs.


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## Introduction

The increasing costs of treatment in intensive care units (ICUs) and the need to use resources with efficiency are reasons to define the adequacy between nursing staff and nursing workload. As nursing costs more than any other element of intensive care, its use has to be adjusted to the patients nursing care requirements (Miranda et al., 1998). Therefore, indicators of nursing workload have become increasingly necessary in order to assure patient safety, to improve quality of care and to balance cost-effectiveness of ICUs.

Evaluation of the nursing workload and consequently of the patient care needs, is a prerequisite for the adequate allocation of staff in ICUs. This can be explained by the fact that an oversized team becomes more expensive, whereas reduced staff may imply a decrease in care efficacy/quality, prolonging hospitalisation and increasing the cost of patient treatment (Aiken et al., 2002; Guccione et al., 2004; Miranda, 1999).

Thus, considering that the assessment of nursing workload is relevant for planning nursing care and adapting human resources to the patients requirements, the objectives of the present study were (1) to identify the daily nursing workload in an ICU and (2) to analyse the adequacy of nursing staff in the ICU within a six hour shift according to the Nursing Activities Score (NAS).

The purpose of this pilot study is to analyse the allocation of human resources in nursing in a general ICU according to the NAS and provide evidence that contribute to the adequacy of nursing staff in ICU.

## Literature review

A literature review on intensive care units (ICUs) from the 1970s to 2005 (Carayon and Gurses, 2005) showed that nursing workload in ICUs is a major contributing factor for patient safety.

A study performed in North American general hospitals (Tauton et al., 1994) concluded that in situations involving a greater ratio of patients per nurse, surgical patients present a higher death risk after 30 days of hospitalisation and greater failure to rescue rates (deaths due to potentially treatable complications). It was also found that the simple fact of adding one patient per nurse was associated with a 7% increase in the risk of death in the 30 days after admission, and a 7% increase in the risk of death by complications.

A systematic review regarding the effects of the numbers of nursing staff over patients (Lang et al., 2004) showed that the increased staffing ratio was associated with reduced deaths, LOS and surgical complications.

Other investigations have shown an inverse and statistically significant relationship between the percentage of nursing hours recorded and the development of pressure ulcers, urinary tract infection and postoperative infection (Cho et al., 2003), as well as between nursing hours recorded and medication errors, pressure ulcers, death and patient complaints (Sax and Pittet, 2002). Also, an additional study (Lichtig et al., 1999) found an inverse relationship between the number of nursing hours per patient per day and length of stay (LOS) in 10 of the 11 units studied.

Many studies (Anita et al., 2001; Castillo-Lorente et al., 2000; GIRTI, 1991; ICNARC, 1999; Lundgrén-Laine and Suominen, 2007; Miranda et al., 1996, 1997) were developed to measure nursing workload in the ICU with different tools. Despite these relevant investigations, little is known about this matter with the use of NAS.

Proposed by Miranda et al. (2003) the score obtained on the basis of the 23 items NAS 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.

In Brazil, after the process of translation to Portuguese, the NAS was applied to a sample of 200 adult ICU patients (Queijo and Padilha, 2009). The concurrent validity was demonstrated by statistically significant correlation between the TISS-28 and NAS ($r = 0.67$, $p < 0.0001$), and by multivariate regression analysis ($R^2 = 94.4\%$, $p < 0.0001$). The convergent validity was supported by the statistically significant association between the NAS and the SAPS II, when adjusted for age ($R^2 = 99.8\%$, $p < 0.0001$). In general, the results indicated that NAS is a valid and reliable instrument to measure nursing workload in Brazilian ICUs.

Several Brazilian studies found high mean NAS with mean workload of 74.62% (Dias, 2008), 73.7% (Ducci et al., 2008), 69.3% (Gonçalves et al., 2006), 67.2% (Queijo and Padilha, 2009), 65.5% (Conishi and Gaidzinski, 2007), 61.92% (Silva, 2008) and 59.6% (Ducci and Padilha, 2008).

In the international literature, only two studies were based on NAS and their mean scores were lower, of about 41.0% (Adell et al., 2005, 2006).

The characteristics of patients as well as the severity of illness could explain the mean NAS differences among ICU from different countries. Moreover, the difficulties related to a clear operational explanation about some items could contribute to the differences.

Therefore, in view of the relevance of measuring nursing workload to adequate staff to patients' care needs many studies are currently being carried out in the ICU with NAS.

## Methods

An exploratory, descriptive, prospective study was carried out on 68 consecutive patients admitted to a general 25-bed adult ICU belonging to a private tertiary hospital with 250 beds located in São Paulo, Brazil, over a month period in 2004.

Participants inclusion criteria included age equal to or above 18 years and minimal length of stay (LOS) of 24 h in the ICU.

The project was approved by the hospital's ethics and research committee. Written authorization was obtained from families or patients included in the study. Medical records were used to collect demographic data (gender, age, type of treatment, LOS, discharge) and NAS.

All data were collected only by the researchers who had experience with using NAS. The NAS data were filled out daily from admission to discharge from the unit with information provided by nurses whenever necessary. Patients

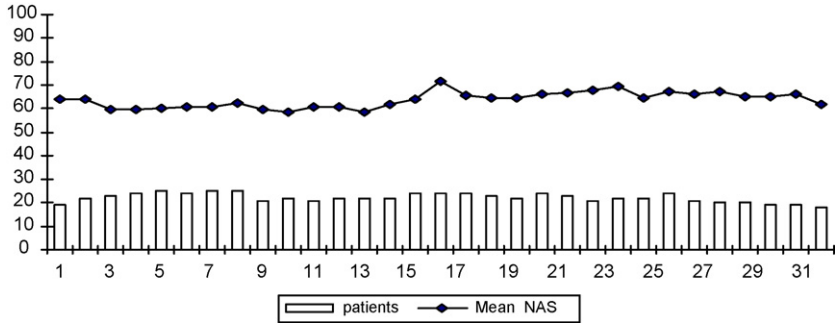


**Figure 1** Results of mean NAS and number of patients in the ICU according to day of the month. São Paulo, 2004.

admitted on the last day of the month were included in the study for computation of nursing workload on this day.

As proposed by Miranda et al. (2003) 24-h NAS was used to describe nursing workload of a patient in any shift.

Regarding the staff allocation, there were always 17 nursing professionals in a six hour day shift. It is important to point out that during the data collection, the ICU nursing staff was fixed and there were not any special conditions that could account for some of the excess nursing hours (for example, a new staff or students).

For analysis of the adequacy of the nursing staff, the mean NAS expressed as percent time was initially converted into hours considering a six hour shift (6 h equivalent to an NAS of 100%).

The value obtained in hours was multiplied by the mean number of patients in the unit in the shift, which resulted in the total hours of nursing care required (nursing workload). The nursing hours available (nursing staff) were calculated by multiplying the number of professionals in the shift (17) by the working hours (6 h), which equals 102 h.

The difference between total hours of nursing staff available and total hours required by patients (nursing workload) was then divided by 6 h to calculate the mean number of excess or lack of nursing staff at the unit during the shift studied.

### Statistical analysis

Data were analysed using the Statistical Package for the Social Sciences (SPSS) 13.0 software. The study sample was characterized 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, LOS and NAS.

## Results

Follow-up of the 68 patients admitted in the ICU on a month period in 2004 resulted in 690 NAS measurements.

Among the patients, 52.9% were males and most (66.1%) were 61 years or older. The mean age was $66.0 \pm 18.5$ years (range from 22 to 97 years). There was a predominance of admissions from the operating room (33.8%) and intermediate unit (27.9%). Most patients (57.4%) were admitted to the ICU for medical reasons; however, 21 (72.4%) of the 29 (42.7%) surgical admissions were elective surgery. The average LOS in the unit was $12 \pm 16.4$ days (ranging between 1 and 111 days) and median was 3.0 days. Of the 68 patients 9 (13.2%) died during their ICU stay and 59 (86.8%) survived.

Analysis of the nursing workload showed a mean NAS of $63.7 \pm 2.4\%$ (ranging between 58.5 and 71.7%) and median of 60.7%. The number of patients ranged from 18 to 25, with more than 20 beds being occupied in 87.0% of the days of month. The mean number of beds occupied per day was 22.7 (Fig. 1). In a six hour shift, mean NAS was 63.7%, corresponding to 3.8 h of care required per patient ($6\,h \times 63.7/100$). Thus, in this unit with mean occupation of 22.7 beds, total hours of care required were 86.3 ($22.7 \times 3.8$).

The hours available for nursing care in the six hour shift remained constant, i.e., 102 h throughout the period since the number of professionals was fixed (17). On the other hand, the mean NAS varied and only on the 16th day the

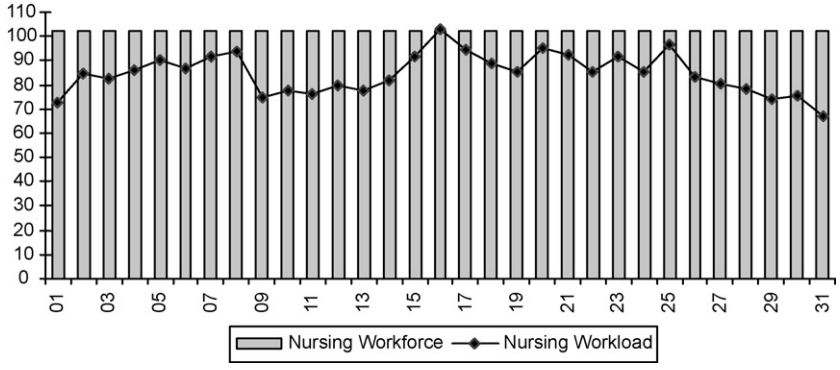


**Figure 2** Nursing workforce versus mean NAS per 6-h shift according to day of the month. São Paulo, 2004.

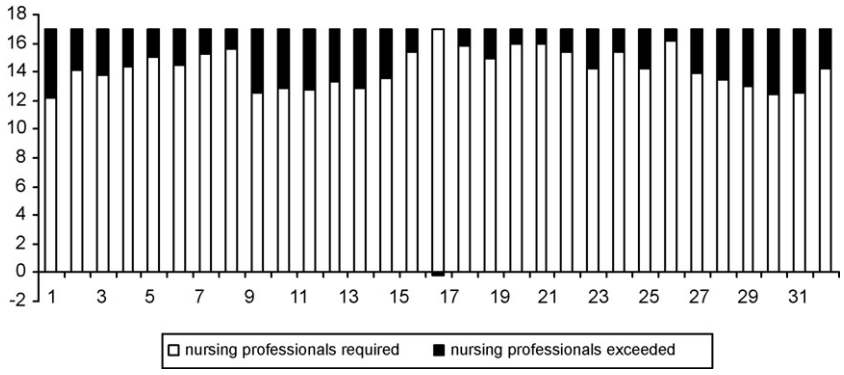


**Figure 3** Number of nursing professionals required and exceeded per 6-h shift according to day of the month. São Paulo, 2004.

nursing workload (103.2 h) exceeded the nursing staff. On this day, the mean NAS was 71.7% (6 h × 71.7/100 = 4.3 h) and there was a total of 24 patients, resulting in 103.2 h of care required versus 102 h available (Fig. 2).

Fig. 3 shows that in almost all days studied nursing staff exceeded the unit's needs by 0.8—4.8 professionals, except for on the 16th day when there was seen a small deficit of nursing staff.

Since mean hours of care required was 86.3 and that nursing staff was available for 102 h, there was an average excess of 15.7 h, corresponding to 2.6 professionals during a six hour shift in the study period (15.7 h:6 h).

## Discussion

Demographic and clinical data showed similar results to those reported in other studies concerning to age (Castillo-Lorente et al., 2000; Lefering et al., 2000; Miranda et al., 1998; Paiva et al., 2002; Queijo and Padilha, 2009), gender (Ducci and Padilha, 2004; Silva and Sousa, 2002;), pre-existing diseases (Silva and Sousa, 2002) and origin of patient, i.e., from the operating room and emergency room (Ducci and Padilha, 2004; Gonçalves et al., 2006; Padilha et al., 2008; Silva, 2008).

The LOS from 1 to 6 days (33.8% of patients) observed in this study is compatible with the results of the Brazilian Census of ICUs performed by the Association of Brazilian Intensive Care Medicine (AMIB, 2003). However, the mean LOS of 12 days can be explained by patients who were hospitalized in the ICU for 13 days or longer, corresponding to about 30% of the sample.

The mortality rate of 13.2% was similar to international studies (Lefering et al., 2000; Miranda et al., 2003), but below of those obtained in Brazilian investigations in which mortality ranged from 29 to 35% (Ducci and Padilha, 2004; Gonçalves et al., 2006; Silva, 2008; Silva and Sousa, 2002). These findings might be explained by the high rate of admission due to elective surgery, indicating that the study population is admitted to the unit with good therapeutic perspectives despite the high rate of chronic diseases and advanced age.

Analysis of the daily NAS, with mean of 63.7%, high values of patient's care needs and consequently the nursing workload in the ICU, reveals important data. Considering that the time spent by a nursing professional on the care of a patient with a mean NAS of 63.7% is 3.8 h during a six hour shift, these results are of help for the quantitative evaluation of the human resources in the ICU. The ratio of one professional to two patients, the minimum recommended in the Brazilian Regulation (Brazil, 1998) and commonly found in Brazilian ICUs, would be insufficient to satisfy the care needs required on average by patients in this unit. However, the proportion found of 1:1.5 professional per patients was even in excess in almost all days studied.

Advancing the analysis of the data, calculation of the hours required for patients care (nursing workload) versus nursing staff showed an exceeded staff, on average of 15.5 h, i.e., a mean excess of 2.6 nursing professionals during a six hour shift. During the study period, apart from one day with deficit of 1.2 h of care (−0.2 professional), in the remaining period there was an excess of nursing staff (Fig. 3).

The results show fluctuations in nursing workload over the month studied either on a weekday or weekends. This finding is consistent with the characteristics of the clients, i.e., mostly patients admitted for medical care (57.4%) with long mean LOS in the ICU (12 days).

Few studies have used NAS to measure nursing workload in ICUs. In Brazil, some investigations reported mean NAS similar to the present study with mean scores near or higher than 60.0%, i.e., 67.2% (Queijo and Padilha, 2009), 69.3% (Gonçalves et al., 2006), 65. 5% (Conishi and Gaidzinski, 2007) and 59.6% (Ducci and Padilha, 2008). Additionally, a study carried out on six ICUs in four Brazilian hospitals to analyse the nursing workload within a sample of 500 patients found a similar NAS average, i.e., 61.92% (Silva, 2008). However, a study investigating workload in the postoperative period of heart surgery in an ICU of a tertiary university hospital found a higher mean daily NAS (74.62%), and 96.79% in the first postoperative day (Dias, 2008). Similar results were found in a cardiac ICU of a high-complexity hospital showing mean NAS of 73.7% (Ducci et al., 2008). It should be noted that none of these studies had the purpose of assessing adequacy between available and required nursing hours in ICUs.

The finding of a daily mean excess of 2.6 nursing professionals during a six hour shift is important and can contribute to rethinking effective allocation of human resources to reduce intensive care costs.

In this sense, the results provide evidence against a fixed workload in ICUs and pose new challenges for nursing man-

agers: select or develop different tools for measuring nursing workload and find new models for nursing staff allocation to assure patient safety, improve quality of care and balance cost-effectiveness and quality in ICUs.

As for the challenge of selecting an adequate tool for measuring workload it is essential to weigh not only patient characteristics but also advantages and limitation of these instruments. Although it is important to cover for fluctuations in demands of care required by patients, it also should be taken into consideration expectations and needs of those working at the unit.

## Limitations of the study

The results of this study do not allow generalisation or intervention for the adequacy of nursing staff in ICU, since several factors such as type of hospital, customer characteristics, organisation of the health system, can dramatically affect these results.

Therefore, due to the fact that it is a pilot study developed in a short period with a small sample from a sole Brazilian ICU whose data were collected only by the researchers the results have to be analysed carefully and further studies over a longer period of time are needed. Considering that NAS is a new instrument to measure nursing workload in the ICU, its use should be expanded to better evaluate its performance Besides, there are few studies in the international literature that allow result comparisons.

## Conclusions

Despite the limitations of this preliminary study, the results showed that in the ICU studied the patients required high nursing workload according to the NAS. However, the number of nursing professionals was overestimated over the period indicating that costs can be reduced with no negative implications to the quality of care provided to ICU patients.

As NAS is an instrument that directly reflects the percentage of time nursing staff spends providing direct care to severely ill patients it proved to be a valuable tool for measuring workload in ICUs. However, NAS performance has to be tested in different ICU scenarios.

## Conflict of interest

None declared.

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