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The influence of delayed admission to intensive care unit on mortality and nursing workload: a cohort study

Ester Góes Oliveira, Paulo Carlos Garcia, Clairton Marcos Citolino Filho and Lilia de Souza Nogueira

ABSTRACT

Background: The results of studies regarding the relationship between length of stay of patients in emergency departments (EDs) and mortality in intensive care units (ICUs) are contradictory, and nothing is known about the impact of delayed admission of patients to ICUs on nursing workload.

Aims and Objectives: To assess the influence of the time lapse between ED and ICU admissions on mortality and nursing workload in relation to intensive care patients.

Design: This was a retrospective cohort study that examined the medical records of patients who were 15 years of age or older and admitted directly to the ICU from the ED.

Methods: The data were collected between 2014 and 2016 in a hospital located in São Paulo, Brazil. Nursing workload was measured by the Nursing Activities Score. Multiple linear and logistic regressions were applied, with a significance level of 5%.

Results: Of the 534 patients analysed, the majority were men (57·49%); the mean age was 55·37 ± 19·64 years. Length of stay in the ED was not associated with nursing workload at the time of admission of patients to the ICU or during their stay in the unit. For mortality, this variable was a risk factor along with cause of admission, length of stay in the ICU and the Simplified Acute Physiology Score 3 score. For every additional hour that patients remained in the ED, their chance of dying in the ICU increased by 1%.

Conclusion: Length of stay of patients in the ED was a risk factor for mortality in the ICU; however, this variable did not have any influence on nursing workload.

Relevance to clinical practice: Strategies need to be implemented to optimize the availability of ICU beds and reduce the length of stay of critical patients in the ED as delays in admitting such patients to the ICU have an impact on mortality.

Key words: Emergency service, hospital • Intensive care units • Length of stay • Mortality • Nursing • Workload

INTRODUCTION

High demand for intensive care unit (ICU) beds is a reflection of the following factors: increased life expectancy and number of chronic health conditions; improvements in the diagnosis and treatment of various pathologies; and introduction of new therapeutic procedures (Zimmerman *et al.*, 2013; Al-Qahtani *et al.*, 2017). In this context, when the number of patients recommended for intensive care exceeds the number of available beds, the entry flow to this critical unit is blocked (Levin and Sprung, 2001), resulting in the allocation of these patients to inadequate units, such as the emergency department (ED), while they wait for an available ICU bed for monitoring and more adequate care. As a result, it is common to find health professionals who are obliged to make difficult decisions in their daily routine, such as selection of patients who will be transferred to the ICU (Chalfin *et al.*, 2007).

Shortage of ICU beds is a public health problem in different countries. Because of this, researchers have analysed the influence of length of stay of patients in the ED on different outcomes in the ICU, such as mortality (Intas *et al.*, 2012; O'Callaghan *et al.*, 2012; Erkuran *et al.*, 2014; Hsieh *et al.*, 2016; Khan *et al.*, 2016; Al-Qahtani *et al.*, 2017; García-Gigorro *et al.*, 2017) and adverse events (O'Callaghan *et al.*, 2012; García-Gigorro *et al.*, 2017). In relation to survival, the results are contradictory: some studies have identified an association between delayed admission of patients to the ICU and increased mortality rates in intensive care (Intas *et al.*, 2012; Hsieh *et al.*, 2016; Al-Qahtani *et al.*, 2017; García-Gigorro *et al.*, 2017). However, other investigations have not identified this association (O'Callaghan *et al.*, 2012; Erkuran *et al.*, 2014; Khan *et al.*, 2016).

In relation to nursing workload, no studies were found that have examined the possible impact of these delays on the requirement for nursing demands required by patients in the ICU. Therefore, the present study is relevant as its results will provide health managers and professionals with important information for developing strategies to optimize ICU beds, improve referral and counter-referral agreements in the context of critical patient care and determine the correct size of nursing teams to ensure the provision of quality care.

AIM

The aim of the present study was to assess the influence of the time lapse between ED

Authors: EG Oliveira, RN, Department of Medical-Surgical Nursing, School of Nursing, University of São Paulo, Brazil; PC Garcia, RN, PhD, University Hospital, University of São Paulo, Brazil; CM Citolino Filho, RN, Master's Student, Department of Medical-Surgical Nursing, School of Nursing, University of São Paulo, Brazil; LS Nogueira, RN, PhD, Assistant Professor, Department of Medical-Surgical Nursing, School of Nursing, University of São Paulo, Brazil,

Address for correspondence: LS Nogueira, Avenida Doutor Enéas de Carvalho Aguiar, 419, São Paulo 05403-000, São Paulo, SP, Brazil

E-mail: lilianogueira@usp.br

and ICU admissions on mortality and the nursing workload for patients in intensive care.

METHODS

Design

This was a retrospective cohort study based on the analysis of medical records of patients admitted between 1 August 2014 and 31 July 2016 to the adult ICU.

Setting

The study was conducted in a public university hospital located in the city of São Paulo, Brazil.

Sample

Patients 15 years of age or older, admitted directly to the ICU from the ED, were included in the study. Patients transferred from other institutions were excluded from the case selection.

Data collection

The dependent variables analysed were: mortality in the ICU and nursing workload measured in the first 24 h and during the patient's stay in the ICU, according to the Nursing Activities Score (NAS) (Miranda *et al.*, 2003). The NAS is an index composed of seven categories (basic activities, ventilatory, cardiovascular, renal, neurological and metabolic support and specific interventions) and a total of 23 nursing interventions, with weights ranging from 1·2 to 32·0. The sum of the weights of the interventions performed results in a score that expresses the percentage of time spent by the nursing team, by shift, on direct patient care, which can total a maximum of 176·8% (Miranda *et al.*, 2003). The information about nursing workload was collected from the hospital's computerized system; it contains the NAS instrument, which is filled out daily by nurses in the unit.

The independent variables were length of stay in the ED (calculated as the time in hours between the opening of the ED care file and admission of the patient to the ICU), age, gender, cause of ICU admission according to the International Classification of Diseases and Related Health Problems (WHO, 2016), the Charlson Comorbidity Index (Charlson *et al.*, 1987), patient severity based on the Simplified Acute Physiology Score 3 (SAPS 3) (Moreno *et al.*, 2005) and length of stay in the ICU. The Charlson index analyses 19 clinical conditions associated with comorbidity, and a score is assigned to each, if present, ranging from 1 to 6. The sum of these scores reflects the influence of the patient's comorbidities on mortality, that is, higher indexes are associated with increased frequency of death (Charlson *et al.*, 1987).

In the SAPS 3 index, scores are assigned to 20 variables, divided into three parts: characteristics of the patient before ICU admission, circumstances of ICU admission, and presence and degree of physiological dysfunction at the time of ICU admission. To calculate the SAPS 3, each variable receives a score (which varies according to the patient's data), and in the end, these scores are added up to give the total score (the higher the score, the greater the severity observed), which is converted into likelihood of death (Moreno *et al.*, 2005).

Data analysis

Descriptive statistics were obtained for all the study variables in order to characterize the sample. Multiple linear regression was used to identify the factors associated with nursing workload. Multiple logistic regression for mortality and the receiver operating characteristic (ROC) diagnosis test was applied to assess the quality of the model. A 5% level of significance was established in all the analyses.

Ethical approval

The project was approved by the Research Ethics Committee of the institution under protocol no. 1622589. The patients were identified by numbers, and their records were saved in a computer with restricted access to the researchers of this study, ensuring the anonymity, confidentiality and security of all collected information.

RESULTS

The sample was composed of 534 patients, the majority of whom were men (57·49%); the mean age was 55·37 ± 19·64 years; 193 patients (36·14%) were elderly (≥65 years). In relation to length of stay in the ED, the mean was 18·45 ± 26·93 h, with a maximum of 259·9 h (approximately 10 days). The main admission diagnosis was diseases of the respiratory system (24·16%), followed by diseases of the circulatory system (19·1%) and diseases of the digestive system (13·48%).

The mean Charlson comorbidity score was 1·96 (±2·19), and 176 (32·96%) patients had no comorbidities. The mean nursing workload identified in the admission of patients to the ICU (77·28 ± 20·18) was higher than the figure calculated during the stay in the ICU (59·58 ± 15·3).

On average, the length of stay of ICU patients was 7·16 ± 8·44 days, and the mortality rate in the unit was 21%. This rate was lower than that estimated by the SAPS 3, which indicated that risk of death was 35·76%, representing a mean score of 54·46 ± 14·76 for the index. The mean length of hospital stay was 13·72 ± 11·44 days.

Table 1 shows that the factors associated with the nursing workload required by patients in the first 24 h were infectious and parasitic diseases, age and SAPS 3 and Charlson comorbidity scores. For nursing workload measured during the stay of patients in the ICU, the associated factors were presence of infectious and parasitic diseases and diseases of the genitourinary system, age, length of stay in the ICU and SAPS 3 and Charlson comorbidity scores (Table 1). It is worth noting that the length of stay of patients in the ED did not influence the nursing workload required by patients either at admission or during their stay in the ICU.

The factors associated with the mortality of ICU patients were cause of admission; symptoms, signs and abnormal clinical and laboratory findings; length of stay in the ED and ICU; and SAPS 3 scores (Table 2). In relation to the variable of interest of the study (length of stay in the ED), it is important to note that, for every hour patients remained in the ED waiting for an ICU bed, their chance of dying in the ICU increased by 1%. The area under the ROC curve was 0·85, indicating the high accuracy of the model.

DISCUSSION

The sociodemographic characteristics of the sample in the present study corroborated the findings of other investigations conducted in ICUs: the higher frequency of men (Silva *et al.*, 2011; Intas *et al.*, 2012; Nogueira *et al.*, 2012; García-Gigorro *et al.*, 2017) and mean age from 53 to 57 years (Intas *et al.*, 2012; García-Gigorro *et al.*, 2017). The literature contains descriptive statistics in relation to mean length of stay in the ED, which has

Table 1 Factors associated with the nursing workload required by patients in the first 24 h and during the stay in the ICU

	β	Standard error (β)	CI (95%) (minimum)	CI (95%) (maximum)	p
Variables – first 24 h in the ICU					
Intercept	60·36	4·72			
Gender (ref: male)					
Female	0·95	1·69	−2·38	4·27	0·576
Cause of ICU admission according to ICD-10 (ref: other causes)					
Certain infectious and parasitic diseases	−10·36	4·71	−19·62	−1·10	**0·028***
Endocrine, nutritional and metabolic diseases	−10·60	5·54	−21·48	0·27	0·056
Diseases of the nervous system	−3·37	5·56	−14·30	7·56	0·545
Diseases of the circulatory system	−5·02	3·94	−12·75	2·72	0·203
Diseases of the respiratory system	−2·76	3·76	−10·15	4·62	0·462
Diseases of the digestive system	−6·86	4·07	−14·85	1·13	0·092
Diseases of the genitourinary system	−3·18	4·75	−12·51	6·15	0·503
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	1·32	4·10	−6·73	9·38	0·747
Injury, poisoning and certain other consequences of external causes	2·73	4·94	−6·98	12·44	0·581
Age	−0·10	0·05	−0·20	0·00	**0·046***
Length of stay in the ED	−0·04	0·03	−0·10	0·02	0·210
SAPS 3 score	0·43	0·07	0·30	0·55	**<0·001***
Charlson comorbidity score	1·60	0·40	0·82	2·38	**<0·001***
Variables – during the stay in the ICU					
Intercept	50·30	3·55			
Gender (ref: male)					
Female	−1·76	1·27	−4·25	0·74	0·167
Cause of ICU admission according to ICD-10 (ref: other causes)					
Some infectious and parasitic diseases	−8·52	3·54	−15·48	−1·56	**0·017***
Endocrine, nutritional and metabolic diseases	−7·77	4·16	−15·94	0·40	0·062
Diseases of the nervous system	−7·91	4·17	−16·11	0·29	0·059
Diseases of the circulatory system	−4·70	2·96	−10·51	1·12	0·114
Diseases of the respiratory system	−3·21	2·82	−8·75	2·33	0·255
Diseases of the digestive system	−4·24	3·06	−10·25	1·76	0·166
Diseases of the genitourinary system	−9·29	3·57	−16·29	−2·28	**0·009***
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	2·22	3·08	−3·82	8·27	0·470
Injury, poisoning and certain other consequences of external causes	1·00	3·71	−6·29	8·29	0·788
Age	−0·10	0·04	−0·18	−0·03	**0·007***
Length of stay in the ED	−0·02	0·02	−0·06	0·03	0·520
Length of stay in the ICU	−0·15	0·07	−0·30	0·00	**0·047***
SAPS 3 score	0·35	0·05	0·25	0·44	**<0·001***
Charlson comorbidity score	0·84	0·30	0·25	1·42	**0·005***

*$p < 0{\cdot}005$. CI, confidence interval; ED, emergency department; ICD-10, International Classification of Diseases; ICU, intensive care unit; Ref, reference; SAPS 3, Simplified Acute Physiology Score 3.

varied from 1·23 to 17·8 h (Cardoso *et al.,* 2011; Erkuran *et al.,* 2014; García-Gigorro *et al.,* 2017), lower than the figures found in the present study: 18·45 ± 26·93 h.

With regard to the predictive factors for the nursing workload required by patients in the first 24 h and during their stay in the ICU, it has been noted that age had an influence on these outcomes. A study that examined 890 patients also found that this variable had an effect on nursing workload during the patient's stay in the ICU, that is, for every additional year in a patient's age, the NAS increased by 0·081 points (Ferretti-Rebustini *et al.,* 2017). Other investigations have not detected any relationship between age and nursing workload, either at the time of admission (Gonçalves and Padilha, 2007) or during the stay of the patient in the ICU (Ciampone *et al.,* 2006; Gonçalves *et al.,* 2006).

Researchers have found that the length of stay in the ICU was a risk factor for high nursing workload, that is, the NAS score increased considerably from the sixth day in the ICU (Gonçalves and Padilha, 2007). A study has found that the NAS score of patients who remained in the ICU for more than 5·5 days was 1·07 times (7%) more likely to increase (Padilha *et al.,* 2008). In the present study, length of stay in the ICU proved to be a predictive factor for nursing work demand during the patient's stay in the unit.

The SAPS 3 score was associated with nursing workload in the first 24 h and during the patient's stay in the ICU, a result that does not coincide with other studies (Gonçalves and Padilha, 2007; Lucchini *et al.,* 2014). Research carried out in two private hospitals showed that the severity of the patient measured by SAPS 3 was not associated with nursing workload demand (Gonçalves and Padilha, 2007). An Italian study also found no statistically significant relationship between NAS and SAPS 3 ($p = 0{\cdot}77$) (Lucchini *et al.,* 2014). In relation to SAPS 2, the version prior to the SAPS 3 index, studies have shown associations between severity (Padilha *et al.,* 2008) or risk of death (Nogueira *et al.,* 2014) and nursing

Table 2 Factors associated with the mortality of ICU patients

Variables	β	Exp (β)	CI (95%) Exp (β) (minimum)	CI (95%) Exp (β) (maximum)	p
Gender (ref: male)					
Female	0·22	1·24	0·73	2·11	0·421
Cause of ICU admission according to ICD-10 (ref: other causes)					
Some infectious and parasitic diseases	0·85	2·35	0·55	9·95	0·247
Endocrine, nutritional and metabolic diseases	0·62	1·87	0·17	20·27	0·609
Diseases of the nervous system	−0·69	0·50	0·04	5·97	0·584
Diseases of the circulatory system	0·59	1·80	0·47	6·91	0·393
Diseases of the respiratory system	−0·01	0·99	0·27	3·60	0·986
Diseases of the digestive system	0·85	2·94	0·63	8·79	0·206
Diseases of the genitourinary system	−0·26	0·77	0·15	4·05	0·762
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	1·88	6·53	1·80	23·65	**0·004***
Injury, poisoning and certain other consequences of external causes	−0·34	0·71	0·10	5·22	0·735
Age	−0·01	0·99	0·98	1·01	0·829
Length of stay in the ED	0·01	1·01	1·00	1·02	**0·009***
Length of stay in the ICU	0·03	1·03	1·00	1·06	**0·023***
SAPS 3 score	0·08	1·09	1·06	1·11	**<0·001***
Charlson comorbidity score	0·05	1·05	0·94	1·18	0·368

*$p < 0·005$. CI, confidence interval; ED, emergency department; ICD-10, International Classification of Diseases; ICU, intensive care unit; Ref, reference; SAPS 3, Simplified Acute Physiology Score 3.

workload in the first 24 h and during the stay of the patient in the ICU.

It is worth highlighting that some studies conducted in private and public hospitals have found associations between mortality and nursing workload, that is, there was a higher frequency of death in the ICU among patients with high NAS scores (Gonçalves *et al.*, 2006; Nogueira *et al.*, 2007; Padilha *et al.*, 2008). Although the present study did not perform this analysis, there is a relationship between SAPS 3 and NAS, that is, between higher chances of dying and nursing workload. As for the Charlson comorbidity score, no studies that have analysed this variable in relation to nursing workload were found in the literature, preventing broader comparisons.

The present study did not identify any influence of length of stay of patients in the ED on the nursing workload required for patients at admission and during their stay in the ICU. Nonetheless, it is essential that health care leaders ensure the adequate sizing of the nursing staff in the ED when a patient awaits ICU admission (Hsieh *et al.*, 2016) so that quality and safe care is provided.

The results showed that the length of time of patients in the ED had an influence on mortality in the ICU (odds ratio 1·01; 95% confidence interval 1·0–1·02). Other investigations have also obtained similar results (Cardoso *et al.*, 2011; Al-Qahtani *et al.*, 2017; García-Gigorro *et al.*, 2017). For every hour that a patient remained in the ED, their risk of dying in the ICU increased by 1·5% (Cardoso *et al.*, 2011); in addition, delays in transferring patients from the ED to the ICU (more than 24 h) were linked to higher rates of mortality in intensive care (Al-Qahtani *et al.*, 2017). A study conducted in Greece also demonstrated an association between staying in the ED for longer than 5 hours and mortality in the ICU, in addition to the occurrence of complications during intensive care (García-Gigorro *et al.*, 2017).

However, other studies have yielded different findings (Carter *et al.*, 2010; O'Callaghan *et al.*, 2012; Erkuran *et al.*, 2014). An analysis of 1609 ICU patients showed that there was an admission delay in 9·3% of the sample. The group categorized as delayed admission needed advanced respiratory support more frequently and remained longer on mechanical ventilation compared with patients admitted earlier. Mortality and length of stay in the ICU were similar among the groups (O'Callaghan *et al.*, 2012).

Researchers have found that, among patients admitted to the ICU straight from the ED, there was no significant difference between survivors and non-survivors in the critical unit in relation to length of stay in the ED ($p > 0·05$) (Erkuran *et al.*, 2014). An investigation carried out in 45 hospitals in Australia and New Zealand noted that patients who were transferred to the ICU in less than 8 h had higher severity, and although 19·1% of the patients were transferred to the ICU with a delay (more than 8 h later), there was no correlation between this variable and mortality in intensive care (Carter *et al.*, 2010).

Studies conducted in New Zealand assessed the effect of a new health goal implemented in the country, which recommended a maximum of 6 h in the ED. The results showed that a lower length of stay in the ED than that recommended improved care quality (Jones *et al.*, 2017a, 2017b). In Brazil, the Federal Council of Medicine recommends that patients remain in the ED for a maximum of 24 h.

The results of this study showed that admission delays of patients to the ICU are associated with increased mortality in intensive care. Therefore, the present study provides important input for health professionals and managers on the importance of and need for strategies and public policies aimed at optimization of ICU beds, thereby reducing the length of stay in the ED.

Limitations

The application of the results of this investigation should take into account that the study was conducted in just one public institution, which could restrict the generalization of its results.

IMPLICATIONS AND RECOMMENDATIONS FOR PRACTICE

- Strategies need to be implemented to optimize ICU bed availability, improve critical patients' flow and reduce their length of stay in the ED.
- Managing critical patients in the ED does not mean providing poor-quality critical care; therefore, health care leaders need to ensure the adequate sizing of the nursing staff in the ED to take care of patients while they wait for ICU admission.
- Critical care nurses should give special attention to patients who have had their ICU admission delayed given the increased risk of death associated with this delay.
- Further multicentre studies that analyse ICU bed allocation and optimal triage practices for critical patients admitted to the ED are recommended.

CONCLUSION

The results of this study support the conclusion that the length of stay of patients in the ED is a risk factor for mortality in the ICU. However, this variable does not have any influence on the nursing workload required by patients at admission and during their stay in intensive care.

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WHAT IS KNOWN ABOUT THIS TOPIC

- The results of studies regarding the influence of length of stay of patients in the ED on the mortality of patients in the ICU are contradictory.
- There are no studies that analyse the relationship between delays in admission of critical patients to the ICU and increased demand for intensive nursing care.

WHAT THIS PAPER ADDS

- The findings of this study show that the length of stay of patients in the ED is a risk factor for mortality in the ICU, which reinforces the need to optimize intensive care beds so that patients recommended for intensive care can be admitted immediately.
- It is worth noting that the length of stay of patients in the ED did not influence the nursing workload required by patients either at admission or during their stay in the ICU.

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