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Research Article

Nursing sensitive indicators of structure and outcome in intensive care units

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Abstract

Objective: To associate the Nursing Sensitive Indicators of structure related to nursing staff with Nursing Sensitive Indicators of outcome in the Intensive Care Units.

Method: Prospective cohort study developed in 8 adult Intensive Care Units, with a sample of patients composed of simple random sampling and nursing professionals composed by 2 categories: nurses and nursing assistants. The nursing workload was measured by the Nursing Activities Score instrument. A linear regression model associated variable of structure and outcome, considering a statistical significance of 5%. Results: The study found 265 patients, 115 nurses and 256 nursing technicians. The length of stay ($p<0.05$), mean of nurse ($p<0.05$) and nursing assistant ($p<0.05$), mean of patient per nurse ($p<0.05$) were associated with the Nursing Sensitive of outcome.

Conclusion: The NSI of structure length of stay, mean of nurse and nursing assistant, and mean of patient per nurse associate with the NSI of outcome in this study.

Introduction

In the 1990s, the American Nurses Association (ANA), working through the programs Patient Safety and Quality Initiative Program, highlighted the importance to make investments in the quality of care and patient safety and created the Nursing Sensitive Indicators (NSI), an important tool for nurses to assess the quality of nursing practices focused on patient outcomes [1].

The NSI are indicators that evaluate nursing practices and patient outcome applying the three pillars of the theoretical model of Donabedian [1,2]: Structure-Process-Outcome. Structure means the organizational aspect, the human and material resources; Process considers the interaction with professionals in nursing care; Outcome examine the health status, results, and adverse events (damages to patients occurred during health care [2]) such as pressure ulcer, infection, loss of device, error of medication [3], and mechanical restraint [4]. In Intensive Care Units (ICU), where critical patients and the environment are very complexes [5-8], the NSI is an important tool for the measurement of nursing structure with the purpose to give support to nursing actions that impact on patient outcome [5-13].

Indeed, nursing workload in the ICU is an example of the NSI of structure that we need to investigate and organize it according to patients needs. The management of nursing workload can be used to provide an adequate number of nursing staff to improve patient's outcome. We observe in the literature that the higher nursing workload increases the intensity of nursing activities and overload the staff currently active in the unit making difficult to supervise patients, what increases the risk of adverse events [10,13].

Therefore, the literature also reinforces the importance to investigate nursing workload in association with the occurrence of adverse events. Studies report that a high

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nursing workload increases the incidence of adverse events such as mechanical restraint [13], pressure ulcer and infection [10-13], loss of feeding tube [11], loss of central catheter of peripheral insertion, central venous catheter, and orotracheal intubation [11], fall [11-12], error of medication and infection [5,10], increase length of stay [9], identification failures, lack of record, mortality [9], and moreover it increases cost of care [9-10].

Researching nursing workload in ICUs, the composition of nursing staff has an important particularity in our investigation that can impact on patient outcome. Nursing assistants are part of nursing staff and have different role and responsibility from nurses. Then, the category of nursing staff is an important NSI of structure to be investigated in this study.

A systematic review that investigated nursing staffing level in association with NSI of outcome confirms that the higher staffing level in ICUs, as the higher presence of nurses than nursing assistants to evaluate hemodynamic conditions is associated with reduced occurrence of adverse events such as mortality, medication errors, ulcers, mechanical restraint, infections and pneumonia [6].

Thus, considering the importance to have an adequate NSI of structure related to nursing staff in the ICU to promote nursing practices and achieve a better patient outcome, this study has the objective to associate NSI of structure with NSI of outcome in the Intensive Care Units.

The hypothesis indicates that the NSI of structure impacts on NSI of outcome in ICU.

Method

Design, local and period

This prospective cohort study has been developed at the 8 adult Intensive Care Units of a Brazilian university hospital, with a capacity for 930 beds, of which 72 for adult intensive care. The units included were General Surgery (11 beds), Burns (4 beds), Nephrology (4 beds), Medical (9 beds), Neurology (9 beds), Infectious Diseases (7 beds), Clinical Emergencies (11 beds) and Surgical Emergencies (17 beds), with follow-up performed from June to August 2017.

Sample with inclusion and exclusion criteria

The sample test considered the occupation tax of the units that varied between 85% and 90% in the last 12 months before starting data collection, the number of patients and the prevalence of adverse events recorded in a preview study done at the same units considering 95% of confiability. It was conducted by a statistician of the university where the researchers were located indicating 265 individuals.

To select the patients, a simple random sampling was done in each unit by lottery through a patient draw of 30% of the total of patients from the ICUs with a higher number of beds (General Surgery, Medical, Clinical Emergencies and Surgical Emergencies) and 50% from the ICUs with a fewer number of beds (Burns, Nephrology, Neurology and Infectious Diseases). This decision was made to balance the number of patients from each unit to compose the sample. The Neurology and Medical ICUs had the same number of beds and they were included in different groups for the lottery. After the discharge of each patient, they were replaced by another one following a new patient draw.

The eligibility criteria included length of stay in the ICUs longer than 24 hours to attend the author's recommendation of the applied instrument to measure the NSI of structure nursing workload.

Patients who presented a lack of data were replaced by others selected by a new patient draw.

Regarding nursing staff, the sample of convenience included 2 categories: all nurses and nursing assistants who worked during the study period. They had regulated roles and their attributions differed according to their level of education. Nurses had graduation degree and were responsible for the supervision of the assistants and patients, decision-making activities, and invasive procedures. Nursing assistants had technical level and were trained to record vital signs, drug administration, mobilization, hygiene, and feeding.

The number of nursing staff followed the Brazilian regulation: 1 nurse to supervise 10 patients and 1 nursing assistant to 2 patients [14]. Then, the number of professionals in each unit was in according with the number of patients.

Variables

Figure 1 describes the variables of the study.

The NSI of process was not analyzed in this study, which objective was to investigate the association of the NSI of structure with the NSI of outcome.

Data collection

Nurses received training to apply the instrument Nursing Sensitive Score (NAS) and use the online system accessing it by a login and individual password to collect the nursing workload everyday, as well as to store data in the dbNAS database. This system was integrated with the institutional server and made possible to extract reports per day.

Professionals' variables were daily collected by the researcher using the ICUs documents.

Patients' data were collected by the researcher from the patients' medical records. All the NSI of outcome was also collected by the researcher through the daily analysis of the patients' medical records and the institutional online system that daily registered the adverse events. This system was controlled by the Committee of quality and safety of the institution.

Statistical analysis

Patient per nurse and patient per nursing assistant were calculated by dividing the number of patients by the number of professionals of each category per day. All data were typed

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Figure 1: Description of the variables of the study, concerning the NSI of structure and outcome.

NSI of Structure							NSI of Outcome	
Nursing professionals				Patients			Adverse events	
Type of indicator	Definition	Data Source	Type of indicator	Definition	Data Source	Type of indicator	Definition	Data Source
Mean of nurses	mean of nurses per day	Institutional documents	Age	in years	patients' medical records	phlebitis	Number of patients who presented phlebitis	institutional databases
Mean of nursing assistants	mean of nursing assistant per day	Institutional documents	Sex	Male; female	patients' medical records	dermatitis	Number of patients who presented dermatitis	institutional databases
Patient per nurse	Division of the number of patients by the number of nurses	Institutional documents	Type of treatment	Clinical; surgical	patients' medical records	pressure ulcer	Number of patients who presented pressure ulcer	institutional databases
Patient per nursing assistant	Division of the number of patients by the number of nursing assistants	Institutional documents	Output condition	Survivor; not survivor	patients' medical records	mechanical restraint	Number of patients who presented the use of mechanical restraint	institutional databases
nursing workload (NAS[1])	Proportion of time required by patients	Online institutional system	Risk of death (SAPS3[2])	Risk of death measured in the admission in the ICU	patients' medical records	infection associated with nursing care	Number of patients who presented infection related to nursing care	institutional databases
			Length of stay	days of inpatients in the ICU	patients' medical records	loss of device	Number of patients who presented loss of device[3]	institutional databases
			Comorbidities	Number of comorbidities by patient	patients' medical records			institutional databases

1. The NAS instrument, translated and validated in Brazil [15], presents a high agreement of 99.8%, which indicates stability and precision for the nursing workload measurement. It is constituted of 7 categories: Basic activities [Monitoring and control, Hygiene procedures, Mobilization and positioning, Support and care for family and patients, Administrative and managerial tasks], Ventilatory, Cardiovascular, Renal, Neurological, Metabolic and Specific Interventions, and 23 items with scores varying from 1.2 to 32 points, 5 of them with subitems that allow to evaluate nursing care according to the level of requirement presented by patients. The final score represents the proportion of time of care required by patients in the last 24 hours, reaching a maximum of 176.8%. In this case, the patient needs more than one nursing professional [15].
2. The SAPS3 instrument is composed of 20 variables measured in the admission of patients in ICU. It is divided into three parts: demographic, reason of admission and physiological, indicating the degree of commitment of the disease and health status prior to admission. The physiological variables are temperature, systolic blood pressure, heart and respiratory rate, oxygenation, hydrogen arterial potential [pH], sodium, potassium, creatinine, bilirubin, hematocrit, leukocytes, platelets, and coma scale of Glasgow. The score varies between 16 and 217 points and allows to identify the risk of death [16].
3. The loss of device included catheters, drainage and feeding tubes, drains, orotracheal tube and tracheostomy.

into Excel, checked, imported and processed in the Statistical Package for Social

Sciences (SPSS) version 19.0 for descriptive and inferential statistical analysis.

The analysis of NSI of structure and outcome was performed using absolute and relative frequencies, central tendency measures (mean and standard deviation). Normality and homogeneity of the quantitative variables were analyzed using the Kolmogorov-Smirnov and Levene tests, respectively. Considering the results, Anova and Kruskal Wallis tests were applied. Qui-square test was applied for the qualitative variables. To find the statistical differences among units, the Scheffe test was calculate, considering the overall F test with statistical significance of 5%.

The association of all NSI of structure, including nursing indicators and variables of patients, with the NSI of outcome was tested using the linear regression model, backward strategy. For all analyzes, results were statistically significant whit $p < 0.05$.

Ethical approval

The study was approved by the Ethics Committee for the Analysis of Research

Projects of the institution and conducted according to the ethical standards required by

Resolution 466, 12/2012.

Results

In the period of the study, a total of 115 (31.0%) nurses and 256 (69.0%) nursing assistants worked in the 8 ICUs. The NSI of structure related to nursing professionals are in the Table 1.

The worst proportion of patient per nurse was reported in the Neurology ICU, where each nurse had 7.1 patients to supervise. Conversely, in the Nephrology ICU, where we observed the highest mean of NAS, each nurse supervised 1.4 patients. The Clinical Emergencies ICU, with the lowest mean of NAS, presented the worst mean of patient per nursing

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assistant, as each professional supervised more than 2 patients. The mean of NAS was high in all units (Table 1).

The sample of patients consisted of total of 290 patients distributed according to the Table 2.

The type of treatment presented higher proportion of surgical patients in the Burns, Neurology and Surgical Emergencies ICUs. The ICUs of Nephrology, Surgical Emergencies and Clinical Emergencies, which presented the highest means of risk of death, also presented a long length of stay (Table 2).

Considering the outcome, 113 (42.6%) patients had no incidence of adverse events and 152 (57.4%) had a total of 518 adverse events, with a mean of 3.4 events per patient.

The proportion of the NSI of outcome identified in the 8 Units of the study is reported in the Figure 2.

The highest proportion of the NSI of outcome was related to loss of device (28.7%) that included catheters, drainage and feeding tubes, drains, orotracheal tube and tracheostomy (Figure 2).

The analysis of the association of the NSI of structure with NSI of outcome in the ICUs was presented in the Table 3.

Length of stay, mean of nurse, and patient per nurse increased the mean of NSI of outcome (adverse events), and the increase mean of nursing assistant decrease the mean of adverse events in the ICUs of the study (Table 3).

Discussion

The application of the NSI of structure and outcome for the assessment of nursing practices and patient outcome represents an important strategy for nurses to make effective decisions concerning the complexity of critical patients in the ICU.

In our study, the rise of length of stay increases in 0.06 times the mean of adverse events in the ICUs. It happens because the high length of stay can rise the time of exposition

Table 1: Descriptive measure of the NSI of structure per ICU. São Paulo, SP, Brazil, 2017.

Variables	General Surgery Mean (sd)	Burns Mean (sd)	Nephrology Mean (sd)	Medical Mean (sd)	Neurology Mean (sd)	Infectious Diseases Mean (sd)	Clinical Emergencies Mean (sd)	Surgical Emergencies Mean (sd)	p
Nurse	6.3 (0.6)	3.2 (0.5) [a]	4.5 (0.8)	7.4 (0.9)	4.0 (0.9)	4.1 (0.7)	10.6 (1.8)	12.5 (1.8) [a]	<0.05*
Nurse assistant	15.0 (0.9)	7.2 (0.8)	4.4 (1.1) [a]	16.8 (1.1)	13.9 (0.3)	9.0 (0.2)	18.4 (1.2)	22.9 (1.5) [a]	<0.05*
Patient per nurse	4.4 (0.6)	3.5 (0.6)	1.4 (0.4) [a]	3.9 (0.7)	7.1 (1.7) [a]	4.4 (0.8)	3.7 (0.7)	3.8 (0.6)	<0.05*
Patient per nursing assistant	1.9 (0.2)	1.6 (0.2)	1.5 (0.4)	1.7 (0.2)	1.9 (0.1)	1.9 (0.1)	2.1 (0.2)	2.0 (0.2)	0.05*
NAS[ǁ]	91.9 (13.3) [a]	105.2 (12.3) [b]	108.4(23.2) [c]	91.3 (11.3) [d]	92.2 (12.4)	91.9 (12.8)	81.9 (10.8) a,b,c,d,e	102.6 (4.4) [a,d,e]	<0.05**

*Anova test; **Kruskal Wallis test; [ǁ]NAS: Nursing Activities Score; [a-f] Scheffe test p

Table 2: Descriptive measure of patients' variables and NSI of outcome. São Paulo, SP, Brazil, 2017.

Variables	General Surgery (n=55)	Burns (n=7)	Nephrology (n=7)	Medical (n=50)	Neurology (n=27)	Infectious Diseases (n=46)	Clinical Emergencies (n=46)	Surgical Emergencies (n=52)	p
Age	48.8 (18.3)	30.7 (7.9) [a]	48.1 (21.7)	52.6 (16.2) [a]	53.6 (15.4)	45.1 (14.2)	50.7 (18.2)	48.7 (18.4)	<0.05*
Risk of death (SAPS3)[+]	30.1 (27.5)	25.3 (19.4)	51.5 (26.0) [a]	35.2 (26.8)	24.7 (24.1) [a]	29.3 (23.1)	40.8 (28.2)	41.2 (23.4)	<0.05*
Length of stay	8.5 (9.1) [a]	20.0 (13.4)	19.2 (14.8)	10.7 (9.1)	20.7 (22.0) [a]	23.6 (29.3)	15.1 (16.4)	20.5 (21.7)	<0.05*
Comorbidity	1.8 (1.3)	0.3 (0.6) [a]	2.4 (1.1) [a]	1.3 (1.3)	1.5 (1.1)	1.2 (1.3)	1.3 (1.0)	1.1 (1.1)	<0.05*
NSI of outcome (n=518)	10.1 (5.4) [a]	8.6 (7.8)	1.3 (1.3)	9.5 (7.9) [b]	15.8 (14.6) [a,b]	4.0 (3.8)	17.0 (12.8)	19.8 (13.1)	<0.05*
				(%)					
Sex *Male* *Female*	52.7 47.3	91.7 8.3	42.9 57.1	58.0 42.0	37.1 62.9	56.3	43.5 43.7	69.2 56.5	<0.05** 30.8
Type of treatment *Clinical* *Surgical*	54.5 45.5	8.3 71.4	91.7[c] 28.6	92.0 8.0	33.3 66.7	93.7 6.3	76.1 23.9	9.6 90.4	<0.05**
Output condition *Survival* Not Survival	72.7 27.3	91.7 8.3	85.7 14.3	74.0 26.0	85.2 14.8	81.3 18.7	76.1 23.9	73.1 26.9	0.76

*Anova test; [+]SAPS3: Simplified Acute Physiology Score 3; **Qui square test; [a-b] Scheffe test p<0.05 Source: Results of research, 2017.

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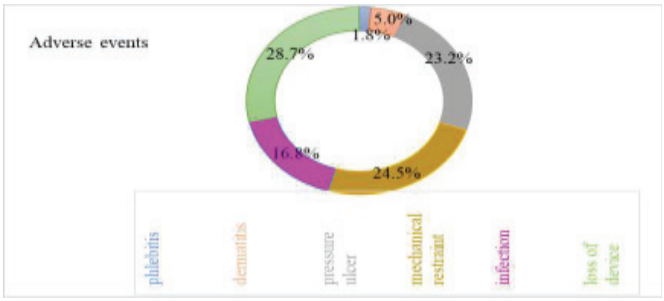

Figure 2: Proportion of the NSI of outcome. São Paulo, SP, Brazil, 2017
Source: Results of research, 2017.

Table 3: Association of the NSI of structure with the NSI of outcome in the ICUs. São Paulo, SP, Brazil, 2017.

Variables	B	CI	p*
Lenght of stay	0.06	[0.05 0.08]	<0.05
Nurse	1.002	[0.2 1.8]	<0.05
Nursing assistant	- 0.5	[-0.8 -0.1]	<0.05
Patient per nurse	1.5	[0.5 2.4]	<0.05

*Linear Regression analysis; Source: Results of research, 2017.

to interventions for intensive care that submit patients to the risk of adverse events. Our units Neurology, Clinical and Surgical Emergencies confirm the long length of stay and a high mean of adverse events.

Studies carried out in ICUs also confirm that the long length of stay increases patient's exposure to clinical exams, procedures and administration of intravenous drugs, which, in turn, increase the risk of adverse events [5,13] such as infection, pressure ulcer and error of medication [17,18], especially when influenced by the high risk of death related to invasive procedures to save life [19].

Conversely, in the Nephrology ICU, the long length of stay and the high risk of death did not impact on the mean of adverse events. It may be justified by the lower mean of patients in the unit that promotes the adequate proportion of patients per nurse and positively impacts on the supervision of patients.

The association of patients per nurse with adverse events confirms this result. The increase mean of patients per nurse increase the mean of adverse events in 1.5 times, indicating that the more patients per nurse, riser nursing workload and less quality on patients' supervision, what expose them to adverse events. In the Neurology, where the mean of patients per nurse is higher, the mean of adverse events is also high.

International studies that investigated the association of the NSI of structure with the NSI of outcome report that the high mean of patients per nurse increase nursing workload because of the lack of time of nurses to perform all activities [7,8].

The results confirm that the high mean of patients per nurse compromises the adequate supervision of patients, impacting on the greater risk of adverse events occurrence such as patient identification failures, lack of record, inadequate supervision, fall, error of medication, pressure ulcer and infection [5,7,9-10,13], increase length of stay [9] and cost of care [9,10]. A systematic review reinforces the high frequency of infection associated with the nursing workload as a consequence of the overload activities [12].

In spite of the results of our study, the mean of patients per nurse in our ICUs is in accordance of the recommendation of the Brazilian resolution, which defines up 10 patients for each nurse in the ICU [14]. However, the nursing workload measured by the NAS is high in all units, highlighting the importance to maintain the mean of nursing professionals according to patients' needs to guarantee an adequate proportion of patients per nurse and supervise them with safety.

It is also important to mention the categories of nurses and nursing assistants associated to the occurrence of adverse events. In our study, the increase mean of nurses increase the mean of adverse events. Probably, in the biggest units that have more nurses because they have more critical patients, nursing workload is higher mainly if the proportion of patients per nurse is not adequate and it impacts on the occurrence of adverse events.

Moreover, the increase mean of nursing assistants decrease adverse events justified by the support they give to nurses to supervise patients. Nursing assistants have specific activities in the units, less years of study and responsibility of basic care, and they support nurses in the distribution of activities. Then, to ensure the adequate management of nursing workload in ICUs, it is essential to provide an adequate number of nursing assistants.

The literature reinforces that the adequate number of nursing professionals in ICU, especially of nurses, impacts on the adverse events' notification and specific actions for supervision and patient safety [9-10,13].

This study has important contributions to nursing practices and patient outcome through the application of NSI. The hypothesis that NSI of structure impacts on the NSI of outcome is confirmed. Protocols of intervention in the length of stay can impact on better patient outcome, as well as the adequate number of nursing professionals in ICUs to attend patients' needs. The adequate mean of patients per nurse and nursing assistants contribute to organize the unit and supervise patients.

The Nursing Sensitive Indicators is a proposal of safe practices where nurses can really intervene, however, future studies including variables of environment of ICU and longer follow up with similar distribution of patients among units can advance the results.

The limitation considers the different number of patients in each unit.

Conclusion

The NSI of structure length of stay, mean of nurse and nursing assistant, and mean of patient per nurse associate with the NSI of outcome in this study.

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