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Interruptions in the activities of intensive care nurses: cognitive repercussions on the professional and patient safety

Interrupciones en la actividad del enfermero de cuidados intensivos: repercusiones cognitivas en la seguridad profesional y del paciente

Interrupções nas atividades de enfermeiros intensivistas: repercussões cognitivas no profissional e na segurança do paciente

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Abstract

The aim was to analyze the interruptions in the primary activities of intensive care nurses. Exploratory research carried out in the Intensive Care Center of a university hospital, through the observation of the activities of 10 nurses. We classify the complexity of the activities considering the risk of errors and required cognitive demand. We registered 630 primary activities, of which 359 were interrupted, generating 359 secondary activities, increasing the professionals' workload by 60%. Prevalence of interruptions 0.57, average 35.9 interruptions / day, 3 interruptions / hour. The interruptions occurred: indirect technical procedures 169, direct 87, assistance management 97, from unit 3, personal activities 3. The primary activities of high complexity interrupted occurred in indirect technical procedures 99, direct 87, assistance management 49, totaling 235 interruptions. There were interruptions in the morning (171), afternoon (188), the main source being the nursing team 174. Main secondary activities recorded: informing / guiding (182), resolution / problem (39), providing material / medication (38). Disruptions were frequent in the nurses' primary activities, predominantly in those of high complexity, predisposing them to errors, compromising patient safety, in addition to increasing their workload with additional secondary activities.

Descriptors: Nursing; Intensive Therapy; Patient Safety; Cognition; Cognitive Ergonomics.

Resumén

El objetivo fue analizar las interrupciones en las actividades primarias de las enfermeras de cuidados intensivos. Investigación exploratoria, realizada en el Centro de Cuidados Intensivos de un hospital universitario, mediante la observación de las actividades de 10 enfermeras. Clasificamos la complejidad de las actividades considerando el riesgo de errores y la demanda cognitiva requerida. Registramos 630 actividades primarias, de las cuales 359 fueron interrumpidas, generando 359 actividades secundarias, aumentando la carga de trabajo de los profesionales en un 60%. Prevalencia de interrupciones 0,57, media 35,9 interrupciones / día, 3 interrupciones / hora. Las interrupciones ocurrieron: procedimientos técnicos indirectos 169, directos 87, gestión asistencial 97, de la unidad 3, actividades personales 3. Las actividades primarias de alta complejidad interrumpidas ocurrieron en: procedimientos técnicos indirectos 99, directos 87, gestión asistencial 49, totalizando 235 interrupciones. Hubo interrupciones en la mañana (171), tarde (188), siendo la fuente principal el equipo de enfermería 174. Principales actividades secundarias registradas: informar / orientar (182), resolución / problema (39), suministro de material / medicación (38). Las interrupciones fueron frecuentes en las actividades primarias de las enfermeras, predominantemente en las de alta complejidad, predisponiéndolas a errores, comprometiendo la seguridad del paciente, además de incrementar su carga de trabajo con actividades secundarias adicionales.

Descriptores: Enfermería; Terapia Intensiva; Seguridad del Paciente; Cognición; Ergonomía Cognitiva.

Resumo

Objetivou-se analisar as interrupções nas atividades primárias de enfermeiros intensivistas. Pesquisa exploratória, realizada no Centro de Terapia Intensiva de um hospital universitário, através da observação das atividades de 10 enfermeiros. Classificamos a complexidade das atividades considerando o risco de erros e demanda cognitiva exigida. Registramos 630 atividades primárias, destas 359 foram interrompidas, gerando 359 atividades secundárias, aumentando 60% a carga laboral dos profissionais. Prevalência de interrupções 0,57, média 35,9 interrupções/dia, 3 interrupções/hora. As interrupções ocorreram: procedimentos técnicos indiretos 169, diretos 87, gestão da assistência 97, da unidade 3, atividades pessoais 3. As atividades primárias de alta complexidade interrompidas decorreram em: procedimentos técnicos indiretos 99, diretos 87, gestão da assistência 49, totalizando 235 das interrupções. Ocorrência de interrupções manhã (171), tarde (188), sendo a principal fonte a equipe de enfermagem 174. Principais atividades secundárias registradas: informar/orientar (182), resolução/problema (39), fornecer material/medicação (38). As interrupções foram frequentes nas atividades primárias dos enfermeiros, predominando naquelas de alta complexidade, predispondo-os a erros, comprometendo a segurança do paciente, além de aumentar sua carga de trabalho com atividades secundárias adicionais.

Descritores: Enfermagem; Terapia Intensiva; Segurança do Paciente; Cognição; Ergonomia Cognitiva.

Introduction

The first reference about the repercussions of interruptions in nursing care was made by Florence Nightingale, in her book "Notes on Nursing: what is and what is not". In the publication, the author states that the interruption harms the sick and the healthy, and states in a visionary way: "I never heard of people exposed for years to constant interruptions that did not develop, in the end, and because of that, mental numbness or confusion"[1:58].

In the 1940s, in military and civil aviation, it was found that the lack of attention caused by interruptions led pilots to error, later, the concern extended to the auto industry and other high-risk activities, such as nuclear power plants[2].

In the health field, the study of interruptions has been explored by researchers since 2000, following the publication of the report "To Err is Human: Building a Safer Health System" by the Institute of Medicine (IOM), which highlighted interruptions as possible contributors for the occurrence of health errors and failures related to the work environment. As interruptions are quite common in hospital institutions, they negatively impact this scenario and its professionals and, consequently, patient safety[3].

Research on medication administration errors (Medication administration errors / MAE) were the first to propose strategies to abolish or minimize interruptions during the process, considering the significant association of errors with interruptions[4].

In addition to inducing errors in tasks, interruptions have been recognized by specialists in human factors as conditions that generate delays in production, reduce efficiency, productivity, creativity, leading to direct and indirect costs[5].

The phenomenon of interruptions was defined as a drop in the performance of an activity, initiated by an internal source (of the individual himself) or an external source (other individuals, physical equipment signals) for the receiver, resulting in the suspension of the initial task, starting a new task programmed, with the assumption of resumption of the initial task. It should be noted that interruptions differ from distractions. In the distraction there is a brief disconnection from a task, where a different object catches our attention, however without suspending the task, while interruptions prevent us from completing an activity by invading the process[6].

Operational failures, such as lack of materials, equipment and personnel, structural and organizational deficiencies in the system and division of labor, favor interruptions in daily life, which, combined with the performance of multiple simultaneous tasks, interfere in solving problems, in making decisions and facilitate the occurrence of errors by the professionals involved. Therefore, it is concluded that the effects of interruptions are the result of a complex set of variables[7-9].

Review article showed that, among the health team professionals, nurses are the most interrupted. The number of interruptions experienced by them varied from 0.4 to 13.9 per hour, according to the type of unit studied, and were more frequent during activities of direct care to the patient (drug therapy) and registration. He concluded that the nurse is rarely able to complete an activity without being interrupted, being constantly activated to provide information and operational failures in the unit. The main sources of interruption were members of the nursing team, other health professionals, telephone, patients, visitors and self-interruption. Regarding the implications of the interruption for patient safety, the studies analyzed identified that 90% of the interruptions resulted in negative consequences, such as delayed assistance, loss of professional concentration and medication errors[10].

Although nurses are frequently interrupted and interruptions require the cognitive resources of the primary task and can hamper their performance, leading to errors and omissions, they may contain necessary and indispensable information for care, referred to in the literature as positive interruptions[11,12].

Evidence from observational, experimental studies, controlled laboratory investigations and with the use of simulators shows that interruptions lead to cognitive implications, such as forgetfulness in professionals, lack of concentration, delays in care, unfinished tasks, worsening performance, which can compromise patient safety. Interruptions touch on different cognitive functions, from attention, to decision making, to memory[13,17].

Authors report that most interruptions (88.9%) can have negative consequences, whereas only (11.0%) have a positive result[13].

The work of health professionals, especially in critical areas, requires high cognitive demands, in particular attention and memory, due to the complexity and the large amount of information that must be processed. In these circumstances, interruptions can be particularly detrimental to the professional's performance and patient safety[18].

Intensive care presents considerable challenges in relation to patient safety, considering the profile of patients, differentiated care, the work process, the large contingent of professionals, with different backgrounds and experiences, in addition to the use of different technologies diagnostics and therapies for the life support of patients admitted to these units. Therefore, interruptions are constant, with a negative impact on the work process and as a contributing factor in the origin of errors[16].

Admittedly, the nursing team plays a fundamental role in promoting and guaranteeing patient safety, since it continuously provides care to the patient. Therefore, as dynamic participants in this process, it is necessary and justifiable to understand the characteristics of the work environment in which nurses work and which may compromise patient safety, including about interruptions in the activities developed by these professionals[10,19].

The identification of systemic and / or environmental conditions that cause interruptions in the nursing work process makes it possible to develop strategies that seek to avoid and reduce the occurrence of this phenomenon and minimize its negative repercussions in care and as a result in patient safety. We cannot change the

human condition, but we can change the conditions in which human beings work[10,20,21].

Thus, the understanding of interruptive events in the activities of intensive care nurses can support managers in the reformulation of work processes in intensive care units, by providing data regarding potential risk factors for error, with the identification of systemic, organizational flaws and restrictions and operational. The reformulation could reduce unnecessary interruptions that negatively interfere with patient care, benefiting their safety and that of the professionals involved, providing a more productive work environment[22].

Understanding the nature of errors in healthcare is a difficult task and, at the heart of this puzzle, are nurses and the nature of their practice[23,24]. Thus, investigations about interruptions and patient safety in intensive care should consider the complexity and working conditions of nurses, as well as the effect of environmental variables on this process.

The problem of interruptions in the activities of intensive care nurses was the main motivation for carrying out this study, which aimed to analyze the interruptions in the primary activities of nurses in an adult intensive care center in a university hospital.

Methodology

This is an exploratory research, with a quantitative approach, carried out in an Intensive Care Center with 10 beds, of a large university hospital in Rio de Janeiro.

The production of data occurred through non-participant observation of the activities performed by 10 nurses on duty in the day service, in 10 different days, after their acceptance and consent. Participants were monitored during their 12-hour shift, individually, uninterruptedly, by a single observer, totaling 120 hours of observation of nursing activities. Data collection took place in January 2016. In non-participant observation, there is no involvement with the investigated scenario.

The inclusion criterion was since nurses are involved in the care of the 10 patients admitted to the unit, both in care and management activities.

Structured instruments were used to record the data obtained.

We chose to categorize primary activities into direct technical procedures (activities performed by nurses at the bedside), indirect technical procedures (activities that do not occur in the nurse / patient space, but linked to direct technical procedures), care management (related to provision interventions for patients), unit management (related to the operation of the unit), personal activities (meeting the nurse's personal needs)[19].

Primary activities were classified as high and medium complexity, considering severity of patients assisted at the unit, differentiated environment from intensive care, predisposition to the occurrence of errors (slips, lapses, mistakes) and omissions resulting from interruptions during their execution, required cognitive demand of the professional in carrying out certain activities[12,17,22,25]. The participants' personal activities were classified as not complex.

For the study of interruptions, the variables included: occurrence of interruption, source, time, secondary activity resulting from the interruption (activity resulting from the interruption) and its complexity, resolution of the reason for the interruption and return to primary activity.

In addition to the structured instruments for data recording, we use two professional digital hand-held chronometers to measure the time of each activity and interruptions.

To characterize the participating nurses, the variables referring to age, sex, time spent at university and working at the unit, post-graduation, employment relationships, weekly workload were studied.

We chose other variables of interest: characterization of noise levels at the study site and characterization of patients admitted to the unit during data collection, age, length of stay, value of the Nursing Activities Score-NAS, which measures the nursing workload and the Simplified Acute Physiology Score 3-SAPS 326,27 prognostic score. Information and scores were collected and calculated by the researcher.

To characterize the noise levels, we measured the maximum and minimum decibels (dB) of the unit, using a digital decibel meter, at intervals of every 2 hours during the shifts where the observations took place (total of 60 measurements). The number of individuals present at the unit and the number of medical assistance alarms (EMA) that sounded during the production of the data were accounted for, factors that can contribute to noise levels, in addition to favoring the occurrence of interruptions.

The findings were analyzed in the light of descriptive statistics and non-parametric inferential techniques, given their non-normal distribution, using the software program Microsoft Office Excel 2007® and the software R version 3.2.3, Copyright (C) 2015 "The R Foundation for Statistical Computing", respectively.

In the inferences, tests with p-value equal to or less than 5% of significance were considered significant, and significant cases at 10% (acceptable for smaller samples) were discussed 28. Recalling that 0.05 represents a 5% significance level; 0.1 represents a 10% significance level.

Thus, tests of difference between means / medians of two groups were used, Wilcoxon test (for paired samples) or Mann-Whitney test (for unpaired samples); adherence test (Kolmogorov-Smirnov test); and association / correlation test (Spearman's Correlation Test).

The study was approved by the Ethics and Research Committees (CEP) of the Proponent Institution Federal University of the State of Rio de Janeiro - UNIRIO (opinion number: 1,262,650) and the Co-Participating Institution Pedro Ernesto University Hospital - State University of Rio de January - HUPE / UERJ (opinion number: 1,297,587).

Participating nurses and those responsible for hospitalized patients during the production of data received verbal and written guidance, were instructed on the objectives of the work, and signed the Free and Informed

Consent Form (ICF). We obtained authorization from everyone involved.

We justify citing references that are more than five years old, given their importance and pioneering spirit in the study of interruptions; in the consolidation of concepts, taxonomies, research methodologies and evidence about the phenomenon, whether in the context of patient safety, cognition, ergonomics, and human engineering.

Results

The 10 participating nurses had a mean age of 31 years, median of 27 years (ranging from 25 to 48 years), a male. The average training time was approximately 5 years and 9 months, median 4.5 (ranging from 2 to 21 years), only one of them was not a graduate. The average time working at the unit was 1 year and 9 months, median 2 years. Five participants (5) had more than 1 job; six (6) had a total weekly workload of 60h, one (1) nurse 30h, and three (3) 70, 84 and 90h respectively, reaching an average of 63 hours and 24 minutes of weekly work, median 60h weekly.

During our investigation, we followed 84 patients in the unit during the 10 days of observation (64 clinical patients, 20 surgical patients). Female patients 36 and male 48. The average age of patients was 61.22 and days of hospitalization 37.59 days.

The average value of the Nursing Activities Score (NAS) obtained was 71.18, with the lowest value being 67.36 and the highest value 77.52 (standard deviation / SD 3.15, median 71.01). Therefore, our sample required 18.60 hours (19 hours) of nursing care within 24 hours. The mean value of the Simplified Acute Physiology Score 3-SAPS 3 of the patients was 87.38 (SD 21.43, median 90.5).

The noise levels measured in dB in the environment were: average minimum dB 49.68; mean maximum dB 68.71; overall average 59.19. The lowest minimum dB value was 41.8; minimum dB with higher value 68.1; maximum dB with lowest value 56.9; maximum dB with highest value 82. Median minimum dB 48.65; median maximum dB 68.50; general median dB 60.

The number of passers-by during data collection ranged from 6 to 25 individuals, with an average of 14.43 people (SD 2.63; median 14.08).

The total number of alarms computed in the 120 hours of observation was 1814 (181.4 alarms / day / 10 days of follow-up; SD 62.75; median 162.00; Interquartile interval / IQR 75.25), with 15.11 alarms / hour / 120 hours (SD 5.23; median 13.49; IQR 6.27). We highlight that 1478 were monitoring alarms (multiparametric monitors).

During this period, 630 primary activities performed by participating nurses were recorded. As primary activities, nurses performed predominantly indirect technical procedures 233 (37%), followed by activities related to care management 185 (29%), direct technical procedures 169 (27%), personal activities 27 (4%) and finally activities associated with the management of unit 16 (3%), thus totaling 630 primary activities.

Therefore, in the 10 days of observation, the participants performed an average of 63 activities per day (during the 12 hours of duty), 5.25 activities per hour, that is, 1 activity every 11.42 minutes.

Of the 630 primary activities performed by the participants, 359 were interrupted, resulting in a prevalence of interruptions of 0.57 (57%), an average of 35.9 interruptions per day, median of 30, SD 11.37 (10 days of observation) 12 hours). With 359 interruptions in 120 hours of observation, we have 3 interruptions per hour, 1 every 20 minutes. There were 29 events where professionals were interrupted simultaneously.

The lowest number of interruptions experienced by nurses in a 12-hour shift was 23 events and the highest value was 57 interruptions in this period.

Interruptions occurred more frequently in indirect technical procedures 169 (47%), followed by care management 97 (27%), direct technical procedures 87 (24%), management of unit 3 (1%), personal activities 3 (1 %) (Table 1).

Table 1. Primary activities of the participants and the frequency of interruptions. Rio de Janeiro, RJ, Brazil, 2017

	Activity Interrupted?			
Primary activity	**No**	**Yes**	**Yes (%)**	**Grand total**
Personal activities	24	3	1%	27
Assistance management	88	97	27%	185
Unit management	13	3	1%	16
Direct technical procedures	82	87	24%	169
Indirect technical procedures	64	169	47%	233
Grand total	**271**	**359**	**100%**	**630**

Source: Bridi[29].

As for the complexity of the 359 interrupted activities, 235 (65.46%) were of high complexity, 121 (33.70%) of medium complexity and 3 (0.84%) personal activities, without complexity.

Regarding the interrupted primary activities of high complexity (235 activities), the greatest number of interrupting events occurred in indirect technical procedures 99 (42.12%), followed by direct technical procedures 87 (37.02%) and assistance management 49 (20.85%) (Chart 1).

Chart 1. Primary activities interrupted and their complexity. Rio de Janeiro, RJ, Brazil, 2017

Indirect technical procedures (high complexity)	**N**	**%**
Medication schedule	68	
Water balance closure (WB)	28	
Labeling of medicines	2	
Double check schedule	1	
Total	**99**	**42,12%**
Direct technical procedures (high complexity)		
Medication administration	46	
Care bedside	17	
Physical exam	8	
Exam collection	9	
Alarm answer	3	
Patient admission	2	
Installation of blood products	2	
Total	**87**	**37,02%**
Care management (high complexity)		
Conference of medicines from the pharmacy	35	
Duty shift	8	
Laboratory material conference	6	
Total	**49**	**20,85%**
Grand total of interrupted activities of high complexity	**235**	**100%**
Indirect technical procedures (medium complexity)		
Records in general	**70**	**57,85%**
Care management (medium complexity)		
Multidisciplinary visit / round, daily care schedule, preparation of material for procedure	**48**	**39,66%**
Unit management (medium complexity)		
Ordering material, stocking material, leaving the unit for outside activity, making vacancies available	**3**	**2,47%**
Grand total of interrupted activities of medium complexity	**121**	**100%**
Personal activities (without complexity) Total	**3**	**1%/100%**
Grand total of interrupted activities	**359**	

Source: Bridi[29].

For analysis purposes, we consider the morning period (morning period / 1st shift) from 7 am to 12:59 pm and afternoon (afternoon period / 2nd shift) from 1 pm to 6:59 pm. We obtained 171 interruptions in the morning (47.63%; average of 17.1, median 13) and 188 (52.37%; average of 18.8, median 16) in the afternoon.

We observed that the interruptions occurred in greater numbers in the morning from 9 am until 10:59 am, a period that, as a routine, is the medical visit, bathing in the patients' beds, dressing changes, medication from 10 am, multi-professional visits. In the afternoon, the interruptions were concentrated in two moments, from 3 pm to 4:59 pm, a period in which they normally occur, procedures with patients, such as deep punctures, tracheostomies, bedside exams, external exams, and after 5pm to 6:59 pm, period of the closing of the water balance, medication at 18h, bedside

care for the shift change and occasionally patient admissions.

The main source of interruption was the nursing team with 174 records (48.47%), (due to patient demands, inputs, whether materials and / or drugs, of the unit's work process), in both shifts, 1st shift (morning) and 2nd shift (afternoon). The second source of interruptions observed was a problem identified with 39 records (10.86%), which were detected by the participating nurse (mainly problems related to patients, medical prescriptions, necessary supplies for the care and environment of the unit), especially in the 2nd shift (evening). The medical team gave rise to 26 events (7.24%), self-interruption / personal activities 25 (6.96%), alarms 20 (5.57%) (Chart 2).

Chart 2. Interruption sources. Rio de Janeiro, RJ, Brazil, 2017

	Absolute Number (n)			Percentage (%)		
Interruption sources	**Shift 1 Morning**	**Shift 2 Evening**	**Total**	**Shift 1 Morning**	**Shift 2 Evening**	**Total**
Alarms	10	10	20	5,85	5,32	5,57
Self-interruption / personal activities	16	9	25	9,36	4,79	6,96
Other health professionals	8	5	13	4,68	2,66	3,62
Support services team	4	3	7	2,34	1,6	1,95
Nursing team	84	90	174	49,12	47,87	48,47
Medical team	11	15	26	6,43	7,98	7,24
Family	0	11	11	0	5,85	3,06
Patient instability	8	5	13	4,68	2,66	3,62
Others	4	1	5	2,34	0,53	1,39
Issue identified	9	30	39	5,26	15,96	10,86
Medical resident	6	2	8	3,51	1,06	2,23
Telephone (work subject)	11	7	18	6,43	3,72	5,01
Grand total	**171**	**188**	**359**	**100**	**100**	**100**

Source: Bridi[29].

The 359 interruptions in primary activities generated participating nurses 359 secondary activities.

There were 29 events in which professionals were interrupted simultaneously, in this situation we noted and measured 2 interruptions and 2 secondary activities. There was no interruption episode during the performance of the secondary activity, which could generate a third activity or even more, a fact that commonly happens in the daily routine of intensive care, but that during our data collection did not occur.

Regarding the complexity of the secondary activity generated from the interruptions, we had 100 (28%) occurrences of high complexity, of medium complexity 224 (62%), without complexity (personal activities of the participants) 25 (7%), and others 10 (3%). We named "other", activities resulting from simple and uncomplicated requests to participants, which occurred in the place where he was and that did not require physical displacement, such as delivering a document relating to the patient, picking up something in a nearby drawer, triggering the door to open of the unit at the nursing station counter (Chart 3).

Chart 3. Secondary activities and their complexity. Rio de Janeiro, RJ, Brazil, 2017

Secondary activity	**Complexity**	**N**	**%**
Troubleshooting	High	39	
Assess patient	High	37	
Care bedside	High	12	
Administer medication	High	3	
Auxiliary bed bath	High	3	
Blood products receiving (Blood Bank)	High	3	
Exam collection	High	2	

Auxiliary procedure	High	1	
Total		**100**	28%
Inform / guide	Medium	182	
Provide material / medicine	Medium	38	
Request X-ray examination	Medium	2	
Take laboratory exam	Medium	1	
Orient maintenance	Medium	1	
Total		**224**	62%
Socialization	No complexity	12	
Cell phone use	No complexity	11	
Feeding / disposal	No complexity	2	
Total		**25**	7%
Others	No complexity	**10**	3%
Grand total		359	100%

Source: Bridi[29].

On average, the interruptions lasted 119.59s (approximately 2 minutes), median 74s (01min and 14s); the shortest interruption was 10 seconds, and the longest interruption was 1800 seconds (30 minutes).

In 93% of the interruption events, the nurses returned and completed the initial (primary) activity and in 100% of the cases the nurses completed the secondary activities that resulted from the interruptions.

The use in the analysis of the interruptions of non-parametric inferential techniques brought us other evidence.

Considering the interruptions recorded per participant over the course of a day (n = 10), according to the Wilcoxon Test, there was no significant difference between the volume of interruptions in the 1st shift (morning) and the 2nd shift (afternoon), (p = 0.65).

Regarding the average time of interruptions registered by a nurse over a day (n = 10), according to the Wilcoxon Test, there was no significant difference between the average time of interruptions in the 1st shift (morning) and the 2nd shift (afternoon), that is, between the days analyzed, there was no greater predominance of average interruption time that differentiated the shifts (p = 0.77).

In the analysis between the hours of the day, the primary activities with medium complexity were those that had the greatest variation in the volume of interruptions (Coefficient of Variation / CV: 75.23), whereas in relation to the average time were the secondary activities of high complexity (CV: 50.62).

We found no difference between the strata in the variables of interest that could be analyzed: nurse age (p≈1), complexity of primary (p = 0.89) and secondary activity (p≈1), in relation to the volume of interruptions (Kolmogorov-Smirnov adherence test).

The analysis of the interruptions in the historical series between the days and between the hours of the day demonstrated that the primary activities of high complexity were constantly interrupted in the period, obtaining in total a greater volume of interruptions.

Still in the analysis of interruptions in the historical series, we observed that at the end of the shift (between 5:00 pm and 7:00 pm) the average time of interruptions of primary activities of high complexity was greater and between 11:00 am and 3:00 pm in primary activities of medium complexity.

At a significance level of 10% (acceptable for smaller samples), the number of interruptions has a significant association with NAS (correlation -0.57 p = 0.09), mean dB (correlation 0.57 p = 0, 09), total alarms (correlation 0.61 p = 0.06) and with the average of alarms (0.61 p = 0.06). With the NAS, the correlation was negative. At a 5% level, the associations were not significant (Spearman's correlation test). The number of passers-by and professionals was not associated with interruptions.

Regarding the average time of interruptions, none of the tests was significant at a level of 5% or 10% in relation to the variables of interest (Spearman association test).

Discussion

Regarding the characteristics of the nurses participating in our study, they were predominantly young, with graduate degrees, training time more than five years, two jobs, 60 hours of work per week.

Survey of the Nursing Profile in Brazil carried out in 2013 showed that, in the country, there is a gradual drop in the percentage of professionals over 40 years old[30]. We must consider the effects of aging on nursing professionals, the continuous tension that these professionals are subjected to, especially in intensive care, can lead to greater psychophysical and emotional stress and contribute to the reduction of concentration and generate memory lapses,

exposing them to possible errors, in addition to the risks to occupational diseases, stress and Burnout Syndrome (BS)[31].

In Brazil, the national health system does not prioritize the training of nursing professionals in their specific area of activity, the issue of the training of nurses and their allocation in the labor market, generalist versus specialist, stands out. The need for an appropriate number of professionals, with adequate qualifications and work systems with structure and processes aimed at promoting patient safety, is indisputable[19].

Several internal and external factors in the environment affect nurses, regardless of the length of experience, however, data indicate that interruptions and information overload most often affect newly graduated or newly hired nurses. Other findings indicate that more experienced nurses suffer more interruptions than those with less experience[23].

In nursing, particularly in workplaces where there are important physical and cognitive demands, such as in intensive care, in addition to exposure to occupational stressors, sleep issues, rest for professionals and weekly workload, they need to be reviewed by legislation and inspected by Organs competent bodies, because workers and patients who are in their care, can be harmed by the high workload performed by professionals. Due to low pay, most nursing professionals have two or more employment relationships. Investigations conclude that in addition to the lack of staff available for care and low qualifications, the excessive workload of nurses is associated with an increased risk of errors and mortality of patients[32,33].

The average dB measured in the unit during observation was 59.19, with an average of 14.43 passers-by, total number of alarms 1814 (≈181.4 alarms / day).

According to the recommendations of the United States Environmental Protection Agency and the Brazilian Association of Technical Standards (ABNT), noise levels in a hospital environment should not exceed 45 dB during the day and 35 dB at night. The World Health Organization (WHO) recommends 30 dB at night and 40 dB at day[34,35].

Thus, we found that the noise levels measured were above the levels recommended by the standardization bodies, in all measurements, including the minimum dB measured. The number of alarms and passers-by contributed to the high dB value in the environment, due to noise from medical assistance equipment / EMA (technological noise), from the conversation and circulation of the team. These factors combined with the occurrence of repeated interruptions have a negative impact on the professionals' cognition.

In intensive care, high noise levels interfere with communication, cause loss of attention, memory lapses, irritability, fatigue, stress, psychological changes, headache, impaired auditory acuity, muscle contractures, cardiovascular changes, in addition to worsening sleep quality, both in the professional team and in patients admitted to the units. High noise levels can lead to health problems for nursing workers, as well as impacting the work process, exposing the group to risks of accidents and errors in the execution of tasks[34,35].

We emphasize that, as a source of interruption in our study, alarms caused 20 events, corresponding to 5.57% of the total interruptions and as a primary interrupted activity (answering the alarm) we recorded 3 events, despite the high number of computed alarms. This finding leads us to deduce that there were in the sample many alarms not attended by the team, a context of concern in relation to patient safety.

The average value of the NAS obtained was 71.18, therefore requiring 18.60 hours (≈19 hours) of nursing care within 24 hours.

The NAS aims to measure the time of nursing care in intensive care and directly expresses the percentage of time spent by the nursing staff in direct and indirect assistance to critically ill patients in 24 hours, reaching a maximum of 176.8%[26].

The results of Brazilian surveys with NAS greater than 50% reveal a high demand for nursing care, especially in situations where the score exceeds 70%, given the degree of dependence that this score value represents, which shows that a professional can fully care for only one patient per work shift, making it impossible for 1 professional to care for 2 seriously ill patients. However, the ratio of 1 nurse for every 10 beds per shift and 1 nursing technician for every 2 patients per shift is determined and recommended by the resolutions of the National Health Surveillance Agency (ANVISA) and the Ministry of Health (MH)[36,37].

Researchers suggest that the proper dimensioning of nurses, with ideal proportionality between patient and professional, helps to reduce the incidence of adverse events, turnover, and professional absenteeism, which result in better indicators of care quality, management, and patient safety[38].

The prognostic indexes quantify acute and chronic physiological disorders during admission, estimating mortality, to correct errors and improve the performance of intensive care. In theory, the lowest value attributed by the Simplified Acute Physiology Score-SAPS 3 prognostic score is 16 and the highest is 217 points. The average value for SAPS 3 found was 87.38 and days of hospitalization in the unit of 37.59 days; relatively high values, which indicates the severity of the patients[27].

The values obtained in NAS and SAPS characterize the clinical conditions of patients admitted to the unit in the period studied, the dependence on the nursing team, the degree of complexity and intensity of care required, making the scenario favorable for interruptions, given the high workload of nurses.

Corroborating this finding, adopting a significance level of 10%, the number of interruptions has a significant association with NAS ($p = 0.09$), average dB ($p = 0.09$), total alarms ($p = 0.06$) and with the average of alarms ($p = 0.06$). These variables express the degree of dependence and instability of the patients, a fact that leads to the need for constant assessment and intervention by the team, triggering interruptions to the nurse.

We recorded 630 primary activities performed by the 10 participating nurses in 120 hours of observation. Participants predominantly performed indirect technical

procedures 233 (37%), followed by activities related to care management 185 (29%), direct technical procedures 169 (27%), personal activities 27 (4%) and unit management 16 (3%).

A national study carried out in five care units at a university hospital in São Paulo found 2,295 activities performed by 25 nurses (150 hours of data collection), classified as indirect patient care (885; 38.6%), direct assistance (516; 22.5%), care management (421; 18.3%), unit management activities (229; 10.0%) and personal activities (244; 10.6)[20].

Research also carried out in a teaching institution in Goiás obtained 739 activities performed by 33 nursing professionals from two intensive care units (99 hours of follow-up), distributed in indirect patient care (405), direct care (288), administrative activities (46)[39].

We can see in the studies cited that indirect patient care was prevalent, in addition to this, there is a significant involvement of nurses in care management.

These findings are not considered ideal, since the nurse plays an essential and determining role in patient safety, however, to be able to perform this function effectively, it is necessary that the professional is more involved in direct and continuous patient care, enabling detecting complications early and preventing errors in patients under the care of healthcare professionals[19].

Aiming at patient safety, scientific evidence indicates that an adequate number of qualified professionals, processes and work structure with appropriate conditions and more time spent on bedside activities, are intrinsically linked to the best outcomes of patient health care and indicators related to nursing care, such as reducing rates of nosocomial infection, falls, pressure injuries, medication errors, length of stay and mortality[19,40].

However, especially in developing countries, the health area and nursing practice are negatively influenced by the shortage of professionals, lack of qualification, low social value and remuneration, excessive workload, high absenteeism and evasion from the profession, and Brazil, these problems are aggravated by structural, political, economic, and cultural issues[19,38,41].

The Professional Exercise Law No. 7498/86 provides that it is one of the private activities of nurses to provide care of greater technical complexity and that require scientific knowledge and the ability to make immediate decisions, however, the current legislation, Resolution-RDC n. 26, of May 11, 2012, recommends 1 nurse to care for 10 patients in intensive care, making it impossible for the nurse to be involved in direct and continuous care for the patient most of the time. Furthermore, the unit's managerial activities required and delegated to the nurse consume much of this professional's time in most institutions[36,42].

Another obstacle faced is that nurses spend a lot of time to solve the institution's problems in actions that could be performed by less qualified professionals, the most appropriate planning and division of work would increase the efficiency and effectiveness of all professionals, giving nurses the opportunity to provide care. the bedside. In many institutions, difficulties in infrastructure and in the work process, compromise the nurse's practice, as it is directed to support activities to other team members and hospital services, thus nurses are removed from care activities to correct failures and systemic, organizational, and operational restrictions of these organizations[9,19,20].

In addition to the distancing from direct patient care, systemic, organizational, and operational failures and restrictions trigger interruptions leading to errors in nursing, as nurses are frequently interrupted to make up for the lack of medicines, materials, diets and replace defective equipment, that is, to rectify faults and errors in the pharmacy, material center, nutrition, maintenance, transportation, laboratory, cleaning, laundry etc[9,20,43].

In the analyzed period, we registered 630 primary activities performed by the participants, where 359 were interrupted, resulting in the prevalence of interruptions of 0.57 (57%), an average of 35.9 interruptions per day, 3 interruptions per hour, 1 every 20 minutes, with 29 events where professionals were interrupted simultaneously. The number of interruptions experienced by nurses in various investigations ranged from 0.4 to 13.9 per hour, according to the type of unit analyzed[10].

Brazilian research found that some activities performed by nurses were interrupted more than once, with an average of 1.6 interruptions per activity, totaling 1,180 interruptions in the 719 interrupted activities (31.3%), varying from one to seven interruptions in the same activity and 7.9 interruptions per hour or one interruption every 7.6 minutes[20].

Another national survey enumerated 739 activities carried out by nursing professionals, of which 346 (46.82%) suffered interruptions, totaling 778 interruptions, average of interruptions per activity was 1.1, with 7.8 interruptions per hour, one interruption a every 7.6 minutes[39].

Different studies carried out in Australia in an intensive care unit and in the USA in medical-surgical units obtained an average of 6.6 to 7.6 interruptions per hour[15,44].

In a Canadian teaching cardiovascular unit, 40 nurses were followed for 48 hours, with 1007 interruptions identified, average 1 interruption every 3 minutes, reaching 20 interruptions per hour[11].

The differences found in the results between the investigations are mainly due to the methodological and conceptual distinctions regarding the classification of the interruptions used, the characteristics of each unit examined, the division of labor and the training of nursing, in addition to the health systems of the countries.

The multiple tasks performed by nurses, associated with interruptions can have negative effects on patient safety, due to work overload, generating incomplete activities, delays, and omissions in care, increasing the risk of errors and patient exposure, in addition to impacts physical and cognitive negatives of professionals, such as fatigue, irritation, burnout, dissatisfaction, frustration, anxiety and stress[6,8,9,12].

The intensive care nurse works in an unpredictable, complex, non-linear, noisy environment, composed of countless professionals from different categories and with

different technologies. In this context, frequent interruptions during the performance of their activities impact their attention, memory, as well as their concentration[6,9,24].

Interruptions require cognitive changes that affect the nurse's decision making, in a place where professionals are constantly interrupted, asked to alternate, or accumulate tasks, there is a greater propensity for incidents, with consequent compromising of patient safety[13,14,24,45].

In relation to the interrupted primary activities of high complexity, in our study, the largest number of events occurred during indirect (99; 42.12%), direct (87; 37.02%) and assistance management (49; 20, 85%), totaling (235; 65.46%) of the 359 (100%) interrupted primary activities.

A study demonstrated that among the 1,180 interruptions observed, 527 (44.7%) occurred in indirect patient care, 284 (24.1%) in care management, 246 (20.8%) in direct patient care, 79 (6.7%) in the management of the unit and 44 (3.7%) during personal activity. The authors recommend the need to guide the health team to minimize the number of interruptions during care activities, especially those of direct care, to promote greater quality and safety for the patient[20].

Another study also found that the activities that suffered the greatest number of interruptions were related to indirect care (196; 56.65%), direct care (142; 41.04%) and administrative (8; 2.32%). Within these activities, the following stand out: in indirect care the nursing notes and records, in direct care the administration of medicines and in administrative activities the use of the telephone[39].

It is worth discussing potential errors resulting from interruptions in primary activities of high complexity identified in our study, given the increased risk of their occurrence from interrupting events in these activities. Of the 99 indirect technical procedures of high complexity interrupted, the main activities were: scheduling of medications (68) and closing the water balance (28). The interruptions that occurred in these activities could result in errors such as: incorrect scheduling of medications, failure to recognize inaccuracies in the prescriptions, loss of information or lack of correct verification in the closing of the water balance, failure to detect changes that occurred with the patient during the shift, delaying or preventing necessary interventions.

The scheduling of medications is the moment when the nurse must be attentive, to avoid drug interactions (common cause of adverse effects) and to detect possible inaccuracies in prescriptions, such as dose, medication discontinuity, among others[46].

In closing and checking the water balance, the nurse can assess hemodynamic changes that have occurred with the patient, administered medications, hydration and infused solutions, urine output, blood glucose, among other detectable complications. Adequate annotation in the water balance is essential for making therapeutic and care decisions, using its results in clinical nursing practice[47].

We identified 87 direct technical procedures of high complexity interrupted: medication administration (46), bedside care (17), physical examination (8), examination collection (9), alarm service (3), patient admission (2), installation of blood products (2).

Interruptions in these activities could cause errors in the administration of medications and in the installation of blood products, errors in bedside care, physical examination, attending to the alarm, patient admission, as changes would not be recognized, preventing interventions. Interruptions in the collection of the examination would result in an error in patient identification, type of examination.

Studies have investigated the significant association of medication errors with interruptions, looking for strategies to abolish or minimize interruptions during the process, especially during administration, considered the most vulnerable stage to errors in the presence of interruptions[17,48].

Research on medication administration found that each interruption was associated with an increase of 12.1% in failures in the procedure (hand hygiene, lack of disinfection of the connections, etc.), 12.7% of administration errors (type of medication, dose, route, time, dilution, infusion, etc.) and the severity of the error increased according to the frequency of interrupting events[14].

In care management, we enumerate 49 interrupted high-complexity activities: conference of medicines from the pharmacy (35), shift change (8), conference of material for the laboratory (6). In these activities, the interruptions would be able to result in the exchange of drugs, lack of items, separation of the wrong dose of drugs, error in the material sent to the laboratory, incomplete information in the handover, caused by lapses in the nurses' memory, leading to errors related to this activity. Furthermore, the adequate exchange of information prevents interruptions after the shift between professionals due to lack or incomplete data[49].

With these results, we demonstrate the increased risk of errors occurring from interruptions in primary activities of high complexity, considering the cognitive demands for attention and memory at these times and their limitations.

Regarding the cognitive implications of interruptions, what happens is that when individuals are interrupted, their attention is diverted from the primary (or initial) task to perform another task. Once this shift in attention occurs, the memory of the primary task has a decline to trigger the necessary cognitive processes and skills to deal with the new task. Thus, when the primary task is restarted, the individual may not remember that part of the task has been completed. The amount of memory loss from the primary task depends on the characteristics and degree of complexity of the tasks, the more complex the tasks and the longer the duration, the more harmful to cognitive processes. Therefore, when an individual's attention is shifted from the initial task, the likelihood of an error occurring on returning to the primary task is increased[12,17,25].

Faced with interruptions, the individual may remember to return to the initial task, however, some of the steps may be omitted or repeated, as it takes some time for

the memory to adjust to the phase of the task that was before the interruption. In addition, given the complexity of the tasks, individuals may not spend the necessary time to adapt their memory, predisposing to the occurrence of errors (slips, lapses, mistakes) and omissions. Once interrupted, a worker can take 15 to 20 minutes to return to primary activity effectively, seen in part, to the limitations of memory[5,12,17,25].

In this investigation, there was little difference in the number of interruptions between the morning (morning) and afternoon (afternoon) periods, however the interruptions coincided with the hours of higher volume of procedures in the unit, moments in which the nurse is very requested by the other members of the team. team and consequently more interrupted.

The main source of interruption identified was the nursing team (due to patient demands, inputs, whether materials or medicines and the unit's work process), with 174 events (48.47%), followed by an identified problem (related to patients, medical prescriptions, supplies, unit environment) with 39 observations (10.86%), medical staff 26 events (7.24%), personal activities 25 (6.96%), alarms 20 (5.57%).

The nursing team was also the main source of interruption in the two national studies carried out in university hospitals[20,39], which can be explained by the division of nursing work in Brazil, as the team of nursing technicians who work under the coordination and planning of nurse's requests information, guidance, provision of materials and medicines for the development of nursing care, for this reason, would be the most frequent source.

However, as the study site is a teaching hospital, the on-duty nurse has assistance and preceptorship activities, so the nursing team includes other nurses, nursing technicians, residents, students, nursing teachers. Furthermore, this result is linked to secondary activities generated from the interruptions: problem solving, patient assessment, bedside care, informing / guiding, providing material / medication, having been the nurse on most of these occasions triggered by the team nursing.

Health professionals are not yet aware of the impact of interruptions on their colleagues while performing more complex activities and, consequently, on patient safety. Thus, it is necessary to adopt mitigation strategies and awareness and education of professionals about the cognitive repercussions of interruptions and when they should or should not be avoided[48].

We elaborated the source of interruptions "identified problem", based on our field observation, to quantify situations in which the nurse interrupted his primary activity, moving to solve problems detected by him, related to the patient, whether in the managerial sphere, therapeutic or assistance, such as inaccuracies in prescriptions, issues with medications, exams, obtaining information.

In this circumstance, we highlight the source of interruptions "patient instability", being initiated by the nurse for evaluation and possible intervention, in view of the patient's worsening, which is part of the duties and skills of intensive care nurses.

In intensive care, nursing is the last barrier in the prevention of failures, a reason that puts them in a position to act actively to minimize the occurrence of errors. Therefore, cognitive function is a crucial resource for intensive care nurses, as it relates to the prevention, interception, and correction of possible errors in the care of critical patients[40,43].

The cognitive work of intensive care nurses occurs in response to the continuous changes, priorities and needs of critically ill patients, the professional's work style and the unit's environmental conditions, in which nurses constantly organize and reorganize care activities to accommodate the fluctuating clinical state. of patients. In this perspective, interruptions and the successive exchange of activities carried out by nurses, due to cognitive requirements, are barriers to workflow, critical thinking and decision making, considering the unpredictability of nursing work in therapy intensive, imposed by the clinical instability of the patients[7,23,24].

As a source of interruptions, the medical team, resident physicians, and other health professionals, are due to the fact of the close relationship between professionals in intensive care with the nurse, given the constant complications, interventions, and procedures in view of the patients' needs and severity. In addition, members of the nursing and multiprofessional team often use interruptions to facilitate their work, activating the nurse[3,20].

The 359 interruptions generated 359 secondary activities, mostly of medium complexity, the most frequent being: informing / guiding (182), problem solving (39), providing material / medication (38), evaluating patient (37). These results show that the activities resulting from interruptions increased the participants' workload by approximately 60%. Regardless of the duration and complexity, the fact is that interruptions have generated new activities.

Informing / guiding was the secondary activity with the highest occurrence in our investigation. During tasks that require attention, interruptions should be limited to those that are clearly necessary, essential, and positive for the patient care process, in this case providing information and guidance to health professionals are not negative interruptions, but necessary to care[11-13].

The review found that interruptions were, in most cases, initiated by professionals to obtain information, request assistance, ask questions about the patient, request supplies or deal with personal matters[6].

Through continuous assistance, the intensive care nurse is considered the link between the various professionals and the patient, able to provide information about their evolution and changes, as a result, he is the most sought team member and consequently predisposed to a greater number of interruptions in their activities. In intensive care, the nurse's need to solve problems and emergency situations increases their susceptibility to interruption, in addition to causing this professional constant physical displacement[3,19].

Teams must be aware that the interruption is not part of the work, it should not be considered inherent, natural and an integral part of the work process, it can be a consequence and an alert that signals systemic, organizational, operational and process failures and restrictions of work, in addition to poor communication, deficit of material and human resources, with work overload, causing interference and imbalance in the performance and productivity of the team[48].

As in our study, the lack of material and equipment and the need to supply it has been cited as a source of interruption, spending nurses' time and delaying patient care, which could compromise their safety. These interruptions are preventable, therefore, improvement and organization actions must be established and adopted to reduce these events[9,10,39].

The bedside assessment of the patient appears among the secondary activities in our findings, which is one of the nurse's fundamental duties, in detecting complications, for possible necessary interventions, thus constituting a surveillance system in the face of changes in the patients' clinical conditions. However, problem solving, clinical reasoning and decision making are negatively influenced by the high number of patients under the care of this professional due to the poor dimensioning of human resources[23,24].

Among the main factors that interfere in the effects of the interruption with the probability of errors when restarting or resuming the primary task are: cognitive aspects of the individual (attention and work memory load); moment and duration of the interruption and interrupted activity; need for physical displacement of the professional; similarity between activities; use of the same cognitive mechanism and sensory stimulus between primary and secondary activity; characteristics and complexity of activities; practice and experience of the interrupted professional; interruption management / management; environmental factors. The effect of interruption in the main task is related to the similarity of the secondary task, because when the tasks are similar, they are likely to share the same cognitive mechanism and sensory stimulus of the professional, with similar objectives, thus there is a greater propensity for negative interference in performance of the main task when restarted[7].

We showed a significant percentage of primary and secondary tasks of high complexity, thus demonstrating the predisposition of the occurrence of errors in the resumption of the initial task, after the secondary activity, especially when both activities were overly complex and similar.

The interruptions recorded in this research lasted an average of 119.59 seconds / s (about 2 minutes), the shortest interruption time was 10s and the longest was 1800s (30 minutes).

In the first national study, the maximum interruption time was 7.9 min due to lack of supply and a minimum time 0.1 min from other sources[20]. In another national study, the interruption time ranged from less than 1 minute to 15 minutes[39].

We found that the average interruption time was relatively short, (about 2 minutes), however, references point out that even short interruptions, of just 10 seconds, can divert the professional's attention and thus lose concentration, predisposing to errors, because human beings only take 10 to 40 seconds to forget what they were doing after experiencing an interruption[15,17,50].

In our observation, in 93% of the interruptive events, the nurses returned and completed the initial / primary activity, in comparison, another national study found that the nurse returned to the primary activity in 86.8% of the interruption cases[20].

Not resuming the initial activity or not completing it correctly are mentioned as the most common negative consequences associated with the interruption, with delays, errors or omissions, in addition to the accomplishment of multiple tasks. The return to the initial activity generates an increase in the cognitive load, as it requires the professional to resume thinking to continue the primary task, it takes time and can lead the professional to make mistakes, especially in overly complex activities[17].

Effective management of interruptions for patient safety in intensive care requires understanding the characteristics of the interruption, the context in which it occurs and its content, the 3 “C”, considering the complexity of the primary and secondary task in the errors[11].

Although interruptions in health care cannot be eliminated, considering that there are beneficial ones, authors cite some recommendations for safe practices to minimize them and create a safer environment for performing critical tasks, especially in intensive care. Among them, we mention: adequately configuring alarm parameters of medical assistance equipment; minimize the noise of unnecessary conversations; correct systemic, organizational, operational and work process failures that lead to avoidable interruptions; prioritize tasks; educating the team about the repercussions of interruptions on complex tasks, and how to deal with them; adequate preparation of material and documents before performing tasks and procedures; use checklists, cues and reminders for checking during long tasks and resuming interrupted activity[7,17,25,50].

In relation to the medication process, there were initiatives such as: use of vests or aprons by the professional to show that they should not be interrupted and the adoption in the units of the non-interruption zone (no interruption zone or red zone) areas delimited in red in strategic locations to inhibit interruptions; double checking of schedules and in the preparation of high surveillance medications has also been suggested[7,17,25,50].

All recommendations with the purpose of minimizing interruptions and their repercussions on professionals and patient safety depend on the support of managers and the participation and involvement of the team, in addition to the appropriate dimensioning of professionals, to prevent overload of work and multitasking.

Conclusion

We demonstrated that interruptions were frequent in the primary activities of the participating nurses, predominantly in overly complex activities, whether in indirect or direct technical procedures, related to the process involving medication and bedside care. In the case of more complex activities, there is a greater predisposition to errors, given the cognitive requirements in their execution, thus compromising patient safety.

There was no difference in the number of interruptions between the morning and afternoon periods, however the interrupting events occurred particularly during the procedure times with the patient, which denotes how much the nurse is requested by the team in these situations.

The main source of interruption was the nursing team, due to patient demands, inputs, the work process at the unit; followed by the identified problem source, these problems being pertinent to patients, medical prescriptions, supplies, unit environment. This result indicates that systemic, organizational, and operational failures and restrictions led to interruptions and, consequently, secondary activities, for the provision of supplies or problem solving by nurses.

As the study site is a university hospital, where the nurse on duty has assistance and preceptorship activities, the source of the nursing team included other nurses, nursing technicians, residents, students, nursing teachers. Therefore, the profile of the institution must be considered in the analysis of the phenomenon of interruptions and its repercussions.

The noise levels found in the unit were above that recommended by the literature and standardization bodies, which can cause health problems for nursing workers, in addition to the losses in the recovery of hospitalized patients. In addition, environmental noise is described as an aggravating factor to the cognitive effects of interruptions, negatively impacting the work process, expanding the complexity of activities, exposing the group to risks of accidents and errors in the performance of its activities.

The data related to the characterization of patients, considering the NAS values obtained, reflect the high workload in the unit, which combined the interruptions and the need to perform secondary tasks considerably increase the nurses' workload, sometimes already strenuous.

The description of the secondary activities resulting from the interruptions, confirm the importance of the nurse as a protagonist in the exchange of information and guidance with the team, so beneficial to care, a fundamental role in patient safety goals about effective communication. However, this role requires high cognitive demands, given the complexity and amount of information processed, which can be particularly harmful to the professional's performance, in view of the constant needs of patients, unpredictability, multiplicity of tasks, environmental stimuli experienced by nurses in intensive care.

Recognizing that human error is, in most cases, the result of a combination of individual and systemic factors, in the case of interruptions, the ideal is to distinguish the obstacles of the systems and work processes that produce them. Thus, the results presented allowed to identify some systemic, organizational, and operational flaws and restrictions that trigger interruptions, bringing elements that enable interventions and strategies to minimize them, with positive repercussions on patient and professional safety.

As limitations of the study, we assume the possibility of the Hawthorne effect in some circumstances, where the presence of the researcher can modify and influence the participant's behavior, however, although the nurses were aware of the observation, the other professionals involved were not aware of our objectives, which may have minimized the effect on our sample. In addition, the fact that it was developed in a unit, involving a specific population, may limit the findings regarding its generalization, however, we highlight the ecological validity of the research, as well as the rigor in the methodological procedures.

The science of interruption is becoming increasingly important in the search for safer and more effective health care, as its impact becomes increasingly evident. As we unveil the complexity that exists between the health work process, its care spaces and human cognition, we will not only understand the interruption and its repercussions, but much more about patient safety.

References

1. Nightingale F. Ruídos In: Notas sobre a Enfermagem: o que é e o que não é. Tradução de Amália Correa de Carvalho. 1. ed. Ribeirão Preto S.P.: Cortez, ABEN-CEPEN; 1989. p.58.
2. McGinley P. Studies and Strategies to Reduce Interruptions and Improve Care. Patient Safety & Quality Healthcare-PSQH [Internet]. 2010 [acesso em 07 nov 2016];24. Disponível em: http://www.psqh.com/analysis/distractions-and-interruptions-impact-on-nursing/
3. Rivera J. A socio-technical systems approach to studying interruptions: Understanding the interrupter's perspective. Applied Ergonomics [Internet]. 2014 [acesso em 14 nov 2016];45:747-56. Disponível em: https://pdfs.semanticscholar.org/0d78/e8455160219767ed3462f494ee62cbc040a4.pdf
4. Pape TM. Applying airline safety practices to medication administration. Medsurg Nurs [Internet]. 2003 [acesso em 27 nov 2016];12(2):77-93. Disponível em: https://www.ncbi.nlm.nih.gov/pubmed/12736927
5. Brogan J. Constant distractions can take a toll. The Boston Globe [Internet]. 2012 [acesso em 12 out 2016]. Disponível em: http://archive.boston.com/lifestyle/health/articles/2012/02/27/constant_distractions_can_take_a_toll/?page=2

6. Brixey JJ, et al. A concept analysis of the phenomenon of interruption. Advances in Nursing Science [Internet]. 2007 [acesso em 01 ago 2013];30(1):E26-E42. Disponível em: http://journals.lww.com/advancesinnursingscience/pages/articleviewer.aspx?year=2007&issue=01000&article=00012&type=abstract
7. Li YW, Magrabi F, Coeira E. A systematic review of the psychological literature on interruption and its patient safety implications. J Am Med Inform Assoc [Internet]. 2012 [acesso em 30 ago 2013];19(1):6-12. Disponível em: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3240749/pdf/amiajnl-2010-000024.pdf
8. Kalisch BJ, Aebersold M. Interruptions and multitasking in nursing care. Jt Comm J Qual Patient Saf [Internet]. 2010 [acesso em 27 nov 2016];36(3):126-32. Disponível em: https://www.researchgate.net/Playstation/42253476_Interruptions_and_multitasking_in_nusing_care
9. Tucker AL, Spear SJ. Operational Failures and Interruptions in Hospital Nursing. HSR: Health Services Research [Internet]. 2006 [acesso em 22 jun 2015];41(3):643-62. Disponível em: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1713207/pdf/hesr041-0643.pdf
10. Monteiro C, Avelar AFM, Pedreira MLG. Interrupções de atividades de enfermeiros e a segurança do paciente: revisão integrativa da literatura. Rev. Latino-Am. Enfermagem [Internet]. 2015 jan./fev. [acesso em 25 jun 2015];23(1):169-179. Disponível em: http://www.scielo.br/pdf/rlae/v23n1/pt_0104-1169-rlae-23-01-00169.pdf
11. Sasangohar F, et al. Interruptions experienced by cardiovascular intensive care unit nurses: An observational study. J Crit Care [Internet]. 2014 [acesso em 27 nov 2016];29(5):848-53, 2014. Disponível em: https://www.researchgate.net/publication/263315586_Interruptions_Experienced_by_Cardiovascular_Intensive_Care_Unit_Nurses_An_Observational_Study
12. Rivera AJ, Karsh BT. Interruptions and distractions in healthcare: Review and reappraisal. Quality & Safety in Health Care [Internet]. 2010 [acesso em 31 jul 2013];19(4):304-312. Disponível em: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3007093/pdf/nihms249161.pdf
13. Hall LMcG, et al. Going blank: Factors contributing to interruptions to nurses' work and related outcomes. J Nurs Manag [Internet]. 2010 [acesso em 08 nov 2016];18(8):1040–7, 2010. Disponível em: http://onlinelibrary-wiley-com.ez83.periodicos.capes.gov.br/doi/10.1111/j.1365-2834.2010.01166.x/abstract;jsessionid=50E0CC0340F3E271E24EC150367D86E8.f04t04
14. Westbrook JI, et al. The impact of interruptions on clinical task completion. Qual Saf Health Care [Internet]. 2010 [acesso em 30 nov 2016];19(4):284-9. Disponível em: https://www.ncbi.nlm.nih.gov/pubmed/20463369
15. Grundgeiger T, et al. Interruption Management in the Intensive Care Unit: Predicting Resumption Times and Assessing Distributed Support. Journal of Experimental Psychology: Applied [Internet]. 2010 [acesso em 08 nov 2016];16(4):317–334. Disponível em: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.380.7184&rep=rep1&type=pdf
16. Grundgeiger T, et al. Distractions and Interruptions in the Intensive Care Unit: A Field Observation and a Simulator Experiment. PROCEEDINGS of the HUMAN FACTORS and ERGONOMICS SOCIETY 54th ANNUAL MEETING [Internet]. 2010 [acesso em 12 out 2016];835-839. Disponível em: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.380.7184&rep=rep1&type=pdf
17. Grundgeiger T, Sanderson P. Interruptions in healthcare: Theoretical view. International Journal of Medical Informatics [Internet]. 2009 [acesso em 31 jul 2013];78(issue 5):293-307. Disponível em: http://www.ijmijournal.com/article/S1386-5056%2808%2900179-2/abstract
18. Feil M. Distractions and Their Impact on Patient Safety. Pennsylvania Patient Safety Advisory [Internet]. 2013 [acesso em 05 nov 2016];10(1). Disponível em: https://www.researchgate.net/publication/237154749_Distractions_and_Their_Impact_on_Patient_Safety
19. Monteiro C. Interrupções de atividades realizadas por enfermeiros de um hospital universitário: implicações para a segurança do paciente. São Paulo, 2013. 117 f. Dissertação (Mestrado) - Programa de Pós-graduação em Enfermagem - Escola Paulista de Enfermagem - Universidade Federal de São Paulo [Internet]. São Paulo, 2013 [acesso em 25 jun 2015]. Disponível em: https://repositorio.unifesp.br/handle/11600/47410
20. Monteiro C, Avelar AF, Pedreira ML. Interrupções de atividades de enfermeiros: contribuições para a segurança do paciente e do profissional. Acta Paul Enferm. 2020;33:1-10. http://dx.doi.org/10.37689/acta-ape/2020AO0042.
21. Reason J. Human error: models and management. Brit Med J [Internet]. 2000 [acesso em 12 out 2016];320:768-70. Disponível em: http://www.galliera.it/20/58/strutture-e-servizi-in-staff-alla-direzione-sanitaria/ugr/documenti/pubblicazioni/risk_12.pdf
22. Ebright PR, et al. Understanding the complexity of registered nurse work in acute care settings. The Journal of Nursing Administration-JONA [Internet]. 2003 [acesso em 12 out 2016];33(12):630–8. Disponível em: https://www.researchgate.net/publication/8967749_Understanding_the_Complexity_of_Registered_Nurse_Work_in_Acute_Care_Settings
23. Potter P, et al. An Analysis of Nurses' Cognitive Work: A New Perspective for Understanding Medical Errors. Advances in Patient Safety: From Research to Implementation (Research Findings). Rockville (MD): Agency for Healthcare Research and Quality (US) [Internet]. 2005 [acesso em 16 set 2014];1:39-50. Disponível em: https://www.ncbi.nlm.nih.gov/books/NBK20475/pdf/Bookshelf_NBK20475.pdf
24. Potter P, et al. Understanding the cognitive work of nursing in the acute care environment. Journal of Nursing Administration – JONA [Internet]. 2005 [acesso em 18 ago 2013];35(7-8):327-335. Disponível em: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.78.3548&rep=rep1&type=pdf
25. Institute for Safe Medication Practices (ISMP). Sidetracks on the safety express. Interruptions lead to errors and unfinished… Wait, what was I doing? Institute for Safe Medication Practices/ISMP [Internet], 2012 [acesso em 07 nov 2016]. Disponível em: https://www.ismp.org/newsletters/acutecare/showarticle.aspx?id=37
26. Conishi RMY, Gaidzinski RR. Nursing Activities Score (NAS) como instrumento para medir carga de trabalho de enfermagem em UTI adulto. Rev Esc Enferm USP [Internet]. 2007 [acesso em 15 set 2011];41(3):346-54. Disponível em: http://www.scielo.br/pdf/reeusp/v41n3/02.pdf
27. Silva Junior JM, et al. Aplicabilidade do Escore Fisiológico Agudo Simplificado (SAPS 3) em Hospitais Brasileiros. Revista Brasileira de Anestesiologia [Internet]. 2010 [acesso em 19 ago 2015];60(1):20-31. Disponível em: http://www.scielo.br/pdf/rba/v60n1/v60n1a03.pdf
28. Conover WJ. Pratical nonparametric statistics. 2. ed. Nova York: John Wiley; 1980. 493 p.

29. Bridi AC. Interrupções nas atividades de enfermagem em Terapia Intensiva: repercussões na atenção e memória dos enfermeiros. Rio de Janeiro, 2017. Tese (Doutorado) – Programa de Pós-Graduação em Enfermagem e Biociências – Universidade Federal do Estado do Rio de Janeiro [Internet]. Rio de Janeiro, 2017 [acesso em 20 jan 2020]. Disponível em: http://www.unirio.br/ppgenf/dissertacoes/dissertacoes-ppgenf-unirio-ano-2013/dissertacao-adriana-carla-bridi/view
30. Fundação Oswaldo Cruz, Conselho Federal de Enfermagem. Pesquisa Perfil da Enfermagem no Brasil. FIOCRUZ/COFEN [Internet], 2013 [acesso em 25 fev 2016]. Disponível em: http://rj.corens.portalcofen.gov.br/wpcontent/uploads/2015/08/Apresentacao_Perfil_RIO-DE-JANEIRO.pdf
31. Mascarello LJ. Memória de trabalho e processo de envelhecimento. Psic. Rev. São Paulo [Internet]. 2013 [acesso em 17 dez 2016];22(1):43-59. Disponível em: https://www.google.com.br/?gws_rd=ssl#q=decl%C3%ADnio+da+mem%C3%B3ria+com+o+envelheciemnto
32. Machado DA, Figueiredo NMA, Velasques LS, Bento CAM, Machado WCA, Viana LAM. Cognitive changes in nurses working in intensive care units. Rev Bras Enferm [Internet]. 2018 [acesso em 14 set 2018];71(1):73-9. Disponível em: https://www.scielo.br/pdf/reben/v71n1/pt_0034-7167-reben-71-01-0073.pdf
33. Fischer FM, et al. Percepção de sono: duração, qualidade e alerta em profissionais da área de enfermagem. Cad. Saúde Pública [Internet]. 2002 [acesso em 17 dez 2016];18(5):1261-1269. Disponível em: http://www.scielo.br/pdf/csp/v18n5/10998.pdf
34. Sampaio Neto RA, et al. Ruídos na unidade de terapia intensiva: quantificação e percepção dos profissionais de saúde. Rev Bras Ter Intensiva [Internet]. 2010 [acesso em 04 mai 2016];22(4):369-374. Disponível em: http://rbti.org.br/artigo/detalhes/0103507X-22-4-10
35. Macedo ISC, et al. Avaliação do ruído em Unidades de Terapia Intensiva. Braz J Otorhinolaryngol [Internet]. 2009 [acesso em 04 mai 2016];75(6):844-6. Disponível em: http://www.scielo.br/pdf/bjorl/v75n6/v75n6a12.pdf
36. Ministério da Saúde, Agência Nacional de Vigilância Sanitária (BR) Resolução - RDC n.º 26 de 11 de maio de 2012. Brasília (DF): MS/ANVISA [Internet], 2012 [acesso em 12 out 2012]. Disponível em: ftp://ftp.saude.sp.gov.br/ftpsessp/bibliote/informe_eletronico/2012/iels.mai.12/Iels90/U_RS-MS-ANVISA-RDC-26_110512.pdf
37. Santos TL, Nogueira LT, Padilha KG. Produção científica brasileira sobre o Nursing Activities Score: uma revisão integrativa. Cogitare Enferm [Internet]. 2012 [acesso em 07 mar 2016];17(2):362-8. Disponível em: http://ojs.c3sl.ufpr.br/ojs/index.php/cogitare/article/view/21097/18556
38. Magalhães AMM, Dall'Agnol CM, Marck PB. Carga de trabalho da equipe de enfermagem e segurança do paciente - estudo com método misto na abordagem ecológica restaurativa. Rev. Latino-Am. Enfermagem [Internet]. 2013 [acesso em 20 jan 2017];21(Spec):09 telas. Disponível em: http://www.scielo.br/pdf/rlae/v21nspe/pt_19.pdf
39. Prates DO, Silva AEBC. Interruptions of activities experienced by nursing professionals in an intensive care unit. Rev. Latino-Am. Enfermagem [Internet]. 2016 [acesso em 14 out 2016];24(Esp):2802-09. Disponível em: http://www.scielo.br/pdf/rlae/v24/pt_0104-1169-rlae-24-02802.pdf
40. Harada MJCS, Pedreira MLG. O erro humano e sua prevenção In: Ministério da Saúde, Agência Nacional de Vigilância Sanitária, ANVISA Assistência Segura: Uma Reflexão Teórica Aplicada à Prática [Internet]. 1. ed., 2013 [acesso em 12 out 2016]. p. 40-55. Disponível em: http://www20.anvisa.gov.br/segurancadopaciente/images/documentos/livros/Livro1-Assistencia_Segura.pdf
41. Brixey J, et al. Towards a Hybrid Method to Categorize Interruptions and Activities in Healthcare. Int J Med Inform [Internet]. 2007 [acesso em 26 jun 2017];6(11-12):812 -20. Disponível em: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2211388/pdf/nihms33977.pdf
42. Conselho Federal de Enfermagem (COFEN). Decreto n.º 94.406/87, Lei n.º 7.498/86. Dispõe sobre o exercício da Enfermagem, e dá outras providências. Brasília (DF): COFEN [Internet], 1986/87 [acesso em 12 out 2012]. Disponível em: http://www.cofen.gov.br/categoria/legislacao/resolucoes
43. Elfering A, Grebner S, Ebener C. Workflow interruptions, cognitive failure, and near-accidents in health care. Psychol Health Med [Internet]. 2015 [acesso em 26 nov 2016];20(2):39-47. Disponível em: https://www.ncbi.nlm.nih.gov/pubmed/24787909
44. Redding DA, Robinson S. Interruptions and geographic challenges to nurses' cognitive workload. Journal of Nursing Care Quality [Internet]. 2009 [acesso em 29 ago 2013];24(3):194-200, 2009. Disponível em: http://interruptions.net/literature/Redding-JNursCareQual09.pdf
45. Hopkinson SG, Jennings BM. Interruptions during nurses' work: A state-of-the-science review. Research in Nursing & Health [Internet]. 2013 [acesso em 31 jul 2013];36(1):38-53, 2013. Disponível em: http://onlinelibrary.wiley.com/doi/10.1002/nur.21515/pdf
46. Secoli SR. Interações medicamentosas: fundamentos para a prática clínica da enfermagem. Rev Esc Enferm USP [Internet]. 2001 [acesso em 03 jan 2017];35(1):28-34. Disponível em: http://www.scielo.br/pdf/reeusp/v35n1/v35n1a04.pdf
47. Oliveira SKP, Guedes MVC, Lima FET. Balanço hídrico na prática clínica de enfermagem em Unidade Coronariana. Rev. Rene [Internet]. 2010 abr./jun. [acesso em 27 ago 2020];11(2):112-120. Disponível em: http://periodicos.ufc.br/rene/article/view/4537/3417
48. Raban MZ, Westbrook JI. Are interventions to reduce interruptions and errors during medication administration effective? a systematic review. BMJ Qual Saf [Internet]. 2013 [acesso em 17 ago 2016];1-8. Disponível em: http://qualitysafety.bmj.com/content/early/2013/08/26/bmjqs-2013-002118.full.pdf
49. Beccaria LM, Meneguesso B, Barbosa TP, Pereira RAM. Interferências na passagem de plantão de enfermagem em unidade de terapia intensiva. CuidArte Enferm [Internet]. 2017 [acesso em 02 set 2020];11(1):86-92. Disponível em: http://www.webfipa.net/facfipa/ner/sumarios/cuidarte/2017v1/12%20Artigo%20Interfer%C3%AAncias%20na%20passagem%20de%20plant%C3%A3o%20UTI.pdf
50. Parker J, Coiera E. Improving clinical communication: a view from psychology. J Am Med Inform Assoc [Internet]. 2000 [acesso em 23 jan 2017];7(5):453-61. Disponível em: http://www.interruptions.net/literature/Parker-JAMIA00.pdf