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Attention and memory of intensive care nurses: repercussions on patient safety

Atención y memoria del enfermero de cuidados intensivos: repercusiones en la seguridad del paciente

Atenção e memória de enfermeiros intensivistas: repercussões na segurança do paciente

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Abstract

The aim was to measure the scores of the cognitive functions of attention and memory of intensive care nurses and to discuss their repercussions on patient safety. Quasi-experimental study using neuropsychological pre and post-tests in 10 intensive care nurses before and after their day shift. We found a reduction in the working memory score after duty (median 26.50 / mean 26.40), before (median 27.00 / mean 28.00), representing a 6% decrease. Considering 10% significance, the unilateral test of working memory was significant (p = 0.06), indicating a decrease in the score after shift in all participants. In the split attention tests (TEADI) after duty (median 167.00 / average 154.40), before (median 106.00 / average 110.40), an increase of 40% on average; alternate attention (TEALT), before duty (median 115.50 / average 109.00), after (median 124.00 / average 119.30), an increase of 9% on average. At 10% significance, bilateral tests were significant (TEADI p = 0.002; TEALT p = 0.009), indicating a difference in the scores before and after the shift. We observed an increase in the nurses' attention scores at the end of the shift, justified by facing problem situations along the journey, raising their attention levels. On the other hand, there was a decrease in the working memory score, associated with the multiple tasks performed and constant processing of new information during the shift, imposing high demands on memory.

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

Resumén

El objetivo fue medir los puntajes de las funciones cognitivas de atención y memoria de enfermeras de cuidados intensivos y discutir sus repercusiones en la seguridad del paciente. Estudio cuasiexperimental mediante pre y postest neuropsicológicos en 10 enfermeras de cuidados intensivos antes y después de su turno diurno. Encontramos una reducción en la puntuación de la memoria de trabajo después del trabajo (mediana 26,50 / media 26,40), antes (mediana 27,00 / media 28,00), lo que representa una disminución del 6%. Considerando el 10% de significancia, la prueba unilateral de memoria de trabajo fue significativa (p = 0.06), lo que indica una disminución en la puntuación después del cambio en todos los participantes. En las pruebas de atención dividida (TEADI) después del servicio (mediana 167,00 / promedio 154,40), antes (mediana 106,00 / promedio 110,40), un aumento del 40% en promedio; atención alterna (TEALT), antes del deber (mediana 115,50 / promedio 109,00), después (mediana 124,00 / promedio 119,30), un aumento del 9% en promedio. Al 10% de significación, las pruebas bilaterales fueron significativas (TEADI p = 0,002; TEALT p = 0,009), lo que indica una diferencia en las puntuaciones antes y después del turno. Observamos un aumento en los puntajes de atención de las enfermeras al final del turno, justificado al enfrentar situaciones problemáticas a lo largo del viaje, elevando sus niveles de atención. Por otro lado, hubo una disminución en la puntuación de la memoria de trabajo, asociada a las múltiples tareas realizadas y al procesamiento constante de nueva información durante el turno, imponiendo altas exigencias a la memoria.

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

Resumo

Objetivou-se medir os escores das funções cognitivas de atenção e memória de enfermeiros intensivistas e discutir suas repercussões na segurança do paciente. Estudo quase-experimental mediante aplicação de pré e pós-testes neuropsicológicos em 10 enfermeiros intensivistas antes e após seu plantão diurno. Constatamos redução do escore da memória de trabalho após plantão (mediana 26,50/média 26,40), antes (mediana 27,00/média 28,00), representando 6% de decréscimo. Considerando 10% de significância o teste unilateral da memória de trabalho foi significativo (p=0,06), indicando diminuição do escore após plantão em todos os participantes. Nos testes de atenção dividida (TEADI) após plantão (mediana 167,00/média 154,40), antes (mediana 106,00/média 110,40), aumento de 40% na média; atenção alternada (TEALT), antes plantão (mediana 115,50/média 109,00), após (mediana 124,00/média 119,30), aumento de 9% na média. A 10% de significância os testes bilaterais foram significativos (TEADI p=0,002; TEALT p=0,009), indicando diferença dos escores antes e depois do plantão. Observamos aumento dos escores de atenção dos enfermeiros ao final do plantão, justificado pelo enfrentamento de situações problema ao longo da jornada, elevando seus níveis atencionais. Em contrapartida, houve decréscimo do escore da memória de trabalho, associado às múltiplas tarefas realizadas e constante processamento de novas informações durante seu turno, impondo elevadas demandas à memória.

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

Introduction

The provision of nursing care in intensive care requires a series of skills and abilities of professionals, in addition to physical, emotional, and cognitive abilities.

The term cognition has been used to designate all the processes and structures that relate to the acquisition of knowledge. Cognitive processes refer to the procedures we use to add new knowledge and make decisions based on that knowledge. The different cognitive functions such as: memory, attention, language, perception, and executive functions (reasoning, logic, strategies, decision making and problem solving), play a role in these processes. It is from the relationship between all these functions that we understand most behaviors, from the simplest to the most difficult situations, and which require more elaborate brain activities[1].

Results of studies demonstrate that the work of nurses, especially in critical areas, imposes high demands and cognitive changes, with high demands for attention and memory, which is due to the complexity and the large amount of information that must continuously be processed for the serious patient care[2-6].

The intensive care nurse organizes and performs care activities in response to changes in patients' clinical conditions and needs. In such an environment, clinical decisions must be made continuously to ensure that patient care is adequate, effective and safe[3-6].

Admittedly, the nursing team plays a fundamental role in promoting and guaranteeing patient safety, since it assists the patient directly and permanently. Therefore, as dynamic participants in these actions, it is necessary and justifiable to investigate the conditions and complexities of the process and the work environment in which nurses work and which can compromise patient safety[7].

Understanding the demands and cognitive changes of these professionals offers a new perspective for the analysis of conditions that generate risk for errors (slips, lapses, mistakes) and omissions in care[3-6].

Therefore, in view of the above, the objective of this study was to measure the scores of the cognitive functions of attention and memory of intensive care nurses and to discuss their repercussions on patient safety.

Methodology

The study had characteristics of a quasi-experiment with pre and post-tests in a single group. The study site was a 10-bed adult intensive care unit in a university hospital in Rio de Janeiro.

Data collection took place in January 2016 and was carried out through the application of neuropsychological tests by a psychologist (testing specialist), on 10 nurses on duty in the day service, before and after their work shift.

The inclusion criteria for the sample were established with the professionals' acceptance to participate in the research, work in the day service with a 12-hour working day and be involved in the care and management activities of patients admitted to the unit.

Neuropsychological tests duly validated according to the international guidelines of the Standards for Educational and Psychological Testing[8-12], were indicated, applied, and analyzed by the psychologist and research assistant who participated in the study, as recommended by the Federal Council of Psychology (CFP).

The tests were applied by the psychology professional with each participant individually, in a reserved room at the place of study, at the beginning and at the end of their respective day shift, on 10 different days, with the 10 participants, who took on average between 20 to 30 minutes for each test.

To assess attention, the divided attention test (TEADI) and the alternate attention test were applied (TEALT)[8,9].

TEADI provides a measure of a person's ability to share attention, or the individual's ability to seek and deal with more than two stimuli simultaneously. TEALT assesses the subject's ability to focus attention at one stimulus, at another, or the ability to switch attention.

For the assessment of memory, the Brief Neuropsychological Assessment Instrument was applied – Neupsilin[10-12].

Neupsilin provides a brief overview of the individual's cognitive status, with tasks capable of assessing different cognitive functions, in different situations and populations. In our study, we evaluated the functions of working memory, episodic-semantic verbal memory (immediate, late recall, recognition), long-term semantic memory, prospective memory.

The working memory has the function of saving the necessary information for a task, its duration depends on the time of this task. As it needs to archive different data at the same time, since tasks require several cognitive resources, working memory has a strong attentional content[10].

Episodic-semantic verbal memory was assessed through immediate recall, delayed recall, recognition. In evocation we have the update of the fixed data that depends on the established relationships; in recognition we detect where and when a certain event happened in time and space. Episodic memory refers to experienced events; semantics to facts stored in verbal form through knowledge[10].

Long-term semantic memory relates to facts that are stored more permanently and that require acquired knowledge. Prospective memory refers to remembering a previously planned action intention[10]. The reference values of the tests are shown in Chart 1

Chart 1. Reference values of the applied tests - minimum and maximum scores, maximum time of accomplishment. Rio de Janeiro, RJ, Brazil, 2017

Neuropsychological tests of attention and memory	Reference values Score (minimum / maximum)	Maximum time to perform the test
TEADI	0 to 180	5 minutes

TEALT	0 to 130	2 minutes and 30 seconds
Working memory	0 to 38	Exempt
Semantic episodic verbal memory - immediate recall	1 to 9	Exempt
Episodic-semantic verbal memory - late evocation	0 to 9	Exempt
Episodic-semantic verbal memory - recognition	1 to 18	Exempt
Long-term semantic memory	1 to 5	Exempt
Prospective memory	0 to 2	Exempt

Note: TEADI: Split attention test, TEALT: alternate attention test.
Source: Bridi[13].

To describe the characteristics of the sample and for correlation tests, demographic and other variables of interest related to the participants were investigated.

To characterize the noise levels of the study site: we measure the decibels (dB) of the unit (using a digital decibel meter), we count the number of individuals present (passers-by and professionals) and the number of alarms of medical assistance equipment (EMA) that sounded during the production of the data.

To characterize patients admitted to the unit, we raised the value of the Nursing Activities Score-NAS, which measures the nursing workload and the prognostic score Simplified Acute Physiology Score 3-SAPS *3*[14,15].

Through non-participant observation, where there is no involvement with the investigated scenario, we accompany all participants during their respective shifts regarding the occurrence of interruptions in their primary activities (totaling 120 hours of observation).

Except for neuropsychological tests, the other information and scores were collected and calculated by the main researcher.

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 a p-value equal to or less than 5% of significance were considered significant and significant cases of 10% were discussed (acceptable for smaller samples)[16]. Recalling that 0.05 represents a 5% significance level; 0.1 represents 10% significance level.

Thus, difference tests 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).

In addition, bilateral tests were used to assess whether there was a variation between before and after, whereas unilateral tests were used to assess significant decreases or increases in medians.

As limitations of the study, we assume the size of our sample, which may limit the findings regarding its generalization. However, we highlight the rigor in the methodological procedures and the ecological validity of the results of the neuropsychological tests of this investigation, since they were applied in the intensive care environment, representing the real demands of the participants, different from the measurements in the laboratory, in an artificial situation.

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

Participating nurses and those responsible for hospitalized patients during data production received verbal and written guidance, were instructed on the objectives of the study, and signed the Informed Consent Form (ICF). We obtained authorization from everyone involved.

All research costs were borne by the principal researcher.

This article was extracted from the Doctoral thesis entitled: Interruptions in nursing activities in Intensive Care: repercussions in the attention and memory of nurses presented to the Postgraduate Program in Nursing and Biosciences (PPGENFBIO) - Doctorate - from the Federal University of the State of Rio de Janeiro (UNIRIO).

Results

The 10 participating nurses had a mean age of 31 years, median of 27 years (ranging from 25 to 48 years), a male. Three participants were married and 1 had children.

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.

The participants' average sleep per night was 5 hours and 24 minutes, median 5 hours and 30 minutes.

The average travel time to work was 76 minutes, and most subjects used public transport (7), one (1) went on foot and two (2) by car.

Participants did not report use of psychotropic drugs.

None of the participants at the time of applying the tests and observation was coming from another duty, that is, they came from their homes in the pre-test and did not exceed 12 hours of shift in the post-test.

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

The mean 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. Minimum median 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).

As for the number of professionals during the data collection of the unit's fixed scale (considering belonging to a teaching hospital), we counted 1 nurse per shift responsible for 10 patients, the presence of 1 second year resident (R2), 2 or 3 first year residents (R1) and 5 nursing technicians, thus registering an average of 10 people per shift on the nursing team, with variations for a smaller number of professionals on duty.

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 (multi-parameter monitors).

Of the 630 primary activities performed by the participants, 359 were interrupted, resulting in a prevalence of interruptions of 0.57 (57%) in activities, an average of 35.9 interruptions per day, median of 30, SD 11.37 (10 days observation time). With 359 interruptions in 120 hours of observation, we have 3 interruptions per hour, 1 every 20 minutes. The 359 interruptive events generated 359 additional secondary activities, increasing the professionals' workload by 60%. There were 29 events where the professionals were interrupted simultaneously. The lowest number of interruptions experienced by nurses during a 12-hour shift was 23 events and the highest value was 57 interruptions in this period.

Regarding the results of the neuropsychological tests of Memory and Attention, in the values of the summary statistics presented in Table 1, we can notice a decrease in the working memory score after the shift, representing a 6% reduction. In the long-term semantic memory, there was no difference between the scores. In the prospective memory we observed a difference, with a slight increase of 6% after the shift. In episodic-semantic verbal memory, all scores increased after duty, immediate recall (15%), late recall (38%), recognition (14%).

The prospective memory and long-term semantic memory tests, despite having scales from 0 to 2 and 1 to 5 respectively, registered only two values in the results, reducing them to a dichotomous scale, making it impossible to apply inferential tests, even if not parametric. In these cases. Attention scores increased after the shift. In TEADI, the increase in score was 40% after the shift, in TEALT, by 9%.

Table 1. Statistics summary of attention and memory tests (before and after duty) per nurse / day. Rio de Janeiro, RJ, Brazil, 2017

	Before duty						After duty				
Variable	**Min.**	**Max.**	**Med.**	**Average**	**CV**		**Min.**	**Max.**	**Med.**	**Average**	**CV**
Memory											
Working memory	22	36	27,00	28,00	18,44		19	34	26,50	26,40	22,10
Prospective memory	1	2	2,00	1,80	23,42		1	2	2,00	1,90	16,64
Episodic-semantic verbal memory: Immediate recall	4	7	6,00	5,50	17,67		4	8	6,00	6,30	24,87
Episodic-semantic verbal memory: Late evocation	1	6	4,00	3,90	37,16		3	8	5,00	5,40	30,49
Episodic-semantic verbal memory: Recognition	13	17	14,50	14,80	9,45		15	18	17,00	16,80	6,15
Long-term semantic memory	4	5	5,00	4,90	6,45		4	5	5,00	4,90	6,45
Attention											
TEADI	82	157	106,00	110,40	19,87		110	179	167,00	154,40	16,54
TEALT	80	128	115,50	109,00	16,25		88	128	124,00	119,30	10,79

Note: n = 10; CV: Coefficient of variation; Med: median; TEADI: Split attention test, TEALT: alternate attention test.
Source: Bridi[13].

In Table 2, considering the memory tests and the caveats of not applying the tests in two cases (prospective memory and long-term semantics), as discussed, the following bilateral tests were significant: Late evocation p = 0, 05 and recognition p = 0.02, that is, they showed a significant difference in the score before and after the shift.

In relation to the unilateral test, at a level of 10% significance (p = 0.06), the unilateral test of working memory was significant, indicating that there was a decrease in the memory score after the shift.

Table 2. Wilcoxon tests to assess the memory score. Rio de Janeiro, RJ, Brazil, 2017

	Before			After			
Test / Variable	**Median**	**SD**		**Median**	**SD**	**Increment (%)**	**p-value**
Bilateral: H_1: $Med_{before} \neq Med_{after}$							
Working memory	27	5,16		26,5	5,83	-1,85	0,12
Prospective memory	2	0,42		2	0,32	0	*
Episodic-semantic verbal memory: Immediate recall	6	0,97		6	1,57	0	0,23
Episodic-semantic verbal memory: Late evocation	4	1,45		5	1,65	25,00	0,05
Episodic-semantic verbal memory: Recognition	14,5	1,40		17	1,03	17,24	0,02
Long-term semantic memory	5	0,32		5	0,32	0,00	*
Unilateral: H_1: $Med_{before} \neq Med_{after}$							
Working memory	27	5,16		26,5	5,83	-1,85	0,06
Prospective memory	2	0,42		2	0,32	0	*
Immediate recall	6	0,97		6	1,57	0	0,91
Late evocation	4	1,45		5	1,65	25,00	0,98
Recognition	14,5	1,40		17	1,03	17,24	0,99
Long-term semantic memory	5	0,32		5	0,32	0	*

Note: n = 10. * Binary response, making the test unfeasible; SD: Standard deviation; Increment = growth rate; Median before ≠ Median after.
Source: Bridi[13].

Considering the attention tests it is noted that the two bilateral tests were significant TEADI p = 0.002 and TEALT p = 0.009 (with a 10% level of significance), that is, they showed a significant difference in the score before and after the shift, as we see in Table 3. Regarding the unilateral test, none was significant.

Table 3. Wilcoxon tests to assess the attention score. Rio de Janeiro, RJ, Brazil, 2017

	Before			After			
Test / Variable	**Median**	**SD**		**Median**	**SD**	**Increment (%)**	**p-value**
Bilateral H1: $Med_{before} \neq Med_{after}$							
TEADI	106	21,94		167	25,54	57,55	0,002
TEALT	115,5	17,71		124	12,87	7,36	0,009
Unilateral H1: $Med_{before} > Med_{after}$							
TEADI	106	21,94		167	25,54	57,55	1
TEALT	115,5	17,71		124	12,87	7,36	0,997

Note: n = 10; TEADI: split attention test, TEALT: alternate attention test; SD: Standard deviation.
Source: Bridi[13].

Regarding the factors associated with the variation in memory and attention (the variation in the score of the tests before and after the shift being understood as variation), the test used was the Mann-Whitney (unpaired samples), to assess whether there was a significant difference between the profile strata of nurses subject to association analysis.

In working memory, the median was negative in all groups, indicating a decrease in the score of this variable: Age: <= 29 years (n = 6): -2.50,> 29 years (n = 4):

-3.0; Employment Links: 1 (n = 5): -2.0,> 1 (n = 5): -3.00; Travel time to work: Up to 1 hour (n = 5): - 4.0, More than 1 hour (n = 5): -1.00; Sleep Hours: Up to 5h (n = 5): - 3.0, More than 5h (n = 5): -1.00.

According to population characteristics (profile), there was no significant difference in the other tested memories.

In the case of attention tests, the only significant test, with a difference between the groups, was the TEADI, in the travel time to work: Up to 1 hour (n = 5), More than 1 hour (n = 5) with p -value 0.016.

According to population characteristics (profile), there was no significant difference in attention tests.

To analyze the factors related to the variation in memory and attention scores, the Spearman association test was used (n = 10).

We demonstrated that there is a significant association with the delayed recall memory score and the number of professionals, with a negative relationship (correlation -0.76, p = 0.011) and the recognition memory score and the number of interruptions (correlation 0, 71, p = 0.020). Recalling that, positive and significant relationship, the values are in the same direction, directly proportional to the relationship. The negative and significant relation, one value goes up and another goes down, inversely proportional to the relation.

It is worth noting that the working memory associated with interruptions showed a negative relationship (correlation -0.55 and p = 0.102), that is, in an approximate and borderline position at a level of 10% significance, in an inversely proportional relationship.

In reference to the attention tests, we highlight the association of the TEALT score and the number of interruptions, with a negative relationship (correlation -0.65, p = 0.041). The inversely proportional relationship between TEALT and interruptions shows that the greater the number of interruptions, the lower the alternating attention score value of the participants.

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. Your average sleep per night 5 hours and 24 minutes and commuting time 76 minutes.

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 aged 40 and over[17].

We must consider the effects of aging on nursing professionals, especially in intensive care, the continuous tension to which these professionals are subjected can lead to greater psychophysical and emotional stress, thus contributing to the reduction of attention, concentration and generate memory lapses, exposing them to possible errors, in addition to the risks to occupational diseases, stress and Burnout Syndrome[18].

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. There is no doubt that there is a need for the appropriate dimensioning of professionals, with adequate qualifications and work systems with structure and resources aimed at promoting patient safety[7].

In nursing, particularly in workplaces where there are important physical, emotional and cognitive demands, such as in intensive care, in addition to exposure to occupational stressors, issues of sleep, rest for professionals and weekly workload need to be reviewed by legislation and monitored by Organs competent bodies, as workers and patients in their care, may be harmed by the high workload performed by professionals[19,20].

Due to the low remuneration offered in the job market, mostly nursing professionals have two or more employment relationships as a compensatory form. Investigations conclude that the insufficient sizing of professionals, the lack of resources and conditions leading to overload of work and the excessive workload of nurses, are associated with increased incidents and risk of death for patients[21].

Data show how much sleep changes caused by shift work and / or excessive workload influence, among other occupational problems, the cognitive processes of health professionals, especially attention and memory, fundamental conditions for nurses to perform their nursing activities. effectively and safely[22,23].

The travel time of the participants in the present study was relatively high, more than 1 hour. Problems in urban mobility have a strong effect on the economy and quality of life of professionals, as they cause delays, less productivity and stress, because those who take an hour or two to get to work are fatigued, affecting their performance[24].

The average dB measured in the unit during observation was 59.19, the average of passers-by 14.43, of professionals 10 and the 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) indicates 40 dB by day and 30 dB by night[25,26].

We found that the noise levels measured were above the levels recommended by the standardization bodies, in all measurements. The number of alarms, passers-by and professionals contributed to the high dB value in the environment, due to the conversation and circulation of the team and passers-by and the noise from medical assistance equipment / EMA (technological noise).

These factors combined with the occurrence of successive interruptions tend to have a negative impact on the professionals' cognition, due to the number of consecutive hours of exposure to noise and the multiple tasks resulting from interruptive events.

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[25,26].

In the case of interruptions, we recorded a high number of interrupting events during our production of data involving participants. Evidence from studies shows that interruptions lead to cognitive implications for professionals, such as forgetfulness, lack of concentration, worsening performance, in addition to inducing delays in care, unfinished, concomitant, and multitasking tasks. This context predisposes the professional to the occurrence of errors (slips, lapses, mistakes) and omissions, thus compromising patient safety. Furthermore, interruptions affect cognitive functions distinct from the individual, from attention to memory, negatively influencing decision making and problem solving[27-31].

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

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%[14].

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 and care that this value represents. From this value, it emerges that 1 professional is capable of fully caring for only 1 patient per 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 (MS) for the functioning of Intensive Care Units[32,33].

Researchers suggest that the proper dimensioning of nurses, with ideal proportionality between patient and professional, helps to reduce the incidence of adverse events, dissatisfaction, turnover and absenteeism among professionals, which result in better indicators of care quality, management and patient safety[34].

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[15].

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 [15].

The values achieved in NAS and SAPS characterize the clinical conditions of patients admitted to the unit during the period studied, about the intensity of care provided, degree of complexity and dependence, indicating a high workload, requiring high physical demands from the nursing team, emotional and cognitive.

Therefore, it is important to emphasize the importance of the attention and memory of the intensive care nurse, considering their role in the leadership, communication and education of the team, in carrying out procedures, in the use, handling and provision of medical assistance equipment (EMA) and materials, in problem solving and decision making, in addition to constant surveillance of critical patients in view of the instability and unpredictability of their evolution, permeating their safety.

As for decision-making, authors discuss the complexity of the cognitive work of intensive care nurses, also called invisible work, that is, the organization, prioritization, and decision-making of this professional in their work environment, continuously seeking safe and quality care for your patients[3-6].

We can then state that 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 status of patients[4,5,35].

Cognitive load refers to the total amount of mental effort being used in working memory. This ongoing cognitive load, maintained by a nurse, is fundamental to his ability to, at any time, remember the care activities required for a patient. However, the literature suggests that its exacerbated increase may adversely affect decision making in critical environments resulting in patient care errors[5].

Among the identified factors that affect nurses' cognitive load, there is information overload, interruptions, intentional omissions of care, communication inconsistencies, lack of time, cognitive changes, simultaneity and multiplicity of tasks, in addition to personal, environmental, administrative, system and technology related[3-6].

As for neuropsychological tests, the results obtained through the application of Neupsilin showed a decrease in the working memory score after the shift, representing a 6% reduction in the average.

In the long-term semantic memory, there was no difference between the scores at the beginning and at the end of the shift.

In the prospective memory, we observed a 6% increase in the average after the shift.

In the episodic-semantic verbal memory, all scores increased after the shift, immediate recall (15%), delayed recall (38%), recognition (14%).

Considering the memory tests and the caveats of not applying the tests in two cases (prospective memory and long-term semantic memory), the significant bilateral tests were: Late evocation p = 0.05 and recognition p = 0.02, that is, these showed a significant difference in the score before and after the shift. In the others, there was no considerable variation in the scores.

In relation to the unilateral test, to verify the reduction of memory scores, at a level of 10% significance (p = 0.06) the unilateral test of working memory was significant, indicating a decline in this score after the shift.

Regarding the memory tests, we found that in working memory the median was negative in all groups regarding the profile of nurses, indicating a decrease in the score of this variable.

In the other memories according to population characteristics, there was no significant difference.

In the analysis of the factors related to the variation of memory scores, we demonstrated that there is a significant association between the memory score of late evocation and the number of professionals, with a negative relationship (correlation -0.76, p = 0.011), which leads us to infer that the greater the number of professionals, the lower the value of the delayed recall memory score, that is, the high number of professionals during the shift influenced the decrease in the episodic-semantic verbal memory of the participant.

Episodic-semantic verbal memory - recognition and the number of interruptions showed a positive correlation, therefore, the interruptions influenced the increase in the score of this cognitive function (correlation 0.71, p = 0.020).

It is worth noting that the working memory associated with interruptions presented a negative relationship (correlation -0.55, p = 0.102), that is, in a borderline position at a level of 10% of significance, in an inversely proportional relationship, thus leading considering the marginal value obtained, we can infer the influence of interruptions in working memory, that is, the high number of interruptions caused a decrease in the value of the working memory score of the professionals tested.

The nurse's work requires a concomitant processing and cognitive storage of information in working memory, particularly when new elements compete for attention, leading to cognitive changes. Remembering the priorities and activities planned for a group of patients, given their needs, requires organizational skills and working memory to maintain or suppress information. Nurses in their daily lives already have a high cognitive load, thus, the very limitations of memory can lead to errors due to lapses and omissions[4].

In agreement with the quotes at the end of the shift, we observed a decrease in the results regarding the working memory of our participants, which suggests an overload of this cognitive function throughout the shift and at the close of the shift.

In cognitive psychology, the concept of working memory capacity refers to the short-term cognitive system used for processing and storing information. An individual's working memory capacity is a portal to a multitude of cognitive processes, including reasoning, knowledge, use of strategy, resources required mainly for problem solving and decision making[5].

The working memory also allows fine-tuning of the behavior while it is happening, fulfilling a management function of our contact with the real. A failure in working memory would make it difficult or nullify the judgment about the importance of events that occur constantly and, therefore, would impair our perception of reality[36].

Nurses continuously upload and download patient and procedure data to their memory. All nursing activities have schemes and steps stored in memory, for example, how to carry out an assessment or a procedure, the preparation of drugs, exams, and future schedules for patients, etc., therefore, memory is an essential cognitive function in nurse's work[37].

Our results related to prospective memory and episodic-semantic verbal memory validate the reference, as the scores of our participants increased after the shift, demonstrating the demands of these cognitive functions. This increase can be justified by the need to retrieve in memory, data about the complications during the shift for the shift change among nurses, activating these functions. In healthcare practice, personal notes and reminders about elements and facts on duty are part of the nurses' routine and daily routine, to avoid forgetting important tasks and communications.

The nurse must be able to think quickly, access knowledge, deal with new information for a patient and make judgments during the execution of care, therefore, accumulates high cognitive loads during their work shift[5].

The scores of the attention tests increased after the shift, in TEADI there was an increase of 40% on average and in TEALT 9% increase.

Considering the attention tests, the bilateral tests were significant, TEADI p = 0.002 and TEALT p = 0.009 (10% level of significance) due to the difference obtained in the score before and after the shift, with an increase after the shift, mainly in the TEADI.

As for the factors associated with the variation in attention, the only significant test, with difference between the groups, was the TEADI, in the variable travel time to work (up to 1 hour of travel) with p = 0.016. In the others according to population characteristics, there was no significant difference.

In the analysis of the factors related to the variation of the attention scores, the association of the TEALT score and the number of interruptions, presented a negative relationship (correlation -0.65, p = 0.041), in an inversely proportional relationship. Alternating attention was sensitive to the occurrence of interruptions.

Research on the repercussions of environmental noise on workers' bodies found a significant increase in heart rate, systolic and diastolic blood pressure in professionals. In the investigation, attention testing was also carried out with the participants, which proved the influence of environmental noise on their level of attention, indicating a compromised state of surveillance, deficit in the execution of complex and / or simultaneous activities, in addition to high motor arousal[38].

A study measured the levels of stress, anxiety, depression of nurses who worked in intensive care, relating them to the levels of care before and after a 24-hour day and concluded that the workload of nurses after 24-hour shifts is correlated with increased stress levels, decreased attention process and psychomotor decline[19].

In our results, the attention levels of the participants increased after the 12-hour shift, diverging from the cited references, however the author of cognitive psychology points out that the individual being tired, sleepy or under the influence of drugs, can limit their attention, however in the face of problem situations, an individual's attention levels tend to increase considerably[1].

The author's statement leads us to assume that due to problem situations being part of the daily routine of intensive care nurses, their attention levels in view of this, would increase during the shift. In addition, at the end of the shift, where the attention test scores have increased, the nurse needs to organize the shift, review the patients, calculate the water balance for the 12 hours of their shift, check medications and drippings administered, assessing complications in the clinical conditions of patients, providing discharge and admissions of patients, among other activities. In this period, involved in multiple activities, the attentional levels of these professionals are predisposed to rise due to the circumstances presented and the need for this professional to pass the shift to the substitute colleague in appropriate conditions.

In this way, the results of the neuropsychological tests of attention carried out at the end of the shift may have been influenced by this context, with an increase in the scores, mainly in TEADI, and indicate how much divided attention is required by nurses at the end of the shift to perform their activities.

Prolonged work, which requires high concentration for its development, which suffers interruptions, which produces questions to be performed, results in a compensatory cognitive effort on the part of the professional. In the case of intensive care nurses, the need for this extra cognitive effort is increased, since their actions are carried out under complex, unpredictable, and even precarious and adverse conditions, that is, there is a higher mental cost for this professional[39-41].

We reiterate cognitive functions as a crucial resource for intensive care nurses in their care activities, as well as in the prevention, interception and correction of possible errors related to the care of critical patients[39].

Conclusion

The results of this study corroborate with the references that memory and attention are sensitive to the influences and demands of the environment.

We observed an increase in the attention scores (divided and alternating) of the participants at the end of the work shift, which is justified in the literature by the constant coping with problem situations in the daily lives of these professionals, raising their attention levels throughout the journey.

On the other hand, there was a decrease in the nurses' working memory score, associated by researchers, with the multiple tasks performed by these professionals and the constant processing and storage of new information during their shift, imposing high demands on working memory.

Considering the unpredictability of nursing work in intensive care, the complexity of care for critically ill patients and the multiplicity of activities performed, the importance of the cognitive functions of intensive care nurses needs to be recognized, as it is essential for detecting complications, surveillance, problem solving, decision making and prevention of errors in care, therefore, fundamental for patient safety.

Our data regarding the attention and memory of professionals arouse interest for the nurses' cognitive work, the dynamic and invisible work of organizing, prioritizing and making decisions about the provision of care, taking into account that it cannot be measured by instruments measurement of nursing workload, however, is the essence and support for all nursing activities.

The nurse conducts his assistance in the face of changes in the patient's needs, procedural and environmental demands. In this context, the literature continues to search for the causes of errors or omissions in care, therefore, a new look must be given to the way in which care systems, environment and work conditions complement or interfere with nurses' cognitive work.

In critical moments, the cognitive load of memory and the attention of a professional can be seriously compromised in their ability to solve problems, make decisions, and attend to a patient's situation, and thus have repercussions on patient safety.

It is necessary to explore and recognize the dimension of nurses' cognitive processes and how, especially in complex activities, appropriate models of human resources, systems and working conditions can be adequately employed, aiming at better professional performance and patient safety.

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