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Nursing allocation and adverse events/incidents in intensive care units*

ALOCÇÃO DA EQUIPE DE ENFERMAGEM E OCORRÊNCIA DE EVENTOS ADVERSOS/ INCIDENTES EM UNIDADE DE TERAPIA INTENSIVA

DISTRIBUCIÓN DE LA EQUIPO DE ENFERMERÍA Y OCURRENCIA DE EVENTOS ADVERSOS/INCIDENTES EN UNIDAD DE CUIDADOS INTENSIVOS

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ABSTRACT

Patient safety is a challenge for the quality in health care system. This study aimed to analyze the appropriateness of the allocation of nursing staff according to the hours of care required by patients and to identify the relationship between this allocation and adverse events/incidents (EA/I). This research was observational, descriptive and prospective, developed in Clinics ICU located in the 4th floor and 6th floor at a university hospital, in São Paulo, Brazil, from 01/11/07 to 10/12/07, with 46 patients. In the 4th floor and 6th floor ICU, respectively, 43,3% and 10,3% of allocations were inadequate ($p=0.000$). There was a difference in the frequency of EA/I between the adequate and inadequate allocation of nursing staff in the 4th floor and 6th floor ICU, $p=0.0004$ and $p=0.000$, respectively. It was concluded that the greater the difference between available and required hours of care in nursing allocations, the lower the frequency of EA/I.

DESCRIPTORS

Intensive Care Units
Nursing, team
Nursing care
Patient safety

RESUMO

A segurança do paciente representa um desafio para a excelência da qualidade no setor saúde. Este estudo objetivou: verificar a adequação entre a alocação da equipe de enfermagem e as horas de cuidado requeridas pelos pacientes, bem como identificar a relação entre essa alocação com eventos adversos/incidentes (EA/I). Trata-se de pesquisa observacional, descritiva e prospectiva, desenvolvida nas Unidades de Terapia Intensiva Clínicas do 4º andar e 6º andar de um Hospital Universitário, do município de São Paulo, Brasil, no período de 01/11/07 a 10/12/07, com 46 pacientes. Nas UTIs 4º andar e 6º andar, respectivamente, 43,3% e 10,3% das alocações foram inadequadas ($p = 0,000$). Houve diferença na frequência de EA/I nas alocações adequadas e inadequadas da equipe de enfermagem da UTI 4º andar e UTI 6º andar, $p = 0,0004$ e $p = 0,000$, respectivamente. Concluiu-se que, quanto maior a diferença entre as horas disponíveis e requeridas de cuidado nas alocações de enfermagem, menor a frequência de EA/I.

DESCRIPTORES

Unidades de Terapia Intensiva
Equipe de enfermagem
Cuidados de enfermagem
Segurança do paciente

RESUMEN

Este estudio tuvo como objetivos determinar la distribución de personal de enfermería conforme las horas de los cuidados requeridos por los pacientes y identificar la relación entre esta distribución con los eventos adversos/incidentes (EA/I). Estudio observacional, descriptivo y prospectivo, desarrollado en la UCI Clínicas de 4º y 6º piso de un hospital universitario, en Sao Paulo, Brasil, desde 01/11/07 hasta 10/12/07, con 46 pacientes. Los resultados apuntan que en la UCI 4º piso y en la UCI 6º piso, respectivamente, 43,3% y 10,3% de las distribuciones fueron inadecuadas ($p=0,000$). Hubo diferencia en la frecuencia de EA/I en la distribución de personal de enfermería adecuada e inadecuada en la UCI 4º y 6º piso, respectivamente, $p = 0,0004$ y $p=0,000$. Se concluyó que cuanto mayor la diferencia entre horas disponibles y necesarias de cuidados en la distribución de actividades del equipo de enfermería, menor es la frecuencia de EA/I.

DESCRIPTORES

Unidades de Cuidados Intensivos
Grupo de enfermería
Atención de enfermería
Seguridad del paciente

*Extracted from the thesis "Segurança do paciente em Unidade de Terapia Intensiva: carga de trabalho de enfermagem e sua relação com a ocorrência de eventos adversos e incidentes", University of São Paulo School of Nursing, 2011. ¹Ph.D. in Adult Health Nursing, University of São Paulo School of Nursing. São Paulo, SP, Brazil. leilane@usp.br ²Doctoral student of the Graduate Program in Adult Health Nursing, University of São Paulo School of Nursing. CAPES Fellow. São Paulo, SP, Brazil. rafaelaandolhe@usp.br ³Post-doctorate student of the Graduate Program in Adult Health Nursing, University of São Paulo School of Nursing. CAPES Fellow São Paulo, SP, Brazil. elainemachado@usp.br ⁴Post-doctorate student of the Graduate Program in Adult Health Nursing, University of São Paulo School of Nursing. PNPd Fellow São Paulo, SP, Brazil. rluisbarbosa@usp.br ⁵RN. Associate Professor, University of São Paulo, Medical-Surgical Nursing Department, São Paulo, SP, Brazil. rafacris@usp.br ⁶MD. Ph.D. Professor of the Department of Clinical Emergencies at the University of São Paulo Faculty of Medicine. São Paulo, SP, Brazil. renatagallotti@terra.com.br ⁷Full Professor of the Department of Medical-Surgical Nursing at University of São Paulo School of Nursing. São Paulo, SP, Brazil. kgpadilh@usp.br

INTRODUCTION

Patient safety represents a major challenge toward the excellence of quality in the healthcare sector.

The high occurrence of adverse events and incidents clearly expressed by the yearly numbers of preventable deaths as a result of inadequate health care⁽¹⁾ - ranging between 44,000 and 98,000 - has been rising great concern across the globe. By definition, adverse events (AE) are understood as the emergence of non-intentional injuries unrelated to the natural evolution of an underlying disease that generate measurable injuries in affected patients and/or prolong the length of stay and/or cause death⁽²⁾; Incidents (I) are health complications that originate in the health care process that do not generate measurable injuries or prolong the length of stay⁽³⁾.

Adverse events and incidents (AE/I) are relevant quality indicators, as they allow for the measurement of the existing distance between the rendered health service and the ideal care, thus offering indispensable information toward the construction of a safer health care system⁽⁴⁾.

In Intensive Care Units (ICU), patients who require intensive care are considered vulnerable to the occurrence of adverse events, as they present constant hemodynamic alterations and imminent death risks, thus demanding health professionals to provide them with complex care, uninterrupted attention and immediate decisions⁽⁵⁾.

The environment, the tasks, the organization and the technology are pointed out by specific investigations as the health care system elements that interfere in the quality of the care delivered to critical patients. Work conditions, especially the adequacy of the staff, are factors that may compromise the quality of intensive care⁽⁶⁾.

The findings pointing out the workload as a risk factor to patient safety⁽⁷⁾ are endorsed by literature reviews produced between 1970 and 2005.

Therefore, an adequate number of professionals is an indispensable premise toward a safe care, and it is an institutional responsibility to provide human resources with favorable work conditions in health care units. After all, the quantitative adequacy of professionals to the needs of the patients not only lowers their vulnerability, but also decreases the incidence of more serious risks to the health workers⁽⁸⁾.

Among the different health teams that work in the ICU, the nursing staff stands out as a fundamental player in the processes aimed to ensure and improve the quality of the rendered care. However, isolated training and qualification measures toward nursing staff are not a guarantee of total absence of risks, which justifies this study related

to the hours of nursing staff available / hours required by patient care and nursing allocation processes in the ICUs.

In the last decade, several studies have observed the correlation between workloads in the nursing practice and care results⁽⁷⁻⁸⁾. Some authors⁽⁹⁾ concluded that a 0.1% increase in the patient/nurse ratio could lead to a 28% rise in adverse event rates.

Additionally, the clinical practice clearly shows that the occurrence of adverse events is not only related to the total number of the nursing staff, but also to the allocation of these professionals at bed side, or in other words, the inadequate distribution of patients for each professional whenever the 1:1 ratio is not a reality. This is a common profile observed both in national and international ICUs. However, we did not find studies that addressed such issue.

In this context, this study aims to verify the balance between the allocation of nursing staff and the care hours required by patients, as well as identify the correlation between the allocation of nursing staff per patient and the occurrence of adverse events/incidents.

METHOD

Some authors concluded that a 0.1% increase in the patient/nurse ratio could lead to a 28% rise in adverse event rates.

This observational, descriptive, prospective study was performed in four ICUs of a University Hospital Clinical Emergency Services (Emergency Room, Medical Outpatient Clinic, Pneumology and Hematology) located in the central area of São Paulo, Brazil. For standardization purposes, the emergency room ICU was analyzed together with the Hematology unit, designated as *4th Floor ICU*, and the medical clinic ICU was analyzed in conjunction with the Pneumology unit, designated as *6th Floor ICU*. The justification for such grouping is based on the fact that all units are located in a single physical structure, having the same professionals working in the teams.

During the study interval, the *4th Floor ICU* showed a patient/nurse distribution of 5:1, while the distribution ratio on the *6th Floor ICU* was 6:1. The patient/nursing technician distribution in both units was 2:1.

The convenience sampling studied between 1 November 2007 and 10 December 2007 was comprised of all patients aged 16 or older admitted into the ICUs, submitted to clinical and/or surgical treatments, and who stayed for a minimum of 24 hours in those units; readmitted patients were also taken into account.

Data collection was performed after the Research Ethics Committee approved the study proposal and counted on the active participation of doctors, nurses and undergraduate students taking the 2nd and 3rd years in the Nursing College. Health care professionals, including one

doctor and two nurses expert in the application of the instruments used in this study and with vast knowledge on other research instruments, provided the data collection team with specific training. The data collection process was similar in all four units and complied with the same methodological proceeding.

The study made use of following instruments:

The so-called *Adverse Events and Incidents in ICUs* instrument was employed toward collecting data related to the identification of patients, injury severity parameters and adverse events and incidents.

The Simplified Acute Physiology Score II (SAPS II) was applied on a daily basis in order to measure the patients' severity of illness⁽¹⁰⁾. All necessary information required to fill in the instrument was taken from the patients' medical reports; whenever data was missing, the reference value of each respective parameter was employed. For the purposes of this study, the following AE/Is were taken into account: loss of therapeutic devices, medication error, diet management failures, hypoglycemia, phlebitis, errors related to the collection and/or forwarding of exams to clinic analysis laboratories, and mistaken entries in the Nursing Care System (NCS).

Aiming to monitor AE/Is, medical reports were daily skimmed and analyzed by researchers and data collectors. In addition, the 7 a.m. and 7 p.m. shift change processes, as well as the medical visits scheduled to take place in the morning shift, were followed up throughout the 40 days of the investigation in order to capture and notify eventual AE/Is during those activities.

After this set of information was filled in, the assigned researchers categorized the observations found in the AE/I forms.

The application of the second instrument aimed to collect information related to the nursing workload measured by the Nursing Activities Score (NAS). Developed by Miranda et al.⁽¹¹⁾, this instrument consists of 23 items related to medical and nursing interventions ICU patients were submitted to. The instrument's maximum score reaches 176.8%. The NAS's total score calculation results from the sum of the scored items, which expresses, in a percentage basis, the time spent by the nursing staff to care for critical patients⁽¹¹⁾.

After the ICU's nursing staff was trained to fill in the NAS, individual data collection processes were daily carried out for each patient, based on the information gathered in the previous 24 hours. The exception was the first admission day, which took into account the activities performed from the patient's admission to 7 o'clock. A similar procedure was applied to patients discharged from the ICU: interventions that took place up until the time of discharge were reckoned, whether or not the 24 hour-period was completed.

This second instrument was filled in by the data collection team based on the information made available in the medical report and in the attached instrument - Nursing Activities Score. In order to homogenize the records of each one of the index components, we adopted the Nursing Activities Score⁽¹²⁾.

A third form was elaborated in order to assess nursing available working hours and allocation of nurses per patient. In this instrument, the identification of the professional (assistant nurse or nursing technician) held responsible for the care of admitted patients and respective beds in all three work shifts were noted down in a daily basis.

First, the nursing care required for each patient-day was calculated based on the NAS index. This calculation took into account that each NAS score is equivalent to 14min40sec⁽¹³⁾.

The number of assistant nurses or nursing technicians working at the ICUs, the hour-based work journey of each professional (6 hours in the morning and afternoon shifts, and 12 hours in the night shift), as well as the number of admitted patients, were taken into account to calculate the available nursing working hours per patient.

As for the allocation of the nursing staff, the analysis of the personnel's daily shift distribution, that is, the division of professionals by patients, took into account all distributions carried out throughout the study month, on all three work shifts (morning, afternoon and night). The allocation of professionals was considered adequate whenever the available nursing working time was equal to or higher than the time required to care for patients according to the NAS. On the other hand, whenever the available nursing working hours were lower than the time required to the patient's care, the allocation of professionals was considered as inadequate. For this calculation, it is worth highlighting that the working hours of those nurses responsible for up to five patients were proportionally distributed, taking into account the number of patients under their personal responsibility.

Quantitative variables were initially analyzed by the Kolmogorov-Smirnov test, aiming to select the tests that would fit the analyses. The comparison of quantitative variables among the groups was carried out by the t-Test for age and the Mann-Whitney test for length of stay (LOS), severity of illness and discharge.. This same test was applied to analyze the AE/I average and the adequate allocation of professionals. The Spearman correlation test and the Square-Chi test were used to analyze the difference between available and required working hours in the allocation processes, as well as the AE/I frequency and the AE/I proportion between the studied ICUs.

In order to compare the difference between ICUs related to required and available working hours, the research used the t-Test, as those variables presented normal distribution.

The significance level of all performed tests was 5% and all of them made use of version 19.0 of the Statistical Package for the Social Sciences (SPSS).

RESULTS

Characterization of patients, hours of nursing staff available, required patient care hours, and AE/I

Throughout the period of the study ($n = 40$ days), 46 patients were admitted into the 4th Floor ICU and 40 patients were admitted into the 6th Floor ICU.

The gender ($p = 0.536$), age ($p = 0.869$), severity of illness according to the SAPS II ($p = 0.142$) and LOS in the unit ($p = 0.774$) indexes were similar in both ICUs.

The average age of patients was 53.1 years ($sd = 18.1$) and 53.7 years ($sd = 16.2$), and the SAPS II average reached 43.7 ($sd = 20.4$) and 36.5 scores ($sd = 14.7$), respectively in the 4th and 6th Floor ICUs.

The LOS reached an average of 6.7 days ($sd = 7.3$) at the 4th Floor ICU, and 8.0 days ($sd = 9.7$) at the 6th Floor ICU. The septic shock was the major reason for the patients' admission in the units (41.4% and 47.5%, respectively, in the 4th and 6th Floor ICUs).

The analysis of the discharge from the 4th Floor ICU showed that 50.0% out of the 46 patients ($n = 23$) evolved to death. At the 6th Floor ICU, on the other hand, the mortality rate reached 22.5% ($n = 9$). The difference between both groups was $p = 0.016$.

The patients' required hours for caring (NAS average = 60.9% and 57.5% at the 4th and 6th Floors, respectively) reached 15.7 hours ($sd = 1.7$) at the 4th Floor ICU and 14.7 hours ($sd = 1.7$) at the 6th Floor ICUs ($p = 0.008$), showing that 4th Floor ICU's patients demanded more hours than the patients admitted into the 6th Floor ICU.

The hours of nursing staff available per patient-day showed an average of 16.9 hours ($sd = 2.8$) and 24.4 hours ($sd = 3.9$) at the 4th and 6th Floor ICUs, respectively. The statistical difference between them was $p = 0.000$. Therefore, the available nursing staff hours in the 4th Floor ICU were lower than the available nursing staff hours in the 6th Floor ICU.

A total amount of 1,082 occurrences (AE/I) was observed in both ICUs during the study period; from these, 669 (61.8%) took place at the 6th Floor ICU and 413 (38.2%) at the 4th Floor ICU. The average AE/I per patient-day was higher at the 6th Floor ICU than in the 4th Floor ICU ($p = 0.000$), 2.2 ($sd = 0.9$) and 1.3 ($sd = 0.7$) occurrences, respectively.

In the 4th Floor ICU, 301 (81.6%) incidents and 68 (18.4%) adverse events were observed, totaling 369 reported AE/I. In the 6th Floor ICU, from the total amount of 618 reported EA/Is, 564 (91.2%) incidents and 54 (8.8%) adverse events were recorded.

As for the type of AE/I, the 4th Floor ICU showed that the majority of occurrences was related to mistaken check into the medical records ($n = 116$; 28.1%), followed by errors in the preparation and administration of medication ($n = 93$; 22.5%), errors regarding the collection and/or forwarding of exams to clinic analysis labs ($n = 55$; 13.4%), and hypoglycemia ($n = 42$; 10.2%). The 6th Floor ICU also identified frequent errors in the preparation and administration of medications ($n = 226$; 33.8%), mistaken checks into medical reports ($n = 197$; 29.4%) and failures in diet management ($n = 78$; 11.7%).

Allocation of the nursing staff and occurrence of AE/I

Taking into account the morning, afternoon and night shifts during the 40-day study, there was a total amount of 1,165 nursing staff allocation processes per patient in both ICUs (Table 1).

Table 1 – Adequacy of the nursing staff allocation process per patient in the 4th and 6th Floor Intensive Care Unit, according to the NAS - São Paulo, 2007

Allocation according to the NAS	4th Floor ICU		6th Floor ICU		p-value	4th and 6th Floor ICUs		p-value
	n	%	n	%		N	%	
Inadequate	199	43.7	73	10.3	0.000 ¹	272	23.3	0.000 ¹
Adequate	256	56.3	637	89.7	0.000 ¹	893	76.7	0.000 ¹
Total	455	100.0	710	100.0		1.165	100.0	

Note: 4th Floor ICU ($n=455$) and 6th Floor ICU ($n=710$)

When taken separately, the 4th Floor ICU shows a total of 455 allocations, from which 199 (43.3%) were inadequate. The 6th Floor ICU, on its turn, showed 710 al-

location processes; from these, 73 (10.3%) presented inadequate distribution of patients. There was a statistically significant difference between units ($p = 0.000$).

Table 2 – Descriptive statistics of AE/I in the 4th and 6th Floor Intensive Care Units, according to adequate and inadequate allocations - São Paulo, 2007.

Adverse Events and Incidents	Adequate		Inadequate	
	4th floor	6th floor	4th floor	6th floor
Average	(n = 256)	(n = 637)	(n = 199)	(n = 73)
Minimum	0	0	0	0
Maximum	6	6	4	8
Standard Deviation	1.2	1.1	1.0	1.6

Table 2 shows that the average occurrence of EA/I in the 4th Floor ICU concerning adequate and inadequate allocations of nursing staff per patient was 0.8 (dp = 1.2) and 0.9 (dp = 1.0), respectively. In the 6th Floor ICU, on the other hand, adequate allocations showed an AE/I occurrence average of 0.8 (dp = 1.1), while inadequate allocations reached 1.6 (dp = 1.6).

When the AE/I frequency is analyzed in adequate and inadequate allocation processes of the nursing staff, a significant difference is shown both in the 4th Floor ICU ($p = 0.004$) and in the 6th Floor ICU ($p = 0.00$). Therefore, these results allow us to affirm that the more inadequate the distribution of patients per professional, the higher the frequency of AE/I in both ICUs.

Table 3 – AE/I in the 4th and 6th Floor ICUs together, according to adequate and inadequate allocations - São Paulo, 2007.

Adverse Events and Incidents	Adequate (n = 893)	Inadequate (n = 272)	p-value
Average	0.8	1.1	0.000 ¹
Minimum	0	0	
Maximum	6	8	
Standard Deviation	1.1	1.2	

When analyzed together, results in Table 3 show that the average of AE/I occurrences in adequate allocations reached 0.8 (dp = 1.1) and 1.1 (dp = 1.2) in inadequate allocations in the ICUs, highlighting a significant difference between them ($p = 0.000$).

Table 4 – Correlation between the difference of hours of nursing staff available and patients' required care hours in nursing staff allocation processes and AE/I frequency in the 4th and 6th Floor Intensive Care Units - São Paulo, 2007.

Intensive Care Unit	Correlation Coefficient	p-value
4th floor ICU	-0.245	0.000
6th floor ICU	-0.279	0.000
4th and 6th floor ICUs	-0.245	0.000

According to Table 4, the 4th and 6th Floor ICUs show a significantly negative correlation between the difference of available nursing staff hours and patients' required care hours, and the AE/I frequency when units are analyzed either together or separately. The Table shows that the higher the difference between hours of nursing staff avail-

able and patients' required care hours in nursing allocation processes, the lower is the AE/I frequency.

DISCUSSION

For several years, the correlation between available nursing working hours and number of existing professionals and patient safety has been drawing the attention of healthcare professionals who work in hospitals. In critical units, such as the ICU, this becomes a much more relevant issue, as they demand a proper adequacy of human resources and the care of severely ill patients. In this study, the patients' required nursing care hours showed a NAS average of 60.9%, or 15.7 hours per patient-day in the 4th Floor ICU and a NAS average of 57.7% or 14.7 hours in the 6th Floor ICU ($p = 0.008$). These values were found to be above the average shown by a study carried out in a general private hospital in São Paulo, which observed a variation of 9-13 care hours⁽¹⁴⁾. However, several other studies obtained higher NAS averages⁽¹⁵⁻¹⁶⁾, which can be justified by demographic and clinic characteristics, as well as by the patient's illness severity.

On the other hand, taking into account the characteristics of the studied field hospital, that is, a high complexity, reference hospital in caring for severely ill patients, the NAS average was expected to be higher. These findings presuppose at least two hypotheses: low demand of real care, or otherwise, high demand of nursing care by an insufficient number of professionals, causing implemented interventions not to be faithfully recorded and consequently an underestimated NAS.

The second hypothesis is corroborated by the fact that the available nursing staff hours in the 4th Floor ICU (16.9 hours) are lower than the 6th Floor ICU's (24.4 hours), although the care demands by patients in the 4th Floor ICU are found to be higher. Such results allow us to infer that lower available nursing staff hours cause relevant reports not to be made, including those related to AE/Is.

With regards to the occurrences, therefore, average daily AE/Is in the studied units was 2.2 occurrences (sd = 0.9) in the 6th Floor ICU and 1.3 (sd = 0.7) in the 4th Floor ICU; the largest number of occurrences was found in the 6th Floor ICU ($p = 0.000$). These values are respectively above and below the average of occurrences found in a study carried out in a university hospital's ICU located in Jerusalem, which identified 1.7 occurrences per patient per admittance day⁽¹⁷⁾.

As for the adequacy of nursing staff allocation processes aimed to care for critical patients (Table 1), a statistically significant difference between the units was observed. Supported by the data shown in Table 3, these results allowed for the conclusion that the occurrence of AE/Is was higher when allocation processes were not adequate (average of 1.1 AE/I) compared to adequate allocations (av-

erage of 0.8 AE/I). The results not only point to the need of an adequate re-dimensioning of nursing personnel in the unit as a whole, but also show the need of adjusting allocation processes according to the hours of care required by patients.

In this sense, an American study carried out in general hospitals with 10,184 nurses and 232,342 patients concluded that in a condition of high proportion of patients per nurse, surgical patients presented higher risks of death 30 days following the admittance process, as well as higher levels of inadequate rescue rates (death caused by potentially preventable complications). The authors observed that adding one single patient per nurse was associated with a 7% higher risk in the probability of death in a 30-day period following a hospital admittance process and a 7% increase in the death risk originated by complications⁽¹⁸⁾.

Besides reporting a higher number of AE/Is when allocations were inadequate, the study also observed that the correlation between available nursing hours and the hours required by patients in staff allocation processes was negative and meaningful when they were both separately and conjointly analyzed. The study showed that the higher the difference between the available nursing working hours and the patients' required care time, the lower the frequency of AE/Is (Table 4). These results reinforce the findings of other studies, which identified lower infection rates (63) and AE/Is (73,79) when the proportion of available care hours was higher than those required by patients/day.

Patient care as a process is managed by the nurse whenever he plans, delegates or executes it by training his team, educating patients, interacting with other professionals, articulating and negotiating on behalf of the consolidation and improvement of care, and also when he foresees and provides both human and material resources⁽¹⁹⁾.

Within this context, in addition to caring for the health of patients, the objective of the nursing work is to articulate, integrate and coordinate the nursing staff toward organizing a work structure that favors care and minimizes risks.

Although the human factor may be present in the occurrence of AE/Is, the structural aspects of the unit, in addition to the work process often determined by the nurses themselves, become factors that make way to professional errors⁽²⁰⁾.

In the everyday activity of ICUs, the daily distribution of nursing staff based on subjective criteria concerning the care requirements demanded by patients may influence the occurrence of AE/Is, thus jeopardizing patient safety, as shown in this present study.

In the light of these findings, the adequate allocation of nursing staff per patient in ICUs should essentially make use of objective instruments that can measure the care demand per patient, in a way to contribute toward a safe care practice both for patients and for professionals.

Contributions and limitations of the study

The implementation of a prospective study that counted on a follow-up process comprised of daily visits to the units and to each change of nursing staff shifts, in addition to the full reading and thorough analysis of the patients' report toward collecting AE/Is, is the turning point of this present study. The achievement of AE/I occurrences through these strategies enabled us to make progress in the collection process of this information, allowing for the suppression of the deficiencies related to voluntary, subjective notifications that work against more precise analyses.

However, the major contribution of this study may stem from the results of the analysis of the nursing staff allocation process per patient in the daily life of the ICU, as they allowed for the investigation of the influence of this issue in the safety of critical patients.

Despite the relevance of achieved results, some limitations must be mentioned and considered by other studies. Among them we may state the performance of the study in one single hospital and the convenient choice for the ICUs, in addition to the short-term follow up (40 days). Last, another limitation was the calculation of the available nursing working hours per patient, which took into account the nurse's available working hours proportionally distributed among admitted patients in the above-mentioned period, leaving aside the precise measurement of the time spent by the professional to care for each patient.

CONCLUSION

The AE/I average showed to be higher in inadequate nursing staff allocation processes in comparison with adequate allocations, both in the 4th Floor ICU ($p = 0.004$) and in the 6th Floor ICU ($p = 0.000$). The average of occurrences for adequate distributions was equal (0.8) in both 4th and 6th Floor ICUs. In inadequate allocation distributions, AE/I averages were 0.9 and 1.6 in the 4th and 6th Floor ICUs, respectively.

When analyzed together, the average of AE/I occurrences in adequate allocations was 0.8 ($sd = 1.1$) and 11 ($sd = 1.2$) in inadequate allocations, showing a statistically significant difference ($p = 0.000$).

When analyzed both separately and together, the correlation between available nursing staff hours and patients' required care hours and nursing staff allocation processes was negative and quite significant in the 4th and 6th Floor ICUs. The study concluded, therefore, that the greater the difference between hours of nursing staff available and hours required by patients care in nursing allocation processes, the lower the frequency of adverse events and incidents.

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