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Association between nursing work conditions and adverse events in neonatal and pediatric Intensive Care Units*

Associação entre condições de trabalho da enfermagem e ocorrência de eventos adversos em Unidades Intensivas neopediátricas

Asociación entre las condiciones de trabajo en enfermería y la ocurrencia de eventos adversos en Unidades Intensivas neonatales y pediátricas

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ABSTRACT

Objective: To investigate the association between intensive nursing staff's work conditions and the occurrence of adverse events in patients. **Method:** Evaluative documentary study conducted in six public neonatal and pediatric Intensive Care Units from hospitals in Paraná state, from April 2017 to January 2018. The predictive variables concerning staff sizing and work environment were measured through the instruments *Nursing Activities Score* and *Brazilian Nursing Work Index-Revised*. The thirty adverse events corresponded to the outcome variable and were detected using the instruments *Pediatric* and *Neonatal Trigger Tool*. **Results:** Two-hundred and three professionals participated in this research. The nursing staff sizing was verified to be appropriate. Work conditions were favorable and Cronbach's Alpha was 0.90 (IC= 0.87 – 0.92). The most frequently detected events in patients were infection and skin lesion. The statistical analysis of correlation and adverse event occurrence was not significant. **Conclusion:** Despite the lack of evidence on statistical significance between the variables, the results reveal commitment by the public sector and professionals with patient safety and assistance quality.

DESCRIPTORS

Critical Care Nursing; Working Conditions; Intensive Care Units Neonatal; Pediatric Nursing; Patient Safety.

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INTRODUCTION

An appropriate number of active and satisfied professionals in environments providing for satisfactory, efficient communication and a feeling of safety are highly important factors for quality of nursing care and patient safety[1]. The latter is defined as reduction in the risk of unnecessary treatment-related damage to an acceptable minimum[2]. Patient incidents caused by health assistance are denominated Adverse Events (AE) [2] and analysis of their associated factors is relevant due to their morbimortality.

A study conducted in sixteen USA hospitals analyzed 3,790 medical records of pediatric patients hospitalized between 2007 and 2012, identifying 414 AEs. Out of these, 210 were considered avoidable[3]. In Brazil, an investigation conducted in a university hospital Intensive Care Unit (ICU) confirmed 324 AEs in 115 patients and identified a 19-day average increase in hospitalization time, as well as higher mortality[4]. However, underreporting hinders the recognition of institutional problems.

To fill this gap, the *Institute of Healthcare Improvement* (IHI) developed in 2002 the *Global Trigger Tool* (GTT) methodology for AE identification[5]. Such a strategy is directed at searching for trackers, named triggers, for detecting possible AEs and provides investigators with instructions for collecting the necessary data from a retrospective record review[5]. The UK's National Health Service (NHS), aiming at applying the GTT methodology to pediatric patients, developed and publicly provides tools to be used in Neonatal Intensive Care Units (NICU)[6-7], which have been tried and approved for pediatric use[8].

These patients, when in a critical state and hospitalized in the ICU, are more vulnerable to errors due to multiple interventions and treatment complexity. In this context, the nursing staff, which accounts for most health professionals, works under a high demand for activities, rapid action and continuous observation. Its frequent work overload is a risk factor for patient safety[9].

In Brazil, Nursing Staff Sizing (NSS) in ICUs is regulated by National Sanitary Surveillance Agency's (ANVISA – *Agência Nacional de Vigilância Sanitária*) Resolution 26/2012 and by the Federal Nursing Council's (Cofen – *Conselho Federal de Enfermagem*) Resolution 543/2017. However, such determinations do not account for care demand, a relevant variable regardless of patient severity. In this context, the Nursing Activities Score (NAS) is the most used instrument for determining the time taken by the staff, in accordance with the required care, and measuring workload[10].

Regarding these variables, a study conducted in South Korea concluded that staff size, work environment and patient/nurse ratio are associated to patient mortality; when appropriate, they contribute to a reduction in avoidable deaths[11]. Another study, conducted in 300 hospitals in nine European countries, demonstrated that increasing workload led to a 7% higher probability of a hospitalized patient dying within thirty days. The same study proved that a 10% increase in the number of nurses reduced that probability by 7%[12].

To evaluate work environment characteristics, Brazilian researchers have translated, adapted and validated Nursing Work Index-Revised (NWI-R), naming the resulting instrument Brazilian Nursing Work Index-Revised (B-NWI-R). This instrument enables evaluating the general environment and the variables autonomy, environment control, relation between doctors and nurses and organization support. Its application gives ground to initiatives that ensure higher quality of assistance and improved professional satisfaction[13].

In the context of intensive care, neonatal and pediatric patients hospitalized in pediatric or mixed neonatal units, such as the neonatal and pediatric Intensive Units, are in the category of patients who are vulnerable to risks during assistance. This statement justifies the importance of research identifying gaps and contributing to the promotion of safety and quality of care to this population.

In such context, this research aimed at investigating whether there is a relation between work conditions of the neonatal and pediatric intensive nursing staff and the occurrence of AE in patients.

METHOD

Study type

Evaluative, documentary, cross-sectional study.

Setting

Research conducted in six ICUs in five public hospitals in Paraná state, out of which four are neonatal, one is pediatric, and one is both neonatal and pediatric.

The units were identified by numbers from one to six to prevent institutions from being identified. Out of the four neonatal unities, one has twenty beds, two have ten and one has seven. The pediatric unit and the neonatal and pediatric unit have ten beds each. One of the hospitals is large sized and the others are medium sized.

Population

Research participants were organized in two groups. Group I included nurses and nursing technicians in the work schedule for the data collection month and active in at least one day during the period. Each participating professional received an envelope with the instrument B-NWI-R and the Informed Consent Form (ICF). Those who did not return the data collection instruments were excluded.

Group II was divided into two subgroups. Subgroup A for NAS application included patients hospitalized for more than twenty-four hours in the unit during the seven days

of prospective data collection. Only medical records data were collected for this group and the responsible nursing professional was consulted in case of doubt. Subgroup B, to which the instruments Neonatal Trigger Tool and Paediatric Trigger Tool were applied, consisted of medical records of patients who were discharged, transferred or died in the collection month.

Data collection

Data collection was conducted between April 2017 and January 2018, always in the last week of each month. Chronological order was conveniently established by proximity between hospitals. The instruments B-NWI-R, NAS, Neonatal Trigger Tool and Paediatric Trigger Tool were used.

Work environment data were obtained and evaluated through the instrument B-NWI-R. Its scores range from one to four: when <2.5, they represent favorable environments and unfavorable when >2.5[14]. In this study, the environment was considered favorable when <2.5 and unfavorable when ≥2.5.

NAS was applied on a prospective and daily basis during the seven days of data collection in each participating hospital's ICU, always at 2 PM, considering the hospitalized patients. The data were obtained through consultations of the daily nursing record and, when in doubt, the professional responsible for assistance was contacted for clarity.

This instrument is composed of twenty-three items, divided in seven healthcare areas; a score between 1.2 and 32.0 is assigned to each activity. Each one corresponds to 14.4 minutes of patient attendance and the total corresponds to the percentage of nursing assistance time provided to the patient in twenty-four hours[10]. The mean NAS (μNAS) score by patient was obtained by applying the following formula[10]: μNAS X 14.40 = hours of care/24h/ICU.

To calculate the necessary nursing staff members, the formula employed was pE = [E. (μ NAS/100)] + 15%, which was developed by Brazilian researchers[15]. In this formula, pE = necessary number of nursing professionals; E = number of work shifts; μNAS = mean NAS score; with an additional 15% due to the Technical Safety Index (IST – Índice *de Segurança* Técnica). The number of available nursing professionals in the data collection month was obtained through information available in the sector's work schedule and records of the unit's management, regarding absences.

The search for AE was conducted by retrospective consultation of the hospitalized patients' medical records in their units during the data collection month; it was limited to the thirty days before discharge, transference or death. The instruments employed were Neonatal Trigger Tool and Paediatric Trigger Tool provided by the NHS[6-7]. Following the methodology, when there was a trigger, i.e. a positive tracker, the medical records were separated for further search for AEs and analyzed by a pediatrician with expertise on patient safety for confirmation diagnostics.

Data treatment and analysis

The data were typed in an Excel spreadsheet and statistically analyzed. Staff sizing and the environment represented work conditions and were considered predictive variables; AEs were the outcome variable.

Appropriate and inappropriate sizing were considered after comparing between the results obtained by NAS application (considered the necessary minimum) and the number of professionals registered in each ICU's work schedule.

For the quantitative variables, results were described by mean, maximum, minimum and standard deviation. The statistical association analysis was performed by logistic regression, with *odds ratio* (OR) calculation. To infer the association, the unit's staff sizing/AE and work environment/AE were evaluated. B-NWI-R's reliability was tested with Cronbach's Alpha (α) coefficient, whose normal range is 0.00 to 1.00; the higher the coefficient, the more accurate the measurement is[16]. Values higher than 0.80 were considered excellent; those below 0.50 were unacceptable[17].

Ethical aspects

This research was approved by *CEP/SD/UFPR – Comitê de Ética em Pesquisa da Universidade Federal do Paraná* (Universidade Federal do Paraná's Ethics Committee) on Opinion n. 1.790.695/2016 and CEP/HT/SESA on Opinion 1.837.653/2016, according to Resolution n. 466/12 by the National Health Council. Participants in Group I (professionals) signed the Informed Consent Form; as for subgroup A (patients), the term was dismissed, since this was a consultation to medical records and professionals. All the participants were codified.

RESULTS

From 203 eligible professionals, 143 (70.44%) took part in the study, out of which 34 (23.77%) were nurses and 109 (76.22%) were nursing technicians. In the data collection period, 80 hospitalized patients were considered for NAS application; their age was between 11.25 and 30.79 days for neonatal patients and eight months to three years for pediatric patients. The predominant diagnosis were prematurity and congenital respiratory disease. ICUs 4 and 6 had low occupation, which resulted in a lower frequency of NAS application and, consequently, a smaller score in comparison with the maximum values.

NAS was applied 412 times and its score ranged from 55.7% to 93.9%. This indicates the percentage of time spent providing nursing assistance to the patient in 24 hours (Figure 1).

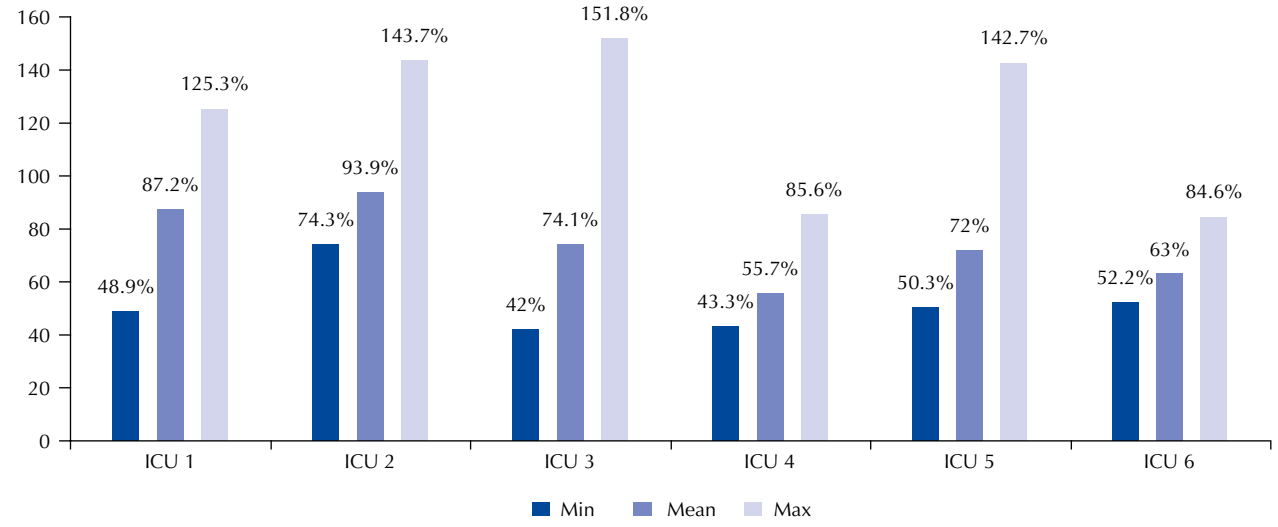

Figure 1 – Nursing Activities Score mean, maximum, and minimum by Intensive Care Unit – Curitiba, PR, Brazil, 2017-2018.

The average NAS score, when converted to care hours in a twenty-four-hour period, was between 13.38 (SD=2.16) and 22.53 (SD=2.87) hours (Figure 2).

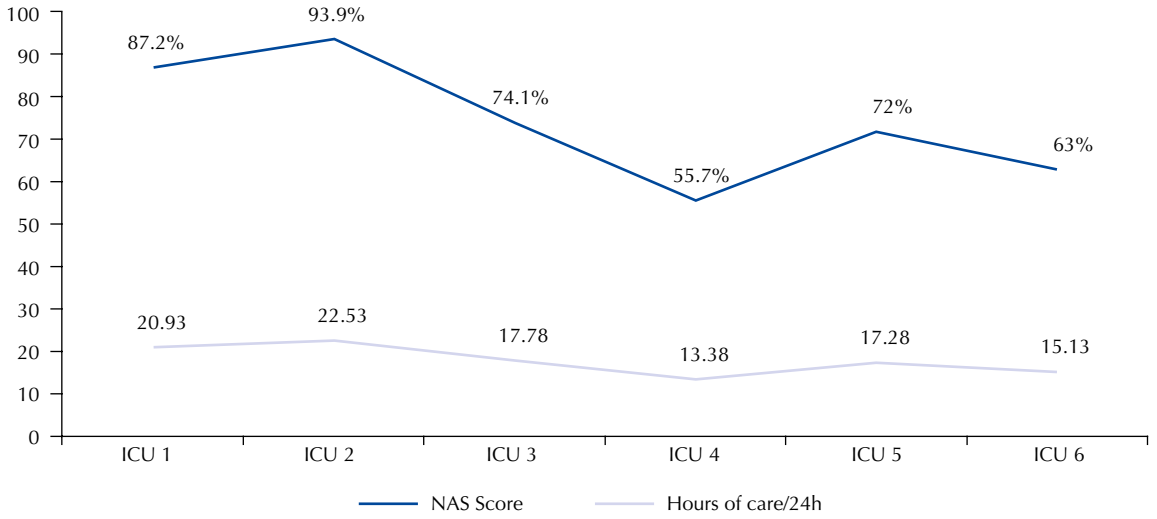

Figure 2 – Nursing Activities Score mean and hours of care conversion by Intensive Care Unit – Curitiba, PR, Brazil, 2017-2018.

The mean NAS score ranged from 225 to 1658. When the formula for staff sizing was applied, the number of necessary professionals ranged from 10 to 76. Table 1 presents the mean NAS score and a comparison between this sizing and each unit's actual staff according to the nursing work schedule. Except for ICU 1, the sizing was considered appropriate.

Table 1 – Mean score and nursing staff sizing by Nursing Activities Score and Intensive Care Unit – Curitiba, PR, Brazil, 2017-2018.

ICU	μNAS	Nursing team NAS	Nursing staff work schedule
ICU 1	1658	76	69
ICU 2	791	36	36
ICU 3	699	32	36
ICU 4	462	21	26
ICU 5	731	34	40
ICU 6	225	10	23

Results for work environment are presented in Figure 3 and indicate a favorable environment, except for ICUs 5 and 6 (mean ≥2,5). Cronbach's test resulted in an excellent internal consistency for B-NWI-R, with α=0.90 (IC= 0.87 – 0.92).

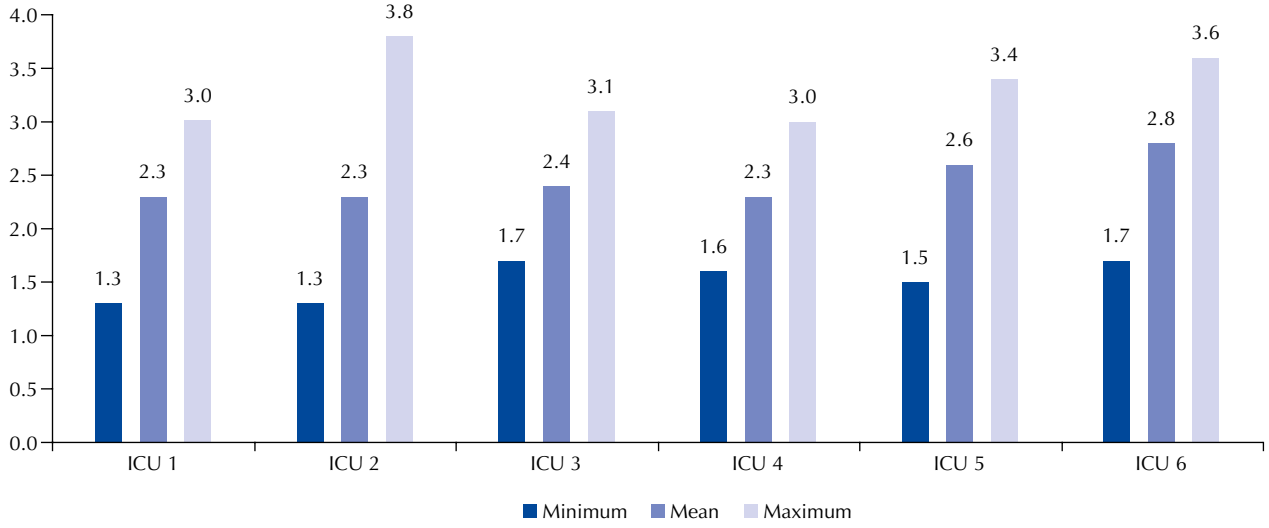

Figure 3 – B-NWI-R distribution by Intensive Care Unit – Curitiba, PR, Brazil, 2017-2018.

In the search for AE, 79 medical records were analyzed and 32 (40.5%) presented 86 triggers (63 in newborns and 23 in children). The predominant triggers for 26 newborns were: Nosocomial infection (17.5%); Lesions due to pressure or skin lesions in general (14.3%); Positive blood culture (14.3%); Irregular drug administration (9.5%); and Accidental extubation or acute worsening in baby under mechanical ventilation (6.3%). For six pediatric patients, the identified triggers were: Damage to tissue or lesion due to pressure (17.4%); Hypoxia, with O2 saturation < 85% (17.4%); Transfusion (13.1%); and Positive blood culture (8.7%).

After analyzing the cases, 30 AEs were confirmed in 22 patients: infection (12), skin lesion (9), extubation (2), reintubation (3), loss of catheter (1), catheter infiltration (1), medication error (1), transfusion (1).

The analysis of association between staff sizing, work environment and AE for each ICU is presented in Table 2, with each variable's considered value, the individual analysis' OR for measuring the association of each factor with AE prognostics, 95% confidence interval and the p-value. The association results for the statistical analysis were not significant.

Table 2 – Each prognostic factor's considered value by place, odds ratio, 95% confidence interval and p-value – Curitiba, PR, Brazil, 2017-2018.

Variable	Intensive Care Unit						OR*	CI† 95%	P-value
	1	2	3	4	5	6			
Favorable environment	1.0	1.0	1.0	1.0	0.0	0.0	1.75	(0.67, 4.59)	0.2554
Favorable NSS**	0.0	1.0	1.0	1.0	1.0	1.0	0.71	(0.24, 2.05)	0.5208

** NSS – Nursing Staff Sizing; *OR- Odds ratio; †- Confidence Interval; ‡ - P-value considered significant if <0.05.

DISCUSSION

The results reveal that the workload, obtained by NAS score, varied from 56 to 94%, which corresponds, respectively, to 13.38 and 22.53 hours of nursing assistance to the patient in a 24-hour period. Other studies conducted in Brazil point a mean pediatric ICU workload of 50%[18-19].

Correct staff sizing was proved to contribute to patient safety and AE prevention[11-12]. Increases in the nursing staff are directly proportional to reduction of overtime, incidents[11] and percentage of deaths[12]. The nursing workload was considered a contributing factor for AE occurrence in neonatal unities of a pediatric hospital in Cincinnati, USA. However, the authors defend that more studies should be conducted in this area, since they are scarce in pediatrics[20].

The difference between maximum and minimum scores obtained by applying NAS is expressive, with a highlight for ICU 1 (48.9-125.3%), ICU 3 (42-151.8%) and ICU 5 (50.3-142.7%). These intervals are explained by the improvement in critical condition among some patients and increased criticality in others. Also, some of these ICU patients could be classified as semi-intensive and intermediate, since

only one hospital offers a Neonatal Intermediate Care Unit. The patients hence leave the ICU only when their condition justifies transference to a clinical hospitalization unit.

An Italian study, conducted in nine NICUs, pointed that 39% of the hospitalized children were classified as requiring semi-intensive care[21]. In Brazil, the results found in a university hospital in the south showed that 51.3% of the 641 evaluated patients were classified as requiring semi-intensive care, which shows a need for reflection regarding bed supply in institutions[22]. This setting contributes to the permanence of semi-intensive patients both in hospitalization units and ICUs, making it difficult to establish a better parameter for NSS in ICUs.

This research's result, regarding the quantitative of nursing professionals obtained by applying NAS, demonstrates that NSS in the participating ICUs was proper, except for NICU 1, which presented deficit. Patient classification – which enables forwarding to the correct hospitalization unit – and NSS are directly related. They are both essential for the adequacy of the staff necessary to assist critical patients with a high degree of dependence. Using management technologies, such as NAS, enables the evaluation of workload and staff sizing, contributing to safe and quality care[23].

According to the results from the application of B-NWI-R, most professionals considered the work environment as satisfactory, except for ICUs 5 and 6. The application of this instrument among 745 nurses from 40 public hospitals in São Paulo showed that worse work conditions are related to higher emotional exhaustion. The authors infer that these results may originate from management model, assistance standards and profile of patients assisted in public services[24]. In a São Paulo pediatric hospital, environments which favor nursing activities were concluded to contribute to the decrease of AE and hospital permanence[25].

Using Trigger Tool enabled investigating AEs afflicting pediatric and neonatal patients in ICUs. The most frequent events were infection and skin lesion, similarly to the results of other Brazilian investigations. In a review of profiles on NICU incidents, researchers confirmed that they were, either with and without damage to the patient, related to mistakes or flaws in drug administration, usage of mechanical ventilation and intravascular catheters, infections associated to healthcare and skin lesion[26].

Using the trigger methodology gives ground to rigorously and systematically detecting damage while providing better understanding of damage epidemiology in hospitalized children, as well as enabling tracking the changes which take place after interventions, focusing on patient safety[27]. The efficacy of Trigger Tool provides motivation for the pediatric community to obtain a better comprehension of the causes of AE and carry on with investigations to reduce damage[28].

However, researchers argue that gaps in medical records and incident notification limit the potential for identifying AEs. In this context, work conditions and AEs are considered a quality of care index which demands permanent education so as to raise the collaborators' awareness for notification, training them on protocols and tracking[26].

The impact of mistakes may be reduced when verification of causes is conducted through careful analysis of consequences, subsidizing the adoption of preventive measures. Therefore, health professionals should be acquainted with patient safety language, implementing the best practices and supporting safety culture while providing extra effort to minimize mistakes[29].

The statistical tests applied to verify the association between the nursing staff's work conditions and the occurrence of AE demonstrated that such conditions were not significant. The results reflect a positive factor, for public management and professionals are committed to patient safety and quality of care provided to pediatric and neonatal patients in ICUs.

This research was limited by the collection period assigned to each participating ICU, given the restricted schedule for conclusion and the logistics of the researchers' commuting due to the distance between cities, as well as low bed occupancy in some ICUs during the investigation period.

As contributions to nursing, this study demonstrated the efficacy of the instruments used to measure the required working hours and staff sizing (NAS), as well as the professionals' level of satisfaction with their work environment (B-NWI-R) and investigating the occurrence of AE (Trigger Tool) focusing on cause and prevention analysis. Such instruments enable the establishment of diagnostics aimed at improving work processes and quality of care.

CONCLUSION

The sizing and workload of nursing professionals were estimated by employing NAS, showing that this instrument is applicable and practical for usage in pediatric and neonatal ICUs. The results contribute to encourage nursing managers towards using NAS to measure workload.

B-NWI-R's excellent internal consistency demonstrates its reliability in measuring the work environment. Most nursing professionals who took part in this research considered their work environment as favorable for professional practice; however, the fact that two units presented negative evaluation deserves attention and presupposes gaps in these services regarding valuing nursing and the participation of these professionals on daily life decisions.

The use of Trigger Tool methodology during the retrospective review of medical records enabled the identification of positive triggers of possible AEs, which were further analyzed and diagnosed. Patient damage during health care was detected, as well as the possibility of measuring these events, which enables elaborating prevention strategies.

No association between work conditions and AE occurrence was evidenced, since the prediction variables evaluated were considered mostly satisfactory. Even if this seems contradictory, the overall result of this research was considered positive for patient security of ICU hospitalized newborns and children, since it exemplified Brazilian services which provide care exclusively through the Unified Health System (*Sistema Único de Saúde*) with a high degree of excellence and quality proven by their low AE incidence and proper sizing of the nursing staff.

RESUMO

Objetivo: Investigar a associação entre as condições de trabalho da equipe de enfermagem intensivista e a ocorrência de eventos adversos nos pacientes atendidos. **Método:** Pesquisa avaliativa e documental realizada em seis Unidades de Terapia Intensiva neopediátricas públicas de hospitais estaduais do Paraná, de abril de 2017 a janeiro de 2018. As variáveis preditoras, referentes ao dimensionamento de pessoal e ambiente de trabalho, foram mensuradas por meio dos instrumentos *Nursing Activities Score* e *Brazilian Nursing Work Index-Revised*. Os 30 eventos adversos corresponderam à variável de desfecho e foram detectados utilizando-se os instrumentos *Pediatric* e *Neonatal Trigger Tool*. **Resultados:** Participaram da pesquisa 203 profissionais. Verificou-se que o dimensionamento do pessoal de enfermagem estava adequado. As condições de trabalho mostraram-se favoráveis e o valor do Alfa de *Cronbach* foi 0,90 (IC= 0,87 – 0,92). Os eventos mais frequentes detectados nos pacientes foram infecção e lesão de pele. A análise estatística de correlação e ocorrência de evento adverso demonstrou não haver significância. **Conclusão:** Apesar de não ser evidenciada associação estatística entre as variáveis, os resultados demonstram comprometimento da gestão pública e dos profissionais com a segurança do paciente e qualidade da assistência.

DESCRITORES

Enfermagem de Cuidados Críticos; Condições de Trabalho; Unidades de Terapia Intensiva Neonatal; Enfermagem Pediátrica; Segurança do Paciente.

RESUMEN

Objetivo: Investigar la asociación entre las condiciones de trabajo del equipo de enfermería de cuidados intensivos y la ocurrencia de eventos adversos en los pacientes atendidos. **Método:** Evaluación e investigación documental realizada en seis Unidades de Cuidados Intensivos públicas neonatales y pediátricas de hospitales estatales de Paraná, desde abril de 2017 hasta enero de 2018. Las variables predictoras, referidas al tamaño del personal y al ambiente de trabajo, se midieron utilizando el puntaje de las actividades de los instrumentos *Nursing Activities Score* y *Brazilian Nursing Work Index-Revised*. Los 30 eventos adversos correspondieron a la variable de resultado y se detectaron utilizando los instrumentos *Pediatric* y *Neonatal Trigger Tool*. **Resultados:** 203 profesionales participaron en el estudio. Se verificó que el dimensionamiento del personal de enfermería era adecuado. Las condiciones de trabajo fueron favorables y el valor Alfa de Cronbach fue de 0,90 (CI = 0,87 - 0,92). Los eventos más frecuentes detectados en los pacientes fueron la infección y la lesión de la piel. El análisis estadístico de la correlación y la ocurrencia del evento adverso no mostró ninguna significación. **Conclusión:** Aunque no se evidencia una asociación estadística entre las variables, los resultados demuestran el compromiso de la administración pública y los profesionales con la seguridad del paciente y la calidad de la atención.

DESCRIPTORES

Enfermería de Cuidados Críticos; Condiciones de Trabajo; Unidades de Cuidado Intensivo Neonatal; Enfermería Pediátrica; Seguridad del Paciente.

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