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INCIDENCE AND FACTORS ASSOCIATED WITH CARDIORESPIRATORY ARREST IN THE FIRST 24 HOURS OF HOSPITALIZATION IN INTENSIVE CARE UNIT

INCIDÊNCIA E FATORES ASSOCIADOS À PARADA CARDIORRESPIRATÓRIA NAS PRIMEIRAS 24 HORAS DE INTERNAÇÃO EM UNIDADES DE TERAPIA INTENSIVA

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ABSTRACT

Objectives: To identify the incidence of cardiorespiratory arrest (CRA) in the first 24 hours of hospitalization in Intensive Therapy Units (ITU) and its associated factors; to determine whether greater severity on admission is associated with a higher occurrence of CRA in patients admitted to the ITU. Methods: In a secondary study, 530 complete patient records of individuals that comprised the case series of the primary study "Clinical Characterization of Adults and Elderly Patients in ITU" were analyzed. Demographic and clinical data were extracted, and also data on severity (Simplified Acute Physiology Score – SAPS II) and the occurrence of CRA (events/24 hours; time; rhythm; reversion measure and outcome). For the analyses, comparisons of means and association tests were used. Biserial point correlation and logistical regression were carried out with analysis of predictive capacity by means of the ROC curve. A p value was fixed at 0.05 and the analyses were performed using the software programs SPSS (version 22) and Medcalc. Results: The incidence of CRA in the first 24 hours of hospitalization was 3.6% (n = 19). Each individual had a mean of 1.61 ± 0.97 CRA events, with a mean time of 7.68 ± 10.59 minutes. The most frequent rhythms were: PEA (42.1%), AS (21.1%); pulseless VT (5.3%). The only comorbidity that was associated with CRA was shock (p = 0.003). The reversion methods most used were: chemical (31.6%), chemical+electrical (10.5%) and only electrical (5.3%). There was no spontaneous return-of-circulation in 57.9% of cases. The SpO2 (p < 0.001), level of consciousness (p < 0.001) and severity (p = 0.032) were associated with the occurrence of CRA. The severity on admission was an independent predictor of the occurrence of CRA (OR = 1.032; p = 0.034), with good predictive capacity (AUC = 0.618). The SAPS2 cutoff point that best predicts CRA is 38.0 points (sensitivity: 52.6; specificity: 72.4). Conclusions: The incidence of CRA in the first 24 hours of hospitalization in the ITU was 3.6%. The factors associated with CRA were: oxygen saturation, level of consciousness, and severity. Severity on admission is a predictor of the occurrence of CRA with good predictive capacity.

Keywords: *Intensive Care Units; Heart Arrest; Incidance; Paciente Acuity; Nursing Care.*

RESUMO

Objetivos: Identificar a incidência de parada cardiorrespiratória (PCR) nas primeiras 24 horas de internação em Unidades de Terapia Intensiva (UTI) e seus fatores associados; verificar se a maior gravidade admissional está associada à maior ocorrência de PCR em pacientes internados em UTI. Métodos: Em um estudo secundário, foram analisados 530 prontuários completos de indivíduos pertencentes à casuística do estudo primário "Caracterização Clínica de Adultos e Idosos em UTI". Foram extraídos dados demográficos, clínicos, gravidade (Simplified Acute Physiology Score – SAPS II) e ocorrência de PCR (eventos/24 horas; tempo; ritmo; medida de reversão e desfecho). Para as análises foram utilizados testes de comparação de médias e de associação. Foi feita correlação ponto bisserial e regressão logística com análise da capacidade preditiva por meio da curva ROC. O valor de p foi fixado em 0,05 e as análises foram feitas por meio do software SPSS (versão 22) e Medcalc. Resultados: A incidência de PCR nas primeiras 24 horas de internação foi de 3,6% (n = 19). Cada indivíduo teve em média 1,61 ± 0,97 eventos de PCR com tempo médio de 7,68 ± 10,59 minutos. Os ritmos mais frequentes foram: AESP (42,1%), AS (21,1%); TV sem pulso (5,3%). A única comorbidade que se associou à PCR foi o choque (p = 0,003). Os métodos de reversão mais utilizados foram: químico (31,6%), químico+elétrico (10,5%) e apenas elétrico (5,3%). Não houve retorno da circulação espontânea em 57,9% dos casos. A SpO2 (p < 0,001), o nível de consciência (p < 0,001) e a gravidade (p = 0,032) associaram–se à ocorrência de PCR.

A gravidade admissional foi um preditor independente de ocorrência de PCR (OR = 1,032; p = 0,034), com boa capacidade preditiva (AUC = 0,618). O ponto de corte do SAPS2 que melhor prediz a PCR é 38,0 pontos (sensibilidade: 52,6; especificidade: 72,4). Conclusões: A incidência de PCR nas primeiras 24 horas de internação em UTI foi de 3,6%. Os fatores associados à PCR foram: saturação de oxigênio, nível de consciência e gravidade. A gravidade admissional é um preditor de ocorrência de PCR com boa capacidade preditiva.

Descritores: Unidade de Terapia Intensiva; Parada Cardíaca; Incidência; Gravidade do Paciente, Cuidados de Enfermagem.

INTRODUCTION

Cardiorespiratory arrest (CRA) is characterized by a sudden interruption of mechanical circulation due to the absence of functional ventricular activity and/or ventilatory failure in an individual not predisposed to death and without intractable or terminal diseases.[1]

According to the cardiopulmonary resuscitation (CPR) and emergency cardiovascular care guidelines published by the American Heart Association, patients who experience CRA, regardless of whether it occurs inside or outside the hospital, should be admitted to an intensive care unit (ICU), where post-resuscitation care and advanced life support can be provided.[2] Additionally, CRA is one of the most common complications in the ICU due to the higher prevalence of patients with complex and severe conditions, and it is associated with high morbidity and mortality.

Nurses witness all events occurring in the hospital; therefore, they are considered to be technically, institutionally, and legally competent in appropriately performing CPR procedures.[3]

Since CRA is associated with high mortality, specifically in the ICU, where disease severity is significantly higher, it is important to identify conditions associated with a higher risk of CRA. Recent epidemiological studies in Brazil have not reported the current incidence and factors associated with CRA in clinical and surgical ICUs. Moreover, studies determining the admission severity of patients with CRA in the first 24 hours of hospitalization in the ICU have not yet been conducted.

Thus, this study aimed to identify the incidence of and factors associated with CRA in the first 24 hours of hospitalization in the ICU and determine whether higher admission severity is associated with higher incidence of CRA in patients admitted to the ICU. Identifying these factors may help nurses in identifying individuals at higher risk of CRA in the ICU, specifically during hospitalization, when the clinical conditions causing patient's instability have not yet been resolved.

METHODS

Using a cross-sectional study, we analyzed the cases belonging to the study series "Clinical Characterization of Adults and Elderly in Intensive Care Unit: the impact of new profiles for advanced clinical nursing care," duly approved by the Ethics and Research Committee of the University of São Paulo School of Nursing (Opinion no. 447.731). The study was conducted in nine ICUs of a large university hospital in São Paulo, with seven hospital accreditation seals of approval in 2018, among them the "Hospital Amigo do Idoso" seal, with 918 beds. They have several specialty ICUs, with an occupancy rate of 80%.

The data collection period was from September 2016 to February 2017. The sample included 530 cases of adults (individuals aged 18 years or older) and elderly individuals (individuals aged 60 years or older) admitted to one of the ICUs of the study (Trauma ICU, Medical Clinic, Emergency Medical Clinic, Anesthesiology, Neurology, Nephrology, Infectology, Pulmonology, and Surgery) with available study variables. We excluded patients whose medical records had errors or were incomplete or duplicated (241 excluded cases).

The demographic and clinical data were extracted from the databases of the primary study, and the variables of this study were the following: (1) demographics (gender, age, type of ICU [clinical or surgical], type of admission [elective, emergency], ICU specialty), (2) clinicians (medical diagnosis upon admission, personal history, level of consciousness [measured using the Glasgow Coma Scale, GCS], noninvasively measured vital signs [temperature; systolic, mean, and diastolic blood pressure; heart rate; respiratory rate and oxygen saturation], severity (measured using the Simplified Acute Physiology Score, SAPS II) (Le Gall et al., 1993), and (3) incidence of CRA in the first 24 hours after hospitalization. The clinical data refer to the period of ICU admission prior to the incidence of CRA.

To determine the incidence of CRA, the number of CRAs in the first 24 hours after hospitalization, CRA time, arrest rhythm (ventricular fibrillation, pulseless ventricular tachycardia [VT without pulse], pulseless electrical activity [PEA], and asystole [AS]), reversal measurement (chemical or electrical), and outcome (resuscitation or death) were extracted.

The data were analyzed using descriptive and analytical statistics. Fisher's exact test was used to determine the association between comorbidities and the incidence of CRA. The Student's *t*-test with Levene's adjustment to verify variance equality was used to compare means, and Pearson's point-biserial correlation analysis was performed for correlations. To determine the association between admission severity and the CRA incidence within the first 24 hours, a prediction analysis was performed using logistic regression, considering CRA as a dependent variable and severity as an independent variable. The predictive capacity of severity measured using SAPS II in relation to CRA was determined using the receiver operating characteristic analysis, and the Youden index was used to identify the best cutoff point of SAPS II. P-values $\leq$ 0.05 were considered statistically significant, and the analyses were performed using the Statistical Package for the Social Sciences (version 22) and MedCalc software programs.

RESULTS

Of the 530 patients included in this study, 54.5% were males (n=289) and 59.4% were adults (n=315). The age of

men and women ranged from 18 to 90 years and 18 to 99 years, respectively. The mean age of women was higher than that of men (56.35±17.87 *vs.* 51.13±17.89 years, respectively; p = 0.001).

Regarding origin, 52.5% came from the emergency room (n=278), 31% from the surgical center (n=165), and 7.4% from wards (n=39). The record of origin was not available in 4.5% of the medical records (n=24). A majority of cases were admitted to the clinical ICU (41.1%, n=218), followed by the surgical ICU (35.3%, n=187) and the specialty ICU (23.6%, n=125). In the specialty ICU, the emergency medical clinic (26.2%) had the highest number of hospitalizations, followed by the trauma (22.1%) and surgical (19.2%) ICUs.

The most frequent medical diagnoses upon admission were related to the cardiovascular system (69%), trauma (63%), neurological system (56%), and respiratory system (41%). Each individual had on average 1.43 ± 1.56 comorbidities, the most common being systemic arterial hypertension (41.7%), diabetes mellitus (18%), shock (11.3%), and heart failure (8.9%).

The characteristics of noninvasively measured vital signs, level of consciousness, and admission severity are presented in Table 1.

The incidence of cardiac arrest in the first 24 hours of hospitalization in the ICU was 3.6% (n=19).

Of the 19 individuals in the sample who underwent CRA, 63.3% were male (n=12) and 52.6% were elderly (n=10). The mean age of individuals with CRA was 55.16±16.69 years, ranging from 21 to 80 years. The difference in mean age of cases with and without CRA (53.44±18.11 years) was not statistically significant (p-value, 0.666).

Regarding the type of hospitalization, 84.2% of the patients were admitted for clinical treatment (n=16) and 10.5% for emergency surgical treatment (n=2). Among them, 63.2% were admitted to the surgical ICU (n=12) and 31.6% to the clinical ICU (n=6). Among the nine ICU specialties of the study, most cases were admitted to the ICU of the emergency medical clinic (36.8%), followed by the medical clinic (26.3%), surgery clinic (15.8%), and trauma clinic (15.8%). One of the cases was admitted to the ICU of nephrology clinic (5.3%).

Most cases of CRA were admitted for treatment of conditions related to the cardiovascular system (31.6%, n=6), followed by trauma (21.1%, n=4) and hemato-infectious conditions (10.5%, n=2). Patients' information was not available in 21.1% (n=4) of the medical records.

More individuals who had CRA had at least one prior comorbidity in relation to those who did not (1.00±1.1 vs. 1.44±1.5 diseases), but this difference was not statistically significant (p = 0.106). There was also no significant difference between the rate of comorbidities of those who had CRA and those who did not (1.42±1.77 vs. 1.87±2.00; p = 0.291). Among the comorbidities analyzed, shock was the only comorbidity that was statistically associated with the incidence of CRA (p-value = 0.003). Systemic arterial hypertension (p = 0.814), coronary arterial disease (p-value = 0.145), heart failure (p = 0.681), atrial fibrillation (p = 0.171), diabetes mellitus (p = 0.134), dyslipidemia (p = 1.00), stroke (p = 1.00), dysthyroidism (p = 0.57), asthma (p = 1.00), chronic obstructive pulmonary disease (p = 0.072), chronic renal insufficiency (p = 1.00), and peripheral vascular disease (p = 0.227) were not statistically significant in relation to the incidence of CRA.

The characteristics of cases according to the noninvasively measured vital signs, level of consciousness, and admission severity according to the incidence of CRA are presented in Table 2.

Each individual had an average of 1.61 ± 0.97 CRA events in the first 24 hours of hospitalization, ranging from 1 to 5, with a mean time of 7.68 ± 10.59 minutes in each event.

The most frequent rhythm of CRA was PEA (n=8, 42.1%), followed by AS (n=4, 21.1%) and pulseless VT (n=1, 5.3%). The rhythm was not recorded in 31.6% of the medical records (n=6).

The most used reversion methods were as follows: chemical (31.6%), chemical combined with electrical (10.5%), and only electrical (5.3%). The method of CRA reversal was not described in 52.6% of medical records (n=10). Most cases of CRA resulted in death (57.9%).

When determining the association between the incidence of CRA and vital signs, an association was only observed with oxygen saturation (p-value = 0.000). The level of consciousness (p = 0.000) and admission severity (p = 0.032) were also associated with the incidence of CRA (Table 3).

Moreover, admission severity measured using SAPS II was an independent predictor of CRA. Individuals with higher admission severity were 3.2% more likely to have cardiac arrest than those with lower admission severity. Admission severity measured using SAPS II was also considered to be

Table 1. Mean and standard deviation of vital signs, level of consciousness, and admission severity before cardiorespiratory arrest (n=530). São Paulo, 2018.

	Mean	Standard deviation
Temperature	35.84 ºC	3.34
Heart rate	89.99 beats/minute	24.26
Systolic blood pressure	124.83 mmHg	58.22
Diastolic blood pressure	70.46 mmHg	18.64
Mean blood pressure	87.17 mmHg	25.53
Respiratory rate	18.27 breaths/minute	7.85
Oxygen saturation	95.20%	6.48
Level of consciousness (Glasgow Coma Scale)	11.70 points	4.6
Severity (Simplified Acute Physiology Score II)	30.22 points	15.02

Table 2. Characteristics of noninvasively measured vital signs, level of consciousness, and admission severity by incidence of cardiorespiratory arrest.

	Cardiorespiratory arrest	Mean	Standard deviation	P-value*
Temperature	No	35.84	3.392	0.720
	Yes	35.71	1.448	
Heart rate	No	89.67	24.048	0.210
	Yes	98.42	28.981	
Systolic blood pressure	No	125.45	58.735	0.080
	Yes	108.05	39.670	
Diastolic blood pressure	No	70.61	18.611	0.369
	Yes	66.28	19.637	
Mean blood pressure	No	87.46	25.348	0.265
	Yes	79.47	29.902	
Respiratory rate	No	18.40	7.827	0.087
	Yes	15.05	7.948	
Invasive blood pressure	No	.13	1.090	0.008
	Yes	.00	.000	
Oxygen saturation	No	95.483	4.6389	0.000
	Sim	87.833	23.8260	
Level of consciousness (electrocardiogram)	No	11.91	4.543	0.002
	Yes	6.55	4.435	
Severity (Simplified Acute Physiology Score II)	No	29.95	14.855	0.089
	Yes	37.47	18.041	

*Student's t-test with Levene's adjustment

an indicator with good predictive capacity (area under the ROC curve = 0.618), predicting CRA in 61.8% of cases. The cutoff point of SAPS II that was best associated with the incidence of CRA was 38 points, with a sensitivity of 52.63 and a specificity of 72.35 (Table 4, Figure 1).

DISCUSSION

The results based on the analysis of nine specialized ICUs belonging to a large university hospital in São Paulo City indicated the following: (1) The incidence of CRA in the first 24 hours after hospitalization was 3.6%, (2) the number of events per patient ranged from 1 to 5, (3) the most frequent initial rhythm was chemically reversed PEA, (4) the return of spontaneous circulation was observed in less than half of the cases, (5) some clinical conditions were associated with the incidence of CRA, and (6) admission severity was an independent predictor of CRA in the first 24 hours of hospitalization.

This was the first study to analyze the incidence of CRA in the first 24 hours of hospitalization in the ICU, limiting its comparison with other studies. In any case, even if we consider the results found in studies that analyzed the incidence of CRA throughout the hospitalization period and not only in the first 24 hours, it is observed that the incidence of CRA found in this study is within the range of variation already reported in the literature. Two recent studies, one of them a review study, point out that the incidence of CRA in the ICU varies from 2.9% to 78.1%.[4,5] Therefore, it is observed that there is a large variation in the incidence rates in various studies already published, which is probably due to methodological differences related mainly to the study population.

The comparison of incidence rates between studies should be carefully examined because the values obtained through the analysis of extra-hospital events are not comparable to those obtained in in-hospital events regarding the function of the patients' characteristics and the factors associated with the implementation of CPR. Moreover, even if events that occurred within the hospital are considered, the incidence of CRA still differs among the hospital units. It is estimated that the incidence of in-hospital CRA is higher in the ICU than that in other hospital units, corresponding to up to 45% of in-hospital events.

Table 3. Association between vital signs, level of consciousness, and admission severity by incidence of cardiorespiratory arrest. São Paulo. 2017.

	CRA			
	Yes	No	r*	P-value
Temperature (ºC)	35.71	35.84	-0.007	0.867
Heart rate (bpm)	98.42	89.99	0.067	0.123
Systolic blood pressure (mmHg)	108.05	124.83	-0.056	0.201
Diastolic blood pressure (mmHg)	66.28	70.46	-0.042	0.334
Mean blood pressure (mmHg)	79.47	87.17	-0.058	0.181
Respiratory rate (rpm)	15.05	18.27	-0.083	0.069
Oxygen saturation (%)	87.83	95.20	-0.220	0.000
Level of consciousness (electrocardiogram, points)	6.55	11.74	-0.202	0.000
Severity (Simplified Acute Physiology Score II, points)	37.47	30.22	0.093	0.032

Pearson's point-biserial correlation.

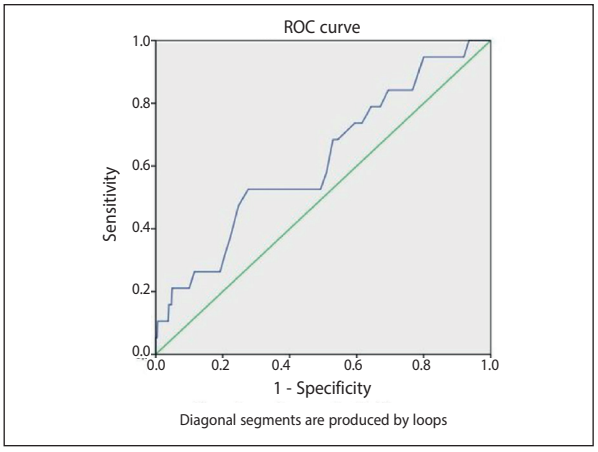

Figure 1. The receiver operating characteristic curve of the Simplified Acute Physiology Score II in relation to cardiorespiratory arrest. São Paulo, 2017.

According to Adamski et al.'s study, [6] the incidence of CRA was higher in the ICU than that in other hospital units (40.2%).

In this study, the factors associated with CRA are also similar to those found in other studies regarding the number of events,[7,8] duration of the event,[4] and most frequent initial CRA rhythm.[4] Generally, the number of CRA events per ICU patient varies from one to five, and the duration of CPR to achieve the return of spontaneous circulation varies from less than 5 minutes to 56 minutes, but usually lasts less than 10 minutes. The faster the return of spontaneous circulation, the higher the chances of survival.[7] The results of this study showed an average duration of CPR of approximately 7 minutes. It was impossible to measure the time interval between the detection of CRA and the beginning of the CPR because these data were not available in the medical records.

The most frequent initial CRA rhythm was PEA, followed by AS. Similar results were also reported by Efendijev et al.[4] It is estimated that in the ICU, generally, the non-shockable rhythms are the most frequent, ranging from 55% to 84% in different studies. Shockable rhythms are most commonly observed in the ICUs, with a higher frequency of ischemic heart diseases,[9] while non-shockable rhythms are associated with a higher state of severity and clinical impairment, such as in advanced stages of hypoxia and sepsis. [4,9]

It is estimated that return of spontaneous circulation is frequent in cases of CRA in the ICU, increasing patients' survival. Outcomes are better in the ICU[7] because in the ICU, the time between the detection of the incidence of CRA and performance of CPR is shorter, with the latter being immediately performed.[6] Moreover, the ICU has a more trained staff who promptly identify severe conditions and perform CPR (compared to lay rescuers in the out-of-hospital environment) and has more advanced technological resources to manage several serious clinical conditions. On the contrary, patients admitted in these units have higher disease severity that may interfere with their clinical outcomes in the short (return of spontaneous circulation), medium (hospital discharge), and long term (from 6 months to 1 year after the event).

Table 4. Odds ratio and predictive capacity of admission severity measured using Simplified Acute Physiology Score II (SAPS II) in the incidence of cardiorespiratory arrest, São Paulo. 2017.

	Odds ratio	CI 95%	P-value	AUC	95% CI of the AUC	Cutoff point	Sensitivity	Specificity
SAPS II	1.032	1.002 – 1.062	0.034	0.618	0.575 – 0.660	>38.0	52.63	72.35
Constant	0.013		0.000					

In the present study, return of spontaneous circulation was observed in 42.1% of the patients; hence, more than half of the individuals did not survive the first CRA event. According to Girotra, [9] most deaths from cardiac arrest occur during resuscitation efforts in the first CRA event. It is estimated that 80% of cases of in-hospital CRA do not survive; approximately 50% of the cases die because of the absence of return of spontaneous circulation; and among those who survive the event, many patients are still at high risk of death, because they present more severe clinical conditions.[9] In 25% to 67% of the cases, death may occur in the first 24 hours after the CRA event.[7] In the present study, 57.9% of the individuals did not experience return of spontaneous circulation.

The literature emphasizes that certain demographic variables, such as gender and age, and clinical variables are associated with the incidence of CRA. An association between the incidence of CRA and gender or age was not observed. A Canadian study conducted by Brindley et al.[10] also found that gender and age were not associated with the incidence of CRA. The results of the present study show that the incidence of CRA was associated with a diagnosis of shock, level of consciousness measured using the GCS, peripheral oxygen saturation, and admission severity measured using SAPS II. Thus, individuals diagnosed with shock in the first 24 hours of hospitalization in the ICU and who had reduced level of consciousness, low oxygen saturation, and higher admission severity had a higher incidence of CRA on the first 24 hours of hospitalization in the ICU.

Individuals who were taking vasoactive drugs for shock management at the time of the CRA event have lower survival rates.[4] Additionally, deaths that occur in the first 24 hours of hospitalization in the ICU after the CRA event and return of spontaneous circulation are caused by shock.[11]

The factors associated with the incidence of CRA previously described were alteration in respiratory rate, dyspnea, alteration in the pulse, decrease in systolic blood pressure, change in temperature, decrease in oxygen saturation, and chest pain. Of these, dyspnea, altered pulse, and systolic blood pressure were identified as predictors of CRA.[12] However, the mapping of these factors and the definition of predictors using multivariate analysis were not performed in a sample of patients in the ICU. In any case, the results of the present study also showed an association between CRA and oxygen saturation and respiratory rate (p –value, marginal), which is probably due to the low number of cases of CRA.

Admission severity measured using SAPS II was an independent predictor of CRA. More severe individuals had a 3.2% greater risk of having CRA than those who were less severe. SAPS II had a good predictive capacity (61.8%) to predict the incidence of CRA, and the best cutoff point on the scale was 38 points. Higher severity was associated with higher mortality after CRA.[5]

Since this is a secondary study, the main limitation of this study was the collection of data from medical records. Hence, collection of complete information was impossible either because the records were illegible or because they were incomplete; hence, clinical characteristics of each individual were not properly determined.

In any case, this is the first study to determine the incidence of CRA in the first 24 hours of hospitalization in the ICU and to analyze the association between admission severity and the incidence of CRA on the first 24 hours of hospitalization in the ICU, with the best cutoff point using SAPS II c predicting the incidence of CRA in the ICU.

The findings are important in clinical practice mainly because of the existing insufficient studies related to CRA in the ICU. Even in international databases, conclusive studies regarding the incidence and clinical characteristics of individuals with CRA, common in the ICUs, where the most severe patients are being admitted, are insufficient. These results can be used by nurses to identify patients with a higher risk of CRA in the first 24 hours of hospitalization in the ICU.

CONCLUSION

The incidence of CRA in the first 24 hours of hospitalization in the ICU was 3.6%. The factors associated with CRA were oxygen saturation, level of consciousness, and admission severity. Admission severity was an independent predictor of CRA with a good predictive capacity.

SUPPORT

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CONFLICTS OF INTEREST

The author declares that he has no conflicts of interest in this work.

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