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The influence of nursing activities score on clinical alarms service

A influência do nursing activities score no atendimento aos alarmes clínicos

La influencia de la nursing activities score en el servicio de alarmas clínicas

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RESUMO

Objetivos: estimar a magnitude do efeito do *Nursing Activities Score* no atendimento aos alarmes dos monitores multiparamétricos e no tempo de resposta da equipe. **Métodos:** estudo observacional, seccional delineado como coorte aberta, realizado em uma Unidade de Terapia Intensiva geral de adultos. O tempo até o atendimento dos alarmes disparados dos monitores multiparamétricos foi cronometrado e caracterizado como atendido ou não. **Resultados:** o estudo obteve um total de 254 alarmes disparados dos monitores multiparamétricos de 63 pacientes. A média de alarmes disparados foi de 4,5 alarmes por período/observação e 1,5 alarmes/hora. O estudo demonstrou que o *Nursing Activities Score* está associado a uma probabilidade adicional de 4% ($p < 0,05$) de um alarme ser atendido, para cada ponto adicional na escala, e redução no tempo de resposta da equipe. **Conclus**ões**:** verificou-se que *Nursing Activities Score* possui relação direta com o atendimento e com o tempo de resposta aos alarmes disparados.

Descritores: Alarmes Clínicos; Unidades de Terapia Intensiva; Segurança do Paciente; Gestão de Riscos; Gestão da Segurança.

ABSTRACT

Objectives: to estimate the magnitude of the Nursing Activities Score effect on multiparametric monitor alarm response and staff response time. **Methods**: an observational, cross-sectional study outlined as an open cohort, performed in an Adult General Intensive Care Unit. The time taken for alarms triggered by the multi-parameter monitors was timed and characterized as attended or not. **Results:** the study obtained a total of 254 alarms triggered from the multi-parameter monitors of 63 patients. The mean number of alarms triggered was 4.5 alarms per period/observation and 1.5 alarms/hour. The study showed that the Nursing Activities Score is associated with an additional probability of 4% ($p < 0.05$) of an alarm being met, for each additional point in the scale, and reduction in team response time. **Conclusion**: it has been verified that Nursing Activities Score has a direct relationship with the attendance and with the response time to the alarms triggered.

Descriptors: Clinical Alarms; Intensive Care Units; Patient Safety; Risk Management; Safety Management.

RESUMEN

Objetivos: estimar la magnitud del efecto del *Nursing Activities Score* en la atención a las alarmas de los monitores multiparamétricos y en el tiempo de respuesta del equipo. **Métodos:** estudio observacional, seccional delineado como una cohorte abierta, realizado en una Unidad de Terapia Intensiva General de Adultos. El tiempo hasta la atención de las alarmas disparadas de los monitores multiparamétricos fue cronometrado y caracterizados como atendidos o no. **Resultados:** el estudio obtuvo un total de 254 alarmas disparadas de los monitores multiparamétricos de 63 pacientes. El promedio de alarmas disparadas fue de 4,5 alarmas por período/observación y 1,5 alarmas/hora. El estudio demostró que el *Nursing Activities Score* está asociado a una probabilidad adicional de 4% ($p < 0,05$) de una alarma ser atendida, para cada punto adicional en la escala, y reducción en el tiempo de respuesta del equipo. **Conclusiones:** se verificó que *Nursing Activities Score* tiene relación directa con la atención y con el tiempo de respuesta a las alarmas disparadas.

Descriptores: Alarmas Clínicas; Unidades de Cuidados Intensivos; Seguridad del Paciente; Gestión de Riesgos; Gestión de la Seguridad.

INTRODUCTION

The Nursing Activities Score (NAS) is a tool that consists in daily assessing the degree of complexity of the patient's condition, divided into seven categories with a total of twenty-three items that should be scored according to the need for care. The tool covers 80.8% of nursing activities and expresses the real time spent by a professional in direct care to critically ill patients during the 24 hours[1].

The scale at the same time that it provides the health needs information and therapeutic interventions essential in maintaining the critically ill patient is a documented legal record. It can become an important tool in guiding claims to managers for increased human resources. Medical Assistance Equipment (MAE) has become an important interface in the care of patients admitted to the Intensive Care Unit (ICU), and among all MAE, the multiparametric monitor is a technological resource routinely employed in ICUs, used as an indirect resource. for evaluation (item 1 - monitoring and controls) at NAS scale[2]. This device offers users (healthcare professionals) a dynamic and constant monitoring of patients.

Multiparameter monitors are equipped with audible and visual alarm systems that fire to notify something inappropriate. Each new generation of equipment increases the number of alarms available. These notifications should happen only by changes in physiological parameters (consistent alarms). However, alarms can also be triggered by inadequate individual parameterization or system-patient disconnects (inconsistent alarms), i.e., they do not really represent a health problem, but are representative for notifying the urgency that something needs adjustment[3].

Alarm systems are designed to notify users of patient complications and are therefore primary sources of information, both for changes in clinical status and equipment malfunction. In the work routine, it is usual that alarms triggered by multiparameter monitors are not promptly answered. Delayed response time or failure to respond to alarms triggered in ICUs is referred to in the literature as alarm fatigue, described as a phenomenon in which alarms no longer draw the attention of professionals. It may be characterized by time delay or lack of staff response to alarms due to excessive number of alarms, resulting in sensory overload and desensitization, with huge repercussions and negative impact on patient safety[4].

Published studies have shown the significant number of fatigued alarms triggered (over 50%) from multiparameter monitors leaving exposed care patients exposed to serious risks. This may compromise patient safety dependent on this technological apparatus[5-6].

The Joint Commission International (JCI) in 2014 revised its patient safety goals by including alarm management as a priority in minimizing alarm fatigue in high complexity units[7]. This was essentially due to the serious consequences and negative impacts on patient safety due to the high number of fatigued alarms.

Annually, the Emergency Care Research Institute (ECRI) publishes a list of the "top 10" major risks to patient safety to disseminate information to healthcare professionals, managers and the population. In 2011 the dangers of alarms occupied the second position in the ranking and, from 2012 to 2015, remains in the leading position[8-11]. It is noteworthy that in 2015 they emphasize the dangers of alarms, specifically inadequate alarm setting policies and practices, and in 2016, again ranking second, they emphasize that missed alarms can have fatal consequences[12].

The critically ill patient is highly dependent on the care of the nurse and the entire team, and this has increasingly demanded from these professionals. In contrast, this demand has resulted in a higher workload and increased cognitive load, despite the increase in the number of technologies that have been incorporated into services, not infrequently for the purpose of monitoring, perhaps to compensate for the reduction. the quantity and quality of human resources in these units. And that doesn't mean that the problem will be solved.

It was considered the incipience of studies in the nursing area and the importance of Brazil to have information about alarm fatigue in its ICU, as well as a good dimensioning of teams in this sector. This study assumes that there is a need to investigate the relationship between NAS and the time to respond to alarms triggered by each patient's multiparameter monitors.

OBJECTIVES

To estimate the magnitude of the Nursing Activities Score effect on multiparametric monitor alarm response and staff response time.

METHODS

Ethical aspects

The premises of Resolution 466/2012 were met, with an opinion approved by the Research Ethics Committee (REC) 1,905,464. The Informed Consent Form (ICF) was provided for employees to sign by explaining the research objectives. Data reliability was respected.

Design, place of study and period

This is an observational, cross-sectional study designed as an open cohort, developed in a general 10-bed adult ICU of a large hospital located in the city of Rio de Janeiro.

Observations occurred during 3 hours (period) in the morning or afternoon shifts, from February to April 2017. Alarms triggered by the multiparameter monitor were classified as answered and missed (fatigued) according to time until the alarm was answered after triggered by the monitor. An unanswered or fatigued alarm was defined as one that remained unattended for at least 240 seconds, time indicated in the Cardiopulmonary Arrest (CRP) guidelines as the maximum limit for care without neurological impairment[13-15].

The variables of interest for outcome assessment were the monitored physiological variables that resulted in alarms triggered by multiparameter monitors, age, gender, number of ICU days, NAS, and reason for hospitalization.

Population; inclusion and exclusion criteria

The population was the patients who occupied ICU beds during the observation period, but the object of observation was the alarms triggered by the multiparametric monitors. Only the alarms of the physiological variables related to cardiac monitoring, pulse oximetry and NIBP were included and recorded. Alarms triggered by the monitor in patients receiving CPR maneuvers.

Study protocol

To make data production as less invasive as possible, a cluster sample was made. The 10 beds were divided into groups identified by color (blue with 4 beds; yellow with 3 beds and green with 3 beds), and each day and observation period was drawn one of the groups.

It was necessary to organize a flowchart for each phase covered by observation period (Phase 1 - draw of the cluster to be observed; Phase 2 - start of observation until the first alarm was triggered); - It is noteworthy that, being an observational study, the researcher responsible had no influence, before starting data collection, in performing any manipulation in the parameterization and volume of the alarms. These in some beds were turned off, with reduced volume to the environment and not adjusted according to the patient's clinic. The unit did not have alarm management by the assistance team; Phase 3 – to check triggered alarm (inconsistent: do not use and wait for new alarm to fire or consistent alarm: register); Phase 4 – to record parameter, alarm start and end time, event (alarm answered or fatigued) clinical and professional outcome that attended; Phase 5 - to record additional information from the medical record: age, sex, ICU days, NAS and reason for hospitalization - the NAS registered was performed by the unit's nurses, the information was always available only by the day care team, because the local protocol was do the NAS every 24 hours).

The information was recorded in a built-in tool. For this collection, the "start time" was recorded as zero at the time of the multiparameter monitor alarm triggering, followed by the stopwatch activation and the "end time" was the number of seconds to answer or 240 seconds. Data collection was performed in 56 periods with a total of 168 hours of observation and the sample consisted of 254 alarms triggered.

A pre-specified adaptive design with modifications of the sampling plan was used, as the research was characterized by an open cohort. To define the adaptive model, two observation steps were performed at different times, with scheduled stops. In the first stage 50 events were observed to analyze the effect of the phenomenon and to estimate the need for a new number of observations. In the second stage, observation remainder was performed until the necessary quantitative sample was reached.

Analysis of results, and statistics

Data were tabulated using Microsoft Excel®, version 2010 software and subsequently analyzed using R version x 64 3.1.1® statistical software. To analyze categorical variables, descriptive statistics with absolute (n) and relative (%), mean and median frequencies were used. To assess the factors associated with the chance of alarm response within the time recommended by the CRP guidelines (240 seconds), the logistic regression model was used. To estimate the effect of a covariate on the risk of alarm response at each time, controlling for other covariates, the Cox regression model was used. All statistical analyzes were applied with a significance level of 5% or p (< 0.05).

RESULTS

The study obtained a total of 254 alarms triggered from multiparameter monitors of 63 patients, with a mean age of 61 years and a median of 63 years. All of these alarms characterized clinical change responses in ICU patients. The mean during the collection period was 4.5 alarms per period/observation and 1.5 alarms/hour. The profile of these patients is presented in Table 1.

Table 1 - Sample profile that triggered alarms

Characteristics	n(%)
Sex	
Male	32(50.8)
Female	31(49.2)
Reason for Hospitalization	
Respiratory System Disease	16(25.4)
Cardiovascular system disease	12(19.1)
Gastrointestinal system disease	12(19.1)
Renal System Disease	6(9.5)
No closed diagnosis	6(9.5)
Oncology	4(6.3)
Trauma	4(6.3)
Integumentary system disease	1(1.6)
Exogenous intoxication	1(1.6)
Orthopedics	1(1.6)
Total	63(100)

The total number of alarms triggered was 254. Only 28 (11%) were answered within the time recommended by the CRP guidelines (240 seconds). The mean response time for the alarms answered was 64 seconds, with a standard deviation of 43 seconds.

The mean length of hospital stay was 11.6 days and the mean NAS on observation days was 59.2 (14.2 hours of nursing care) with a median of 58.2. The mean NAS of patients with fatigued alarms was 58.01 (13.9 hours of nursing care) with a median of 56.1. The mean NAS of patients whose alarms were answered was 69.5 (16.6 hours of nursing care) with a median of 75. Logistic regression was performed to estimate the effects of covariates on the main characteristics of ICU patients in ICUs. chance of answering alarms (Table 2).

It can be seen that in univariate and multivariate logistic analysis, NAS was the only one that had a significant effect with p-value < 0.005. There is a 4% increase in the probability of meeting each point plus the value of this covariate. Meaning that alarms triggered in patients classified as more complex according to NAS scale were more likely to be answered within the recommended time.

Table 2 - Estimates of the effects of covariates on the chance of alarm response by univariate and multivariate models

Variáveis	Univariate		Multivariate	
	OR	*p* value*	OR	*p* value*
Age	0.99	0.15	0.99	0.516
NAS	1.046	0.0005	1.043	0.034
Male	0.517	0.114	0.879	0.780
ICU days	1.030	0.065	1.013	0.514

*Note: *Logistic regression model; OR - Odds Ratio; NAS - Nursing Activities Score; ICU - Intensive Care Unit.*

In the univariate analysis, it is noteworthy that the effect of ICU days on the chance of answering the alarm was not significant at the 5% level, but had p value = 0.065 indicating that analyzed separately, it is estimated that each ICU day of the patient increases the chance that his alarm will be answered by 3%. Males showed a protective effect on females in this analysis, but without statistical

significance. In multivariate analysis, the effect of ICU days when controlled by NAS, gender, and age completely lost significance.

The Cox model also estimated the effect of NAS and ICU days on time to care, and very similar results were found (Table 3).

Table 3 - Estimates of NAS effect and ICU days in time to alarm call

Variables	Univariate		Multivariate	
	HR	*p* value*	HR	*p* value*
NAS	1.04077	0.000271	1.04059	0.00064
ICU days	1.02778	0.0687	1.01964	0.20024

*Note: *Cox model; HR - Hazard Ratio (Time Attendance Risk); NAS - Nursing Activities Score; ICU - Intensive Care Unit.*

The Cox model estimated that at each NAS point the alarm has a 4% greater chance of being answered every second and that this effect is very significant and that every day of ICU would increase the risk of care by 2.8%. every second, and this effect would be significant at a level of 10%. In multivariate analysis, the effect of ICU days when controlled by NAS completely lost significance with p value = 0.20024 and the effect of NAS also controlled by ICU days remained significant with each NAS point increasing the chance of service by 4% every second, reinforcing its importance. The assumption of proportional hazards in time to NAS and days of hospitalization was verified by the Cox regression model (Figure 1).

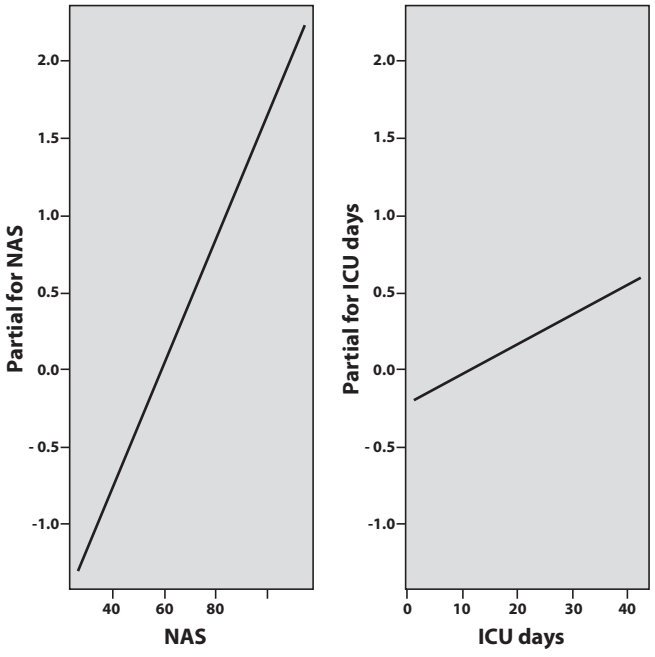

Figure 1 - Cox regression model for NAS and days of hospitalization

It is noteworthy that the assumption of proportional risks indicates that this risk of answering alarms remains constant at any time for both covariates.

DISCUSSION

Published studies show concern with alarm fatigue and seek understanding of the phenomenon. This research aimed to identify the phenomenon of alarm fatigue associated with the clinical characteristics of patients and the health needs and severity characterized by NAS. The results identified that patients who had higher complexity according to the NAS scale had a higher chance of alarms being answered, and that at each point in the complexity, the length of service decreased in the recommended time. These results need to be widely disseminated and discussed for their importance to the ICU universe. The amount of missed alarms over time showed high rates, reinforcing the problem already presented in other studies[16-17].

The study patients were essentially elderly, which has been a common setting in ICUs in the national territory due to increased life expectancy. The results for age were very close to those of research conducted in public and private ICUs in the city of São Paulo, which found a mean age of 60.76 years and a median of 62 years, and which was interested in identifying the evidence. related to the characteristics of patients admitted to critical units[18].

These issues are weakened by the data collected from the alarms of the multiparametric monitors that generated a total of 254 alarms triggered by 4.5 alarms per period/observation and 1.5 alarms/hour. Of these triggers only 11% were answered by users and 89% occurred alarm fatigue. It is noteworthy that only alarms with clinical alteration (consistent alarms) were computed in ICU patients during the data collection period. The results are worrying since all alarms refer to changes in the physiological patterns of patients, which becomes more serious when we refer to the elderly who have their own limitations of senility.

A study carried out in Germany recorded 5,934 multiparametric alarm alarms averaging 6 alarms/hour, where only 15% of the alarms triggered represented a real change in the patients' clinical condition, while the others were classified as technically false[16].

In Brazil, a study performed the observation of multiparametric monitors exclusively for the monitoring of Invasive Blood Pressure (IBP) alarms in an adult ICU. There were 76 alarms (1.26 alarms/hour), of which 28% were answered and 72% considered fatigued. The mean response time to alarms was 2 minutes and 45 seconds. However, the distribution of time between groups of professionals was not verified[17].

No studies were found that used the NAS scale to verify the complexity and care needs of patients associated with alarm fatigue. Studies published in Brazil generally aim to verify the NAS mean by associating the score with the nursing workload and the sizing of professionals, and the interest in highlighting which are the most punctuated items on the scale in their samples[19]. Studies of international origin are frequent in Spain and Italy and also basically aim to analyze the workload of NAS-related ICU nursing[20-21]. Studies that aimed to measure the ICU nursing workload showed NAS mean of 51.47% and 47%[22-23].

One study used the Global Registry Of Acute Coronary Events (GRACE) index to classify as a predictive score of cardiovascular events for coronary disease, indicating the profile of patients admitted to the unit and their clinical diagnoses. The final score may range from 0 to 372, and the mean found in the coronary unit surveyed was 168, indicating a relatively high score[24].

A study conducted at a university hospital in France aimed to assess the relevance of monitoring alarms in adult ICUs, and included the SAPS I scale as a criterion for assessing patients' profiles, finding 15.9 ± 7.4. However, the study only signaled the score and did not discuss the SAPS I scale with the alarm fatigue phenomenon[25].

For the results presented in the logistic regression and in the Cox model, it is important to analyze that at the same time that the NAS has indicated to nurses (because it is their managerial care tool directed to the category) the need to answer the alarms. promptly in these patient groups. At the same time, it was a generator/indicator of alarm fatigue, when we refer to the quantity of the sample universe in which only 11% of the alarms received attention within the time recommended in the censorship. In this study, patients with high NAS had their alarms answered within the recommended time and patients with lower NAS scores had alarm fatigue on multiparameter monitors in use.

This small sample represents what may be happening in critical care units, in which case it is not having uniformity and equality in caring for critical ICU patients. The results suggest that there are choices in the priorities in attending patients with greater complexities and care needs, which is natural, provided that care was also provided in a timely manner to the most baseline patients. So, is it that if less severe, less complex and less dependent patients do not start to take more risks than the more severe, more complex and more dependent patients due to alarm fatigue on multiparameter monitors? All ICU patients need monitoring and surveillance as complications in clinical monitoring can occur at any time for any patient.

It is not up to professionals to judge which patient should be aware of or not to multiparameter monitors alarms. All patients should have their alarms answered and resolved promptly provided they are rationally employed.

It is up to managers to adjust the number of professionals sufficient to assist critically ill patients and enforce the nursing sizing per patient according to the calculated NAS or, if necessary, to increase it according to the patients' demand. In this respect, there is the legal support of the minimum existence of nurses and nursing technicians to meet the care needs of patients and MAE used. A study designed to estimate the cost of nursing care required and available with the use of NAS identified in its results that the cost of nursing care showed a negative difference, requiring the addition of 3.2 nurses and 7.0 nursing technicians[26].

Current legislation in Brazil[27] has become a barrier to the increase of nursing professionals in sizing, as it recommends a nurse for up to ten patients. This may favor the occurrence of alarm fatigue, especially considering if the majority of patients have a high NAS score. In this setting, nurses find many difficulties in meeting all patients' demands. They may neglect an intervention regarding the use of MAE, for example, making them vulnerable to risks that are exposed within an ICU, as the time for bedside nursing care increases progressively as the NAS increases. The increase of nursing professionals within ICU favors the care provided to patients and ensures better outcomes[28].

The results presented in this study are worrisome and intervention strategies need to be considered to minimize ICU patients' injuries through the significant quantitative fatigue of alarms. Reducing alarm fatigue is a responsibility to be shared among all clinical and management team members. Patient assessment, monitoring and appropriate intervention can be considered as the first steps for alarm management, achieving problem elimination and ensuring patient safety[29].

Study limitations

Among the limitations of the research, we highlight the short time of data collection in three months, which prevented a larger sample that would give more accurate estimates. The study also did not research other institutions and/or other highly complex sectors that could analyze and compare NAS alarm response from different pathological profiles, including incorporating other covariate analysis into the study.

Contributions to nursing and health

It is believed that this study may contribute to the collection of studies that investigate alarm fatigue and may cause changes in users' practice and the implementation of institutional strategies in ICUs. The results presented and discussed are expected to favor in order to minimize weaknesses and enhance the safety of critically ill patients.

CONCLUSIONS

The results were similar to other published studies regarding the clinical profile of monitor alarms and the mean length of service. Overall, the results for the proposed objectives are clear as the effect of the NAS ($p < 0.05$) influenced the probability of increasing the multiparametric monitor alarms response probability and reducing the response time of users.

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