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Evaluation of nursing workload and predictive factors of mortality in patients admitted to mechanical ventilation in an adult Intensive Care Unit

Avaliação da carga de trabalho em enfermagem e os fatores preditivos de mortalidade de pacientes admitidos em ventilação mecânica em uma Unidade de Terapia Intensiva adulto

Evaluación de la carga de trabajo en enfermería y los factores predictivos de mortalidad en pacientes ingresados en ventilación mecánica en una Unidad de Cuidados Intensivos para adultos

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ABSTRACT

Objective: To calculate nursing workload and determine predictive factors for mortality in mechanically ventilated patients in an Adult Intensive Care Unit. **Methods:** This is a retrospective, documentary, descriptive, analytical, and cross-sectional cohort study. Data were extracted from patient records from January to June 2014 at the Adult ICU of the Clinical Hospital of Uberlândia, Federal University of Uberlândia. **Results:** A total of 194 patients were included, with the outcome of discharge or death in the ICU assessed with qualitative and quantitative admission, hospitalization, outcome, and NAS variables. Logistic regression models yielded risk and protective factors for ICU mortality. **Conclusion:** NAS-m, NAS-md, NAS-i, and NAS-ri were associated with higher mortality rates, but the workload estimated by NAS was not fully met in scale allocation. Predictive risk factors for mortality included patients with COPD, thyroid disorders, elevated blood urea levels, administration of noradrenaline, corticosteroids, and vasopressin, SAPS3 score, NAS-ad, and NAS-ri. Protective predictors for mortality included patients with tracheostomy and NAS-a.

Keywords: Workload, Nursing, Predictive factors, Nursing activities score, Intensive Care Unit.

RESUMO

Objetivo: Calcular a carga de trabalho na área de Enfermagem e determinar os fatores preditivos de mortalidade, em pacientes admitidos em ventilação mecânica em uma Unidade de Terapia Intensiva Adulto. **Métodos:** Trata-se de um estudo do tipo coorte retrospectiva, documental, descritivo, analítico e transversal, os dados foram extraídos dos prontuários dos pacientes, no período de janeiro a junho de 2014, na UTI de pacientes adultos do Hospital de Clínicas de Uberlândia da Universidade Federal de Uberlândia. **Resultados:** Foram incluídos 194 pacientes, sendo avaliados o desfecho alta ou óbito na UTI com variáveis qualitativas e quantitativas de admissão, de internação, de desfecho e NAS. A partir dos modelos de regressão logística foram obtidos fatores de risco e protetivos para mortalidade na UTI. **Conclusão:** Observou-se que NAS-m, NAS-md, NAS-i, NAS-ri se associaram com maiores índices de mortalidade, porém a carga de trabalho estimada pelo NAS não foram completamente atendidas na atribuição das escalas. Os fatores preditivos de risco para mortalidade foram os pacientes com presença de DPOC, tireoideopatias, níveis elevados de ureia no sangue, administração de noradrenalina, corticoides e vasopressina, pontuação no SAPS3, NAS-ad e NAS-ri. Os fatores preditivos de proteção para mortalidade incluíram os pacientes com presença de traqueostomia e NAS-a.

Palavras-chave: Carga de trabalho, Enfermagem, Fatores preditivos, Escore de atividades de enfermagem, Unidade de Terapia Intensiva.

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RESUMEN

Objetivo: Calcular la carga de trabajo en el área de Enfermería y determinar los factores predictivos de mortalidad en pacientes admitidos en ventilación mecánica en una Unidad de Cuidados Intensivos Adultos. **Métodos:** Se trata de un estudio de cohorte retrospectivo, documental, descriptivo, analítico y transversal. Los datos se extrajeron de los registros de pacientes durante el período de enero a junio de 2014 en la ICU Adultos del Hospital de Clínicas de Uberlândia de la Universidad Federal de Uberlândia. **Resultados:** Se incluyeron 194 pacientes, evaluándose el resultado de alta o fallecimiento en la UCI con variables cualitativas y cuantitativas de admisión, hospitalización, resultado y NAS. A partir de modelos de regresión logística se obtuvieron factores de riesgo y protectores para la mortalidad en la UCI. **Conclusión:** Se observó que NAS-m, NAS-md, NAS-i y NAS-ri se asociaron con mayores índices de mortalidad, aunque la carga de trabajo estimada por NAS no se cumplió de escalas. Los factores predictivos de riesgo para la mortalidad incluyeron pacientes con EPOC, trastornos tiroideos, niveles elevados de urea en sangre, administración de noradrenalina, corticosteroides y vasopresina, puntuación en SAPS3, NAS-ad y NAS-ri. Los factores predictivos de protección para la mortalidad incluyeron pacientes con traqueostomía y NAS-a.

Palabras clave: Carga de trabajo, Enfermería, Factores predictivos, Puntuación de actividades de enfermería, Unidad de Cuidados Intensivos.

INTRODUCTION

The intensive care unit (ICU) is a specialized sector reserved for the hospitalization of critically ill patients, which demands constant attention from qualified professionals, in addition to the use of specific equipment and essential technologies for diagnosis, monitoring and treatment (BRAZIL, 2010). ICUs often accommodate patients who need mechanical ventilator support due to respiratory dysfunctions, as well as patients who require invasive treatments, who can improve their condition and provide satisfactory results, Therefore, the multidisciplinary team in direct contact with these patients should identify and reduce the problems in the best possible way to promote patient recovery, without causing damage or consequences that affect their quality of life (HOOGENDOORN ME, et al., 2020).

In the context of ICU care, the concern increases, since this hospital area is responsible for the care of patients of high complexity, and any inappropriate intervention can result in a deterioration of health status or even death (BUSANELLO J, et al., 2020). The mortality of patients is linked to clinical, social and demographic characteristics, as well as adverse and iatrogenic events and the analysis of indicators of quality of care often applied in ICUs, such as the period of hospitalization, factors related to patient mortality (BUSANELLO J, et al., 2020). Due to the significant impact that Healthcare-Associated Infections (HAIs) have on patient morbidity and mortality, as well as antimicrobial resistance and health care costs, they represent a substantial public health concern (OSME SF, et al., 2020; OSME SF et al., 2021; BARCHITTA M, et al., 2021).

Over an extended period, the assessment of the probability of occurrence of the death outcome was conducted arbitrarily, based on medical and or subjective evaluations (CZAJKA S, et al., 2020). In order to convert them into numerical scales to enable the comparison of performance between units, the score Acute Physiology and Chronic Health Evaluation II (APACHE II) was developed based on information from hospitals in the United States and intended to assess the acute condition of the patient in the first 24 hours of admission to the ICU, while the Simple Acute Physiology Score 3 (SAPS3) had its origin from data collected in Europe and North America and was designed to be applied in the first hours of patient admission to the ICU, but can also be used at subsequent times during hospitalization (CZAJKA S, et al., 2020). Both scores are valuable tools for assessing disease severity in critical patients, helping healthcare professionals make clinical decisions and allocate resources more efficiently, however it is important to note that these scores are only a part of the comprehensive clinical evaluation and do not replace the experience and clinical judgment of health professionals (CZAJKA S, et al., 2020).

The nursing team maintains a direct and constant contact with patients and family members, being responsible for planning care and ensuring safety. In this role, the demands and responsibilities of the professional grow continuously, resulting in the accumulation of activities (MARGADANT C, et al., 2019). The Nursing Activities Score (NAS) is a tool that measures nursing workload in intensive care in the last 24 hours, was proposed by Miranda DR, et al. (2003) and developed through the reformulation of the Therapeutic

Intervention Scoring System 28 (TISS-28). Brazil was one of the 15 countries included in the multicenter study that validated the NAS and represented 5% of the total sample used in the validation.

The scale is divided into seven categories and subdivided into 23 items, each NAS score corresponds to 14.4 minutes and varies from 1,2 to 176.8 points, therefore a score of 100 means that the patient required care from a nursing professional 100% of the time in the last 24 hours (MIRANDA DR, et al., 2003). In 2009, the NAS was translated and validated for Brazil by Queijo and Padilha (QUEIJO AF and PADILHA KG, 2009). Thus, understanding the clinical and epidemiological particularities is crucial and significant to establish qualitative and quantitative actions, identify risk factors and improve the care offered. Given this context, the present study aimed to calculate the workload in nursing and determine the predictive factors of mortality in patients admitted to mechanical ventilation in an Adult Intensive Care Unit.

METHODS

Type and Place of Study

Retrospective, documentary, descriptive, analytical and cross-sectional cohort study. Part of the data presented here are unpublished or were reanalyzed from the study on mechanical ventilation-associated pneumonia of Gomes FA (2018). Some information and results were published with different proposals and samples by Gomes FA, et al. (2019), Gomes FA, et al. (2020) and Mendes-Rodrigues C, et al. (2021). Data were collected in the Intensive Care Unit of adult patients of the Clinical Hospital of Uberlândia of the Federal University of Uberlândia (HCU - UFU).

The hospital is located in the city of Uberlândia, Minas Gerais, Brazil. It is a public university-type teaching hospital, of tertiary care (high complexity), with 525 beds and exclusive member of the Unified Health System (UHS). The Adult Intensive Care Unit where data collection was performed was classified as level of complexity III, which is the highest level of complexity (BRAZIL, 1998), and at the time of data collection, was structured as a general ICU without specialty, with 30 beds and admission of clinical, neurological, traumatic and surgical patients from 13 years, although most patients are over 18 years.

Study and Sample Population

The study population consisted of all patients admitted to the Adult ICU of the HCU - UFU, from January 2014 to June 2014, who met the following inclusion criteria defined by the study of Gomes FA (2018). The inclusion criteria were the medical records of patients aged over 18 years; admitted to mechanical ventilation for a period of more than 48 hours before admission to the ICU or who remained on mechanical ventilation for a period of more than 48 hours immediately after admission to the ICU; and hospitalized for any diagnosis. The exclusion criteria were the medical records that did not contain the variables necessary for the study.

For the current study, we included as an additional exclusion criterion patients with less than two NAS evaluations during hospitalization in the ICU. The criterion of 48 hours in mechanical ventilation was included by Gomes FA (2018), because it represents the criterion of minimum time of mechanical ventilation for diagnosis of mechanical ventilation-associated pneumonia (primary outcome of the original study). Data were collected from 198 patients by Gomes FA (2018), the exclusion of 4 patients occurred due to the absence of at least two NAS evaluations. Thus, the current study included 194 patients, of which 71 died in the ICU and 123 were discharged from the ICU.

Clinical and Demographic Profile

The data used in this study were extracted directly from the patients' medical records. Initially, an individual form was completed for each patient, including information such as age (in years), gender (male or female), diagnosis of admission (classified as clinical, trauma, surgical, noting that a patient may have more than one diagnosis in hospitalization, belonging to multiple groups), execution of invasive procedures, use of neuromuscular blockers, corticosteroids, length of hospitalization (divided into ICU and total hospital time, both in days), time on mechanical ventilation, use and duration of medications (for sedation, analgesia and control of blood pressure), results of admission laboratory tests, severity scores in the ICU - APACHE II and SAPS3.

In this study, the total cost of hospitalization by the Unified Health Service (UHS), referring to the reimbursement of UHS for hospital costs for the HCU-UFU, was incorporated and the UHS reimbursement-day was calculated, obtained by dividing the reimbursement by the number of days of hospitalization. These values were expressed in US dollars, and the conversion of the national currency to dollar was carried out by the hospital discharge day quotation. In addition, only adherence to oral hygiene was used to assess the adequacy of the package of measures (Bundle) for the prevention of VAP, since this indicator is directly related to nursing practice. And to analyze the workload required in nursing during hospitalization, we used the NAS, which was collected daily (recording only the total score per day). The original study includes other variables, which were not described here due to large data loss, see Gomes FA (2018), Gomes FA, et al. (2019) and Gomes FA, et al. (2020).

Ethical and Legal Considerations

The study was conducted in accordance with Resolution 466 of 2012 of the National Health Council and in accordance with the ethical principles of the Declaration of Helsinki for research involving humans. The study was submitted by Gomes FA (2018) to the Research Ethics Committee of the Federal University of Uberlândia and approved under the CAAE number: 43409414.8.0000.5152 and parecer number 1.084.593.

Table 1 - Summary of measures derived from the Nursing Activities Score (NAS) and calculated for patients admitted to mechanical ventilation in the Intensive Care Unit (ICU), considering the event of interest discharge from the ICU or death in the ICU.

Abbreviation	Indicator Name	Description and Unit
NAS-num	NAS number	Refers to the NAS assessment number in the ICU.
NAS-ad	Admission NAS	Refers to the NAS of the first day of ICU admission. Unit: points.
NAS-a	NAS amplitude	Refers to the amplitude of the NAS until the event of interest in the ICU, obtained by subtracting the maximum NAS from the minimum NAS. Unit: points.
NAS-m	Mean NAS	Refers to the average NAS until the event of interest in the ICU. Unit: points.
NAS-md	Median NAS	Refers to the median NAS until the event of interest in the ICU. Unit: points.
NAS-cv	NAS coefficient of variation	Refers to the coefficient of variation of the NAS until the event of interest in the ICU. Unit: %.
NAS-i	NAS increase	The increase in NAS was calculated by subtracting the maximum NAS (obtained by counting from the second day of hospitalization in the ICU until the event of interest) minus the NAS at admission. Unit: points.
NAS-ri	NAS relative increase	The relative increase in NAS was obtained by dividing the NAS-i by the NAS-ad and multiplying the result by 100. Unit: %.
NAS-Δ	NAS delta	The NAS delta measures the increase or decrease in the NAS score, which was calculated by subtracting the NAS on the day of the event of interest from the NAS-ad. Positive values indicate an increase in workload and negative values indicate a decrease in workload. Unit: points. It was calculated for the second and third day of ICU admission, respectively NAS-Δd2 and NAS-Δd3
NAS-rΔ	Relative NAS delta	The relative NAS delta was obtained by dividing NAS-Δ by NAS-ad and multiplying by 100. Unit: %. It was calculated for the second and third day of ICU admission, respectively NAS-rΔd2 and NAS-rΔd3
NAS-dis	Outcome NAS	Represents the NAS on the day of the outcome (discharge or death in the ICU). Unit: points.
NAS-disi	Outcome NAS increase	Calculated by subtracting the NAS from the outcome (NAS-dis) minus the NAS at admission. Unit: points.
NAS-disri	Outcome NAS relative increase	Calculated by dividing the NAS-disi by the NAS of admission (NAS-ad) and multiplied by 100. Unit: %.
NAS-psa	Scale adequacy percentage	The percentage of adequacy of the assignment scale was calculated based on the workload predicted by the NAS and the number of nursing hours offered to each patient. For this purpose, the number of nursing hours allocated in the work schedules during the period of interest was calculated, that is, the number of hours of nursing care provided in the ICU. Additionally, the workload was also predicted by the sum of the NAS in the period of interest divided by 100 and multiplied by 24. On the other hand, to assess adequacy (NAS-psa), the number of nursing hours offered was divided by the predicted and multiplied by 100. Values less than 100 indicate that the predicted load was not offered, if the values are greater than 100, it indicates that the workload predicted by the NAS was met when assigning the shifts. Unit: %.

Source: Silva NR, et al., 2024.; data extracted from Gomes FA, et al., 2019.

RESULTS

Comparison of the profile of the two groups

The study evaluated 194 medical records, treated in two groups: discharge from the ICU (n = 123 patients) and death in the ICU (n = 71 patients). The mortality rate in the ICU for patients admitted to mechanical ventilation was 36.60% (71 deaths in 194 patients evaluated). Of the 123 patients discharged from the ICU, 11 died in the ward with a mortality rate in the ward after discharge from the ICU of 8.94% (11 deaths in 123 evaluated patients). The hospital mortality rate of all 194 patients included in the study was 42.27% (82 deaths in 194 patients evaluated). Of the patients who died in the ICU, the median age was 64 years, predominant male (61.97%; 44) and diagnosis of admission by clinical hospitalization (50.7%; 36), followed by surgical hospitalization (45.07%; 32) and hospitalization by trauma (2.82%; 2).

Regarding the prognostic scores of patients who died in the ICU, the mean SAPS3 was 67.14 points, APACHE II was 18.89 points and PIRO was 2 points. From the information collected during admission in this group, the mean blood pressure (MBP) was 85.20 mmHg, the median urea concentration was 54 mg/dL, temperature of 36ºC and partial oxygen pressure (PaCO2) of 34.50 mmHg. Regarding the clinical characteristics of patients who died in the ICU, 12 (16.9%) patients had congestive heart failure (CHF), ten (14.08%) patients had chronic obstructive pulmonary disease (COPD) and six (8.45%) patients presented thyroid alteration (Tables 2 and 3).

Of the information collected during hospitalization of patients who died in the ICU, 46 (64.79%) patients had circulatory shock, 21 (29.58%) had coagulopathies and five (7.04%) had pneumothorax. Regarding the respiratory system, the median for the use of invasive mechanical ventilation was ten days, 19 (26.76%) patients underwent tracheostomy, 20 (28.17%) patients developed VAP and the median of oral hygiene adherence was 85.71%. Regarding the use of invasive procedures, 63 (88.73%) patients used delayed bladder catheterization, and 38 (53.52%) used invasive blood pressure. Regarding medications, 68 (95.77%) patients used noradrenaline, 42 (59.15%) used propofol with the median of two days, 37 (52.11%) corticosteroid, 30 (42.25) patients used precedex with the median of zero, 21 (29.58%) patients used vasopressin, 19 (26.76%) dobutamine and two (2.82%) used esmeron, for the use of fentanyl the median was four days and midazolam the median was two days. The other medications showed zero medians (Tables 2 and 3).

Although the tests showed differences in the number of days of dobutamine use and vasopressin use between the two groups, both groups showed median zero; a result that may be the excess of zeros in both groups. There are for the two medications a greater number of patients with longer use in the group of patients who died in the ICU. The average rank for dobutamine use day was 91.80 and 107.37 for the discharge and death groups, respectively. The average rank for the day of vasopressin use was 88.96 and 112.29, for the discharge and death groups, respectively. Concerning the outcomes, the median time in the ICU of the two groups of patients was 16 days, which differentiated the median time of hospitalization, 29 days for patients who evolved to death and 35 days for patients who were discharged. The median UHS reimbursement for the death group in the ICU was $9,457.17 and the median UHS reimbursement-day was $343.67, while for the discharge ICU group the median UHS reimbursement was $10,019.99 and the median UHS reimbursement-day was $319.29.

The variables that had significant differences ($p < 0.05$) between the two groups (ICU discharge versus ICU death, respectively) were patients admitted for clinical hospitalization (32.52% versus 50.7%, $p = 0.019$); hospitalization for trauma (30.08% versus 2.82%, $p < 0.001$); occurrence of circulatory shock (41.46% versus 64.79%, $p = 0.003$); presence of coagulopathies (12.2% versus 29.58%, $p = 0.005$); of chronic obstructive pulmonary disease (1.63% versus 14.08%, $p = 0.001$); of CHF (4.88% versus 9%, $p = 0.012$) (73.98% versus 95.77%, $p < 0.001$); use of corticosteroids (28.46% versus 52.11%, $p = 0.002$); use of vasopressin (6.50% versus 29.68%, $p < 0.001$) and use of dobutamine (9.76% versus 26.76%, $p = 0.004$). There were also significant differences for SAPS3 (60.56 points versus 67.14 points, $p = 0.002$), for age (48 years versus 64 years, $p < 0.001$), blood urea concentration (41 mg/dL versus 54 mg/dL, $p = 0.005$) and days of hospitalization (35 days versus 29 days, $p = 0.008$). The other variables did not show significant differences between the two groups (**Tables 2** and **3**).

Table 2 - Descriptive analysis of qualitative admission and hospitalization variables of patients on mechanical ventilation admitted to an adult intensive care unit, evaluated for nursing workload (patients with at least 2 days of mechanical ventilation and at least two days with workload), stratified into death or ICU discharge.

Variable	ICU Discharge		ICU Death		Statistics; *p*
	No % (n)	Yes % (n)	No % (n)	Yes % (n)	
Admission					
Female Sex	65.85 (81)	34.15 (42)	61.97 (44)	38.03 (27)	X^2 =0.15; 0.586
Clinical Hospitalization	67.48 (83)	32.52 (40)	49.3 (35)	50.7 (36)	X^2 =5.51; 0.019
Trauma Hospitalization	69.92 (86)	30.08 (37)	97.18 (69)	2.82 (2)	X^2 =19.17; < 0.001
Surgical Hospitalization	43.09 (53)	56.91 (70)	54.93 (39)	45.07 (32)	X^2 =2.08; 0.149
Presence of COPD	98.37 (121)	1.63 (2)	85.92 (61)	14.08 (10)	*P* TEF = 0.001
Presence of CHF	95.12 (117)	4.88 (6)	83.1 (59)	16.9 (12)	X^2 =6.37; 0.012
Thyroid change	98.37 (121)	1.63 (2)	91.55 (65)	8.45 (6)	*P* TEF = 0.054
Hospitalization					
Coagulopathy	87.8 (108)	12.2 (15)	70.42 (50)	29.58 (21)	X^2 =7.89; 0.005
Presence of VAP	73.17 (90)	26.83 (33)	71.83 (51)	28.17 (20)	X^2 =0.001; 0.972
Use of esmeron	96.75 (119)	3.25 (4)	97.18 (69)	2.82 (2)	*P* TEF = 1.000
Tracheostomy	60.98 (75)	39.02 (48)	73.24 (52)	26.76 (19)	X^2 =2.48; 0.116
Use of IBC	13.82 (17)	86.18 (106)	11.27 (8)	88.73 (63)	X^2 =0.08; 0.773
Pneumothorax	95.93 (118)	4.07 (5)	92.96 (66)	7.04 (5)	*P* TEF = 0.502
Circulatory shock	58.54 (72)	41.46 (51)	35.21 (25)	64.79 (46)	X^2 =8.89; 0.003
Use of IBP	49.59 (61)	50.41 (62)	46.48 (33)	53.52 (38)	X^2 =0.07; 0.788
Use of propofol	39.02 (48)	60.98 (75)	40.85 (29)	59.15 (42)	X^2 =0.009; 0.922
Use of noradrenaline	26.02 (32)	73.98 (91)	4.23 (3)	95.77 (68)	X^2 =13.02; <0.001
Use of dobutamine	90.24 (111)	9.76 (12)	73.24 (52)	26.76 (19)	X^2 =8.47; 0.004
Use of corticosteroid	71.54 (88)	28.46 (35)	47.89 (34)	52.11 (37)	X^2 =9.80; 0.002
Use of vasopressin	93.50 (115)	6.50 (8)	70.42 (50)	29.58 (21)	X^2 =17.08; <0.001
Use of precedex	49.59 (61)	50.41 (62)	57.75 (41)	42.25 (30)	X^2 =0.89; 0.344

Caption: COPD: chronic obstructive pulmonary disease, CHF: congestive heart failure, VAP: ventilator-associated pneumonia, IBC: indwelling bladder catheterization, IBP: invasive blood pressure, X2: Chi-square statistic with continuity correction; p: probability; p TEF: probability associated with Fisher's Exact test.
Source: Silva NR, et al., 2024.

Table 3 - Descriptive analysis of quantitative admission and hospitalization variables of patients on mechanical ventilation admitted to an adult intensive care unit (ICU), evaluated for nursing workload (patients with at least 2 days of mechanical ventilation and at least two days with workload), stratified into death or ICU discharge.

Variable	ICU Discharge			ICU Death				
	Mean	LL	UL	Mean	LL	UL	t	p
Admission								
APACHE II (points)	18.41	16.95	19.86	18.89	16.88	20.89	-0.38	0.701
SAPS3 (points)	60.56	58.13	62.99	67.14	63.60	70.68	3.09	0.002
Mean blood pressure (mmHg)	84.11	81.48	86.74	85.20	80.72	89.67	-0.41	0.682
Age (years)	48.00	39.00	54.00	64.00	58.00	68.00	-4.90	<0.001
Urea (mg/dL)	41.00	36.00	45.00	54.00	46.00	65.00	-2.78	0.005
Temperature (ºC)	36.30	36.00	36.60	36.00	36.00	36.30	-2.38	0.021
PaCO2 (mmHg)	36.70	34.00	38.60	34.50	33.10	37.20	-1.33	0.183
PIRO (points)	2.00	2.00	2.00	2.00	2.00	2.00	-0.80	0.422
Hospitalization								
Fentanyl days	4.00	3.00	4.00	4.00	3.00	6.00	-0.58	0.558
Midazolam days	2.00	1.00	3.00	2.00	1.00	5.00	-0.28	0.778
Days of precedex	1.00	0.00	2.00	0.00	0.00	1.00	-1.68	0.093
Dobutamine days	0.00	0.00	0.00	0.00	0.00	0.00	-2.96	0.003
Propofol days	2.00	1.00	3.00	2.00	0.00	3.00	-0.80	0.807
Vasopressin days	0.00	0.00	0.00	0.00	0.00	0.00	-4.49	<0.001
Mechanical ventilation days	11.00	9.00	14.00	10.00	8.00	14.00	-0.24	0.810
Oral Hygiene Adherence (%)	81.25	77.78	85.71	85.71	80.00	90.47	-1.29	0.197
Outcomes								
Days of ICU	16.00	14.00	19.00	16.00	14.00	21.00	-0.12	0.906
Days of hospitalization	35.00	29.00	44.00	29.00	23.00	34.00	-2.66	0.008
UHS Reimbursement ($)	10019.99	9195.79	11951.27	9457.17	7270.64	11068.67	-1.16	0.097
UHS reimbursement-day ($)	319.29	283.09	358.13	343.67	309.07	419.88	-1.59	0.111

Caption: UHS: Unified Health System; LL: lower limit of the 95% confidence interval, UL: upper limit of the 95% confidence interval; obtained by the Z distribution for the mean when the data follows a Gaussian distribution and by the 0.025 and 0.975 quantiles of data simulated by bootstrap for the median (n=25000) for data with other distributions; p: probability; t: Student's t test statistics; Z: approximate Z statistic for the Mann-Whitney test.
Source: Silva NR, et al., 2024.

It was found that some workload variables were associated with higher mortality rates ($p < 0.05$), namely: mean NAS - NAS-m (52.85 points versus 55.00 points, $p = 0.001$), median NAS - NAS-Md (52.70 points versus 54.00 points, $p = 0.003$), increase in NAS - NAS-i (0.90 points versus 3.50 points, $p = 0.006$), relative increase in NAS - NAS-ri (1.70% versus 6.64%, $p = 0.007$). While the percentage of scale adequacy - NAS-Psa (94.83% versus 91.57%, $p = 0.005$) was associated with higher rates in patients discharged from the ICU ($p <0.05$). The outcome NAS - NAS-dis showed differences, although the medians were identical. This was because the death group had higher average posts than admission (111.68 versus 89.31), meaning higher load on the day of the outcome for patients who died. The other indicators of nursing workload did not show significant differences between the two groups (**Table 4**).

Table 4 - Descriptive analysis of Nursing workload variables, derived from the Nursing Activities Score, for patients on mechanical ventilation admitted to an adult intensive care unit (patients with at least 2 days of mechanical ventilation and at least two days with workload), stratified into death or ICU discharge.

Variable	ICU Discharge			ICU Death				
	Median	LL	UL	Median	LL	UL	Z	p
NAS-num	16.00	14.00	19.00	16.00	14.00	21.00	-0.11	0.906
NAS-ad (points)	52.80	52.70	55.00	54.00	52.70	56.20	-0.23	0.821
NAS-a (points)	9.90	7.30	11.60	13.40	10.50	15.70	-1.27	0.204
NAS-m (points)	52.85	52.46	53.18	55.00	53.49	55.59	-3.35	0.001
NAS-md (points)	52.70	52.70	52.70	54.00	52.70	56.20	-2.96	0.003
NAS-cv (%)	5.81	4.26	7.03	6.23	5.08	8.11	-0.68	0.498
NAS-i (points)	0.90	0.00	3.00	3.50	2.00	6.90	-2.74	0.006
NAS-ri (%)	1.70	0.00	5.34	6.64	3.60	11.32	-2.7	0.007
NAS-Δd2 (points)	0.00	0.00	0.00	0.00	0.00	0.00	-0.46	0.643
NAS-rΔd2 (%)	0.00	0.00	0.00	0.00	0.00	0.00	-0.46	0.646
NAS-Δd3 (points)	0.00	0.00	0.00	0.00	0.00	0.00	-0.21	0.835
NAS-rΔd3 (%)	0.00	0.00	0.00	0.00	0.00	0.00	-0.20	0.838
NAS-psa (%)	94.83	94.16	95.45	91.57	90.09	94.17	-2.83	0.005
NAS-dis (points)	52.70	51.20	52.70	52.70	52.70	55.00	-2.68	0.007
NAS-disi (points)	-1.80	-3.90	-0.10	-0.10	-2.30	0.00	-1.79	0.074
NAS-disri (%)	-3.54	-6.64	-0.19	-0.19	-4.18	0.00	-1.82	0.068

Caption: LL: lower limit of the 95% confidence interval, UL: upper limit of the 95% confidence interval; obtained by quantiles 0.025 and 0.975 of data simulated by bootstrap for the median (n=25000); p: probability; Z: approximate Z statistic for the Mann-Whitney test.
Source: Silva NR, et al., 2024.

Mortality prediction models

In model 1, which evaluated the indicators of nursing workload, four variables were identified, which were NAS-ad (NAS at admission), NAS-a (NAS amplitude), NAS-ri (relative increment of NAS) and SAPS3. We observed that patients with higher NAS-ad had 1.08 more chances of death in the ICU (OR = 1.08; 95%CI: 1.02; 1.15), similar to the NAS-ri that the higher the score 1.07 the more chances of mortality (OR = 1.07; 95%CI: 1.03; 1.12). Moreover, SAPS3 was also shown to be a predictor of mortality, in which the higher 1.03 the more likely to die in the ICU (OR = 1.03; 95%CI: 1.01; 1.05). In contrast, the NAS-a variable decreased 0.94 chances of death of patients in the ICU, being considered a protective factor (OR = 0.94; 95%CI: 0.88; 0.99) (**Table 5**). In model 2, which evaluated the relationship between the presence of chronic obstructive pulmonary disease, thyroid diseases and concentration of urea level, which are the variables of admission, we found that patients with chronic obstructive pulmonary disease had 8,82 more chances of death in the ICU compared to those who did not have COPD (OR = 8.82; 95%CI: 1.82; 42.70), patients with thyroid disorders had 5.98 more chances of mortality in the ICU than those who did not have this condition (OR = 5.98; 95%CI: 1.15; 31.22) and the increased concentration of urea levels resulted in 1.01 more chances of death (OR = 1.01; 95%CI: 1.00; 1.02) (**Table 5**).

In model 3, which evaluated the relationship of all variables, nine of them were selected. We analyzed that patients with thyroid diseases had 19.88 more chances of death compared to those who did not have this condition (OR = 19.88; 95%CI: 3.03; 130.46), patients with COPD had 13.93 more chances of death than those who did not (OR = 13.93; 95%CI: 2.58; 75.20). The use of noradrenaline increased 6.17 more chances of mortality in the ICU (OR = 6.17; 95%CI: 1.46; 26.05), followed by corticosteroids, which increased 2.86 more chances of mortality (OR = 2.86; 95%CI: 1.32; 6.22) and vasopressin, with 5.71 more chances of death in the ICU compared with patients who did not use these drugs (OR = 5.71; 95%CI: 2.03; 16.05). It was observed that the higher the NAS-ad increased 1.09 more chances of mortality (OR = 1.09; 95%CI: 1.01; 1.17) and when the relative increase of the NAS increased 1.09 more chances of death in the ICU (OR = 1.09; 95%CI: 1.04; 1.14). Unlike these results, patients with tracheostomy decreased 0.34 the chances of mortality in the ICU (OR = 0.34; 95%CI: 0.15; 0.77) and the amplitude of the NAS (NAS-a) was also considered a protective factor, in which the chances of mortality of these patients decreased by 0.93 (OR = 0.93; 95%CI: 0.86; 1.00) (Table 5).

In model 4, which evaluated the relationship between the presence of chronic obstructive pulmonary disease, use of norepinephrine, corticosteroid, vasopressin and relative increase of NAS (NAS-ri), which are the variables that significantly we found that patients with COPD had a higher risk of mortality with 13.55 more chances of death than those who did not have this condition (OR = 13.55; 95%CI: 2.61; 70.30). Patients who used noradrenaline had 4.98 more chances of death than those who did not receive it in the ICU (OR = 4.98; 95%CI: 1.32; 18.69), who were administered with corticosteroids had 2.12 more chances of death than those who did not use it (OR = 2.12; 95%CI: 1.06; 4.25) and who used vasopressin had 4.86 more chances of death than those who did not (OR = 4.86; 95%CI: 1.87; 12.58). In addition, when the relative increase in NAS increased 1.03 more chances of mortality in the ICU (OR = 1.03; 95%CI: 1.01; 1.05) (**Table 5**).

Table 5 - Results of logistic regression analysis and Odds Ratio for predicting death in the ICU in patients admitted to mechanical ventilation.

Mi	Predictor Variable	Bi	EP	Wald	p	OR	LI	LS
M1	Admission NAS (NAS-ad)	0.08	0.03	5.96	0.015	1.08	1.02	1.15
	NAS Amplitude (NAS-a)	-0.07	0.03	4.53	0.033	0.94	0.88	0.99
	NAS Relative Increment (NAS-ri)	0.07	0.02	11.62	0.001	1.07	1.03	1.12
	SAPS3	0.03	0.01	6.22	0.013	1.03	1.01	1.05
	Constant	-6.70	1.83	13.36	0.699	0.001	-	
M2	Chronic Obstructive Pulmonary Disease	2.18	0.80	7.31	0.007	8.82	1.82	42.70
	Thyroidopathy	1.79	0.84	4.50	0.034	5.98	1.15	31.22
	Urea Level	0.01	0.00	6.25	0.012	1.01	1.00	1.02
	Constant	-1.34	0.28	22.08	<0.001	0.26	-	
M3	Thyroidopathy	2.99	0.96	9.70	0.002	19.88	3.03	130.46
	Chronic Obstructive Pulmonary Disease	2.63	0.86	9.38	0.002	13.93	2.58	75.20
	Tracheostomy	-1.09	0.42	6.64	0.010	0.34	0.15	0.77
	Use of Noradrenaline	1.82	0.73	6.13	0.013	6.17	1.46	26.05
	Use of Corticosteroid	1.05	0.40	7.05	0.008	2.86	1.32	6.22
	Use of Vasopressin	1.74	0.53	10.90	0.001	5.71	2.03	16.05
	Admission NAS (NAS-ad)	0.08	0.04	5.30	0.021	1.09	1.01	1.17
	NAS Amplitude (NAS-a)	-0.07	0.04	3.87	0.049	0.93	0.86	1.00
	NAS Relative Increase (NAS-ri)	0.08	0.02	11.72	0.001	1.09	1.04	1.14
	Constant	-7.49	2.05	13.37	<0.001	0.0006	-	
M4	Chronic Obstructive Pulmonary Disease	2.61	0.84	9.63	0.002	13.55	2.61	70.30
	Use of Noradrenaline	1.60	0.68	5.65	0.017	4.98	1.32	18.69
	Use of Corticosteroid	0.75	0.35	4.53	0.033	2.12	1.06	4.25
	Use of Vasopressin	1.58	0.49	10.59	0.001	4.86	1.87	12.58
	NAS Relative Increment (NAS-ri)	0.03	0.01	8.98	0.003	1.03	1.01	1.05
	Constant	-3.00	0.67	20.19	<0.001	0.05	-	

Caption: Mi: i-th model; M1: PM1 + workload indicators; M2: PM1 + admission variables; M3: PM1 + all variables; M4: PM1 + all significant variables ($p < 0.05$). Bi: i-th estimate of model parameters, EP: standard error, OR = Odds Ratio; Wald: Chi-square statistic of the Wald test; p: probability based on the Wald test, LI and LS: inner and upper limits, respectively, of the Odds-Ratio confidence interval at 95%.
Source: Silva NR, et al., 2024.

DISCUSSION

The results show that 71 (36.60%) patients' outcome was death in the ICU. This finding can be justified by the profile of hospitalized patients, which plays a significant role in the mortality rate, since demographic factors reflect the reality of each region and allows the study of the prevalence and incidence of diseases, as well as scientific knowledge and the formation of multidisciplinary teams, to enable a more effective management (AGUIAR LMM, et al., 2021). As for the clinical and epidemiological profile of patients admitted to the ICU on mechanical ventilation who died, there was predominance of males, with a median age of 64 years and diagnosis of admission for clinical causes. The result is in agreement with Pinheiro FGMS, et al. (2020), in which 62.1% of patients who had the death outcome in the ICU were male and the average age of patients who did not survive was higher, compared to those who were discharged.

The qualitative variables CCI, circulatory shock and coagulopathies influenced the outcome death in the ICU, compared to the discharge group. These data were related to the systematic review of Aguiar LMM, et al. (2021), who evidenced 66.7% of the causes of admission to the ICU due to cardiovascular diseases (CVD), being Brazil among the countries with the highest mortality rate from CVD. Circulatory shock affected approximately one third of patients admitted to ICUs and correlated with increased mortality rates, most patients who required vasopressor drugs were diagnosed with septic shock, followed by cardiogenic, hypovolemic shock, other types of distributive shock and obstructive shock (SCHEEREN WLT, et al., 2019).

In addition to volume replacement, vasopressor therapy plays a crucial role in the treatment of shock-induced hypotension, aimed at correcting vascular tone depression and, consequently, improving organ perfusion (SHI R, et al., 2020). However, the use of these drugs is not risk-free and may be associated with cardiovascular complications such as arrhythmias, myocardial ischemia, endothelial injury and thrombosis, therefore, the administration of vasoactive drugs requires a careful assessment of the risks and benefits, as well as continuous monitoring to ensure a safe and effective therapy (RUSSELL AJ, 2019). In our study, patients who died in the ICU and had administration of norepinephrine, corticosteroid, vasopressin, dobutamine and the median of days with the use of dobutamine and vasopressin had a higher and statistically significant proportion compared to those who were discharged and, as a consequence, there was renal overload due to the use of highly nephrotoxic drugs, evidenced by the increased concentration of urea in the blood. Noradrenaline is the vasopressor of choice for initial treatment in patients with shock, however, noradrenaline doses above 1mcg/kg/min are correlated with mortality rates above 80% (MERESSE Z, et al. 2020).

Increasing the intensity of therapy with vasopressors during the first 24 hours after the onset of shock has been associated with an increase in mortality, and this association varied with the amount of early administration of fluids and the timing of titration of the vasopressor (ROBERTS JR, et al. 2020). Therefore, it is recommended to start early administration of noradrenaline to achieve a target mean blood pressure (MBP) of 65 mmHg (SCHEEREN WLT, et al., 2019), and the use of dobutamine can be inserted, as vasopressors can reduce ventricular contractility (RUSSELL AJ, 2019).

The days in use of mechanical ventilation, the relationship of development of VAP and oral hygiene adherence were not significant differences in the discharge and death groups in the ICU, but referring to the VAP Bundle the oral hygiene adherence was >80% in both groups. This result can be explained by Lourençone EMS, et al. (2019), who evaluated nursing care related to preventive measures of VAP, including oral hygiene with chlorhexidine and observed that, due to monitoring and continuous reinforcement of preventive measures for VAP performed by the nursing team, adherence rates remained above 77%, causing a concomitant reduction in the rate of pneumonia associated with mechanical ventilation.

In the context of the outcomes, the median length of stay in the ICU did not differ significantly in both groups, but the median length of hospitalization and total UHS reimbursement was lower for patients who died, this discrepancy can be attributed to the fact that the hospitalization period is shorter, referring to patients who were discharged. The UHS reimbursement-day was higher, which is due to the greater dependence of these patients in terms of professional assistance, use of medicines, use of materials and daily procedures (RIOS JR, 2021). These data can be explained by Rios JR, et al. (2021) in which the ICU costs of a university hospital

in Triângulo Mineiro were analyzed, observing that the highest costs were related to labor, followed by medicines. In addition, healthcare-related infections contributed to prolonged hospitalization and eight-time increase in direct costs (OSME SF, et al., 2020).

When analyzing the predictors of mortality from logistic regression, tracheostomy was considered as a protective factor for death, observed in the M3 model, which corroborates Chorath K, et al. (2021) who performed in the meta-analysis the evaluation of the results of 17 randomized controlled trials with 3,145 participants, revealing that early tracheostomy in adults undergoing ventilator support for critical diseases was associated with improvement in the clinical outcome of hospitalization in the ICU. We found that patients with presence of chronic obstructive pulmonary disease increased the chances of death compared to the ICU-discharge group and were considered predictive of risk for mortality, evidenced in models M2, M3 and M4.

This result was observed in the systematic analysis and meta-analysis of Adeloye D, et al. (2020), who estimated the prevalence and risk factors of COPD, concluding that the prevalence of this condition is significantly high in several regions of low and middle income and this high prevalence is in line with the marked presence of the main risk factors, such as smoking, exposure to smoke from organic materials and air pollution. To add, Gonçalves-Macedo L, et al. (2019) showed that COPD mortality rates tended to decrease in both sexes, in the South, Southeast and Midwest regions, whose socioeconomic rates are higher. We found that patients with thyroid diseases were considered as predictive of risk for death, observed in models M2 and M3, findings that agreed with Zhang X, et al. (2024) which showed that subclinical hypothyroidism was associated with an increase in mortality in people aged 65 years or older. It is noteworthy that the thyroid gland plays a key role in the metabolic processes of the body, and patients with mild to moderate chronic kidney disease who presented thyroid dysfunction also presented an increased risk of adverse kidney events and mortality (SCHULTHEISS TU, et al., 2021).

The use of noradrenaline, corticosteroids and vasopressin are predictive risk factors for mortality, as evidenced in the M3 and M4 models. In addition, the urea level concentration is identified as a predictive risk factor for death, evaluated in the M2 model. Domizi R, et al. (2020) observed in their study that the mortality rate was higher among those who received noradrenaline at high doses (≥0.3mcg/kg/min). In addition, the onset of vasopressor administration after 6 hours of (not early) shock recognition was associated with a significant increase in mortality at 30 days (HIDALGO CD, et al., 2020). Current guidelines recommend combining noradrenaline with other vasopressors, such as vasopressin, in order to achieve a target MBP or reduce the dose of noradrenaline, aiming to reduce the mortality rate (SHI R, et al., 2020).

SAPS3 was considered a predictive factor of risk for death, observed in the M1 model. SAPS3 has been shown to be an effective indicator of global mortality (LIMA EB, et al., 2021). Individuals with higher SAPS3 scores demonstrated a higher probability of death, and due to the ease of calculating the SAPS3 index, its implementation in ICUs was proposed to simplify the assessment of the severity and mortality of hospitalized patients (ASSIS LGR, et al., 2020). This conclusion is consistent with the findings of our study, since patients with higher scores are more likely to have undesirable outcomes.

Regarding nursing workload, the variables NAS-ad and NAS-ri presented as predictive factors of risk for mortality, NAS-ad evidenced in models M1 and M3 and NAS-ri in models M1, M3 and M4. In the systematic review by Ross P, et al. (2023) 12 studies showed a relationship between increased nursing workload and increased mortality. When analyzing the data regarding the NAS of admission to the ICU, they found that the average nursing workload per participant increased to 80.67 points, indicating that the care provided during this initial period required greater work effort (SARDO PMG, et al., 2023). Regarding the relative increase of the NAS, a possible explanation for this fact is that the variability of this score draws the attention of the team, making it easier to adjust the scales. However, this scenario does not apply to minimal changes, which may go unnoticed by the team.

The NAS-m, NAS-Md, NAS-i were associated with higher medians for mortality in the ICU, with NAS-Md with 54 points and NAS-m with 55 points. Our results were related to Sardo PMG, et al. (2023), who found the average nursing workload per patient admitted to the ICU of 67.52 points. Nobre RAS, et al. (2019) showed high workload in ICUs with NAS scores >50.00, and the average number of nursing professionals calculated

by the NAS was higher than the average number of professionals required by legislation. These values indicated the need for more than 50% of a nursing professional's time in patient care and the high scores demonstrated the high workload in ICUs and the need for adequate dimensioning for care. Oliveira PMV, et al. (2019), conducted a survey in two adult ICUs of a medium-sized state public hospital, located in the city of São Paulo, and found that the median NAS was 89.3 points in patients who progressed to death, reaffirming that the severity of the patient is directly associated with a higher NAS score, thus increasing the probability of mortality.

Concerning NAS-dis, it indicated a more intense load on the day of the outcome for patients who died. This finding is aligned with what Oliveira PMV, et al. (2019) point out, when they prove that patients with fatal outcomes tend to have a higher NAS, both due to clinical severity and the demand for care that death imposes on the nursing team. Sardo PMG, et al. (2023) observed that the nursing workload during the last 24 hours of hospitalization was higher compared to the average of the other days of hospitalization (except the first day), possibly due to administrative and management responsibilities. NAS-Psa presented a median of (94.83%) in patients discharged from the ICU and (91.57%) in patients who died. In both medians, the percentage was below 100%, which indicated that the workload estimated by the NAS was not fully met in the assignment of scales in any of the groups.

Thus, it is observed that, in patients who died, the allocation of scales had a lower compliance with the load predicted by the NAS, compared to the discharge outcome. Our data follow the trend of the results reported by Sardo PMG, et al (2023), in which the nursing workload assessed in Portugal was higher than the available human resources of the days, overloading the nursing team with risk of compromising patient safety. The NAS-a indicated protective factor behavior for mortality in models M1 and M3, which showed that the variability of this score draws the attention of the team to the assistance provided, indicating that as the amplitude of the NAS increases, the mortality rate decreases. It is clear that knowing the prediction of death and the nursing workload in the intensive care unit is essential to ensure the provision of high-quality care, promote patient safety and optimize the operational efficiency of the health service.

CONCLUSION

The study analyzed the workload in nursing and identified the predictive factors related to mortality in patients admitted to mechanical ventilation in an Adult Intensive Care Unit. It was observed that the mean NAS, median NAS, increase of NAS and NAS of the outcome associated with higher medians of mortality in the ICU. Moreover, in the discharge and death groups in the ICU, the median percentage of adequacy of the NAS scale indicated that the workload estimated by the NAS were not completely met in the allocation of scales. Patients with chronic obstructive pulmonary disease, thyroid diseases, elevated levels of urea in the blood, administration of norepinephrine, corticosteroids and vasopressin were identified as predictive risk factors for mortality, score in the SAPS3, NAS of admission and relative increment of the NAS. Otherwise, the predictive factors of protection for mortality included patients with tracheostomy and NAS amplitude.

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