Prevalence and factors associated with the sepsis continuum in an adult intensive care unit

Prevalência e fatores associados ao continuum da sepse em unidade de terapia intensiva adulto

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ABSTRACT | OBJECTIVE: To verify the prevalence of infection, sepsis and septic shock and factors associated with these conditions in patients admitted to an Adult ICU of a hospital in the interior of Brazil. **METHODS AND MATERIALS:** Cross-sectional, retrospective and documentary study, in an Adult ICU in the interior of Rio Grande do Sul, Brazil. Sample of 259 medical records from 2016 to 2018. Data collection using a structured instrument and descriptive and multivariable analyses. **RESULTS:** It was shown that 19.3% of patients had infection, 17% had sepsis and 10.8% had septic shock. Most women (59.1%), between 51 and 64 years old (27.3%), with hypertension (36.4%) and diabetes (26.1%). 96.6% received antibiotic therapy, but only 50% collected cultures. **CONCLUSIONS:** The prevalence of the sepsis continuum in the ICU was 33.9%; and the associated factors are the use of enteral tubes, central venous catheters, mechanical ventilation and cardiology and pulmonology specialties.

KEYWORDS: Infections. Sepsis. Septic Shock. Intensive Care Units. Septic Shock. Nursing.

RESUMO | OBJETIVO: Verificar a prevalência de infecção, sepse e choque séptico e fatores associados a estes agravos em pacientes internados em uma unidade de terapia intensiva (UTI) adulto de um hospital do interior do Brasil. **MÉTODOS E MATERIAIS:** Estudo de corte transversal, retrospectivo e documental, em UTI Adulto do interior do Rio Grande do Sul, Brasil. Amostra de 259 prontuários no período de 2016 a 2018. Coleta de dados através de instrumento estruturado e análise descritiva e multivariável. **RESULTADOS:** Evidenciou-se que 19,3% dos pacientes apresentaram infecção, 17% sepse e 10,8% choque séptico. Maioria mulheres (59,1%), entre 51 a 64 anos (27,3%), com hipertensão (36,4%) e diabetes (26,1%). 96,6% receberam antibioticoterapia, porém apenas 50% coletaram culturas. **CONCLUSÕES:** A prevalência do *continuum* da sepse na UTI foi 33,9%; e os fatores associados são a utilização de sonda enteral, cateter venoso central, ventilação mecânica e especialidades de cardiologia e pneumologia.

PALAVRAS-CHAVE: Infecções. Sepse. Choque Séptico. Unidades de Terapia Intensiva. Enfermagem.

1. Introduction

Sepsis is a life-threatening organ dysfunction caused by the body's dysregulated response to an infection, which can develop into septic shock. Infections can be caused by bacteria, viruses, fungi, or protozoa, and any infection can develop into sepsis. When sepsis is not promptly diagnosed and treated, it can progress to septic shock, with persistent hypotension on volume replacement (mean arterial pressure ≤ 65mmHg) and require the use of vasopressors. It is, therefore, a continuum represented by the evolution and worsening of a clinical condition.[1]

The diagnosis of sepsis is linked to the assessment of organ dysfunctions based on the Sequential Organ Failure Assessment (SOFA) score, which assesses cardiovascular, neurological, respiratory, renal, hepatic and coagulative functions. These concepts were updated in 2016, considering that the Systemic Inflammatory Response Syndrome (SIRS) criteria are no longer required to diagnose sepsis, as the presence of an infectious focus is not always clear, and SIRS can be secondary to polytrauma or major surgery.[1]

The worldwide incidence of sepsis has increased over the years. In the United States, sepsis affects around 1.5 million people a year, leading to the death of around 250,000.[2] In Brazil, there are approximately 600,000 cases of sepsis per year.[3] The available national data points to a high lethality rate, especially in public hospitals linked to the Sistema Único de Saúde - SUS (Brazilian Unified Health System). However, the data are only estimates, as there is no epidemiological control for monitoring sepsis cases in the country. A single-day prevalence survey of around 230 randomly selected Brazilian Intensive Care Units (ICUs) showed that patients occupy 30% of beds with sepsis or septic shock.[1]

One study showed that sepsis affects 29.5% of patients in ICUs, and 18.0% of these are diagnosed on admission. In North American ICUs, this rate is 20.1%; in South American ICUs, 30.5%; and in European ICUs, 30.8%. Mortality in these units is approximately 12.1% in patients without sepsis, 25.8% in patients with sepsis, and 34.6% in patients with septic shock.[4]

The cost of sepsis is also an important issue. It is estimated at approximately 20 billion dollars a year and can vary based on etiology, with hospital-acquired sepsis costing approximately 30,000 dollars more than community-acquired sepsis. The overall cost of sepsis reflects the initial hospitalization and the use of health resources after hospital discharge and readmissions.[2] Furthermore, in Brazil, an evaluation estimated that the cost of treating sepsis is equivalent to US$9,600 per patient.[1]

Another issue is the heterogeneity in the incidence and mortality of sepsis in the various places studied. This demonstrates that this is a context-dependent problem, varying according to local resources to prevent, identify, and treat it.[5] In this sense, there is a need to improve global and local infection prevention and control strategies, as well as early diagnostic approaches and appropriate treatment to prevent unfavorable prognoses[6], considering each context.[5]

Particularly with this problem in the ICU in Brazil, there is a shortage of beds, which contributes to hospitalization and late access to intensive care, which increases the risk of sepsis developing into septic shock in patients with community infections and comorbidities. Sepsis is also a secondary cause of healthcare-associated infections, with the ICU being the primary setting for the development of these infections, as patients are subjected to numerous procedures and invasive devices. The use of gastric, bladder, venous and arterial catheters, drains, continuous infusions, nutritional restrictions and mechanical ventilation, among other therapeutic and diagnostic procedures, are risk factors for developing the sepsis continuum in the ICU.[1,7,8]

The results of this study are expected to help the institution involved and others recognize the risks of sepsis presented by patients and plan actions for surveillance, prevention, and control of infections to increase the safety of critically ill patients. Thus, considering the sepsis continuum, this study aims to verify the prevalence of infection, sepsis, and septic shock and the factors associated with these conditions in patients admitted to an adult ICU in a hospital in the countryside of Brazil.

2. Method

This study is part of a matrix research project entitled "Clinical and Social Profile of Patients Admitted to the Adult Intensive Care Unit of a Hospital on the Western Border of the State of Rio Grande do Sul", carried out at the Federal University of Pampa (UNIPAMPA). This is a cross-sectional, retrospective, and documentary study conducted in an Adult ICU in the interior of Rio Grande do Sul, Brazil. The unit, which has ten beds for caring for adult patients in critical health situations, is supported by an interdisciplinary team. This team, comprising doctors, nurses, nursing technicians, physiotherapists, emergency and urgent residents, and professionals from nutrition and pharmacy, ensures that patients receive comprehensive and high-quality care.

The study period was from 2016 to 2018, with 419 inpatients. The study period was chosen due to the updated concepts involving the sepsis continuum and diagnostic criteria published in 2016.[1] Based on the proportion of 30% of patients with sepsis in ICUs[4], a standard error of 5%, and a confidence level of 99%, the sample size was 257 medical records. It was decided that 259 medical records, which comprise the matrix research database, were used for the study.

We included the medical records of patients aged 18 or over who had been in the ICU for more than 24 hours. Medical records that did not have complete data on the variables used in this study were excluded.

Data was collected between August and September 2019 using a structured instrument whose variables were social characteristics, comorbidities, risk factors, medical specialty, use of mechanical ventilation, sedation, invasive devices, diagnosis of infection, sepsis, and septic shock in medical records, collection of cultures, antibiotic therapy, length of stay, and clinical outcome.

The data was meticulously organized in an Excel® 2019 spreadsheet and then subjected to rigorous analysis using the advanced Statistical Package for Social Sciences® (SPSS) software version 20.0. Our approach involved a series of steps, starting with descriptive analyses using frequency distribution. A logistic regression model was applied for multivariable analysis to assess the factors associated with sepsis, including variables with a Prevalence Ratio (PR) value of less than or equal to 0.1 and a 95% Confidence Interval (CI).

The ethical precepts determined by the National Health Council were respected, with approval from the institution's Comitê de Ética em Pesquisa - CEP (Research Ethics Committee), under opinion no. 3.404.096 and CAAE: 12237519.4.0000.5323. In addition, it should be noted that when the project was approved, the CEP decided not to require the Informed Consent Form, considering that the data was accessed from the patient's medical records.

3. Results

Of the 259 patient records admitted to the adult ICU between 2016 and 2018, 88 (33.9%) were diagnosed with infection, sepsis, and septic shock during hospitalization. Among these, 19.3% were diagnosed with infection, 17% with sepsis, and 10.8% with septic shock, as shown in Table 1.

Table 1. Patients hospitalized with sepsis continuum in an adult ICU between 2016 and 2018. Uruguaiana, RS, Brazil, 2019 (N=259)

Medical diagnosis	N	%
Infection		
Yes	50	19.3
No	209	80.7
Sepsis		
Yes	44	17
No	215	83
Septic shock		
Yes	28	10.8
No	231	89.2

Source: the authors (2019).

Amidst the 88 patients diagnosed with infection, sepsis, and septic shock, the majority were female (59.1%), aged between 51 and 64 (27.3%), white (73.9%), and with complete primary education (58%). Most were Catholic (53.4%), single, divorced, or widowed (58%). As for place of birth, 78.4% belonged to the municipality where they were based, and the rest were from other cities in the region referred to the ICU studied.

Table 2. Characterization of patients admitted to the Adult ICU diagnosed with infection and/or sepsis and/or septic shock between 2016 and 2018. Uruguaiana, RS, Brazil, 2019 (N=88)

Variables	n	%
Gender		
Female	52	59.1
Male	36	40.9
Age range		
Up to 51 years old	22	25
51 to 64 years old	24	27.3
64 to 73 years old	20	22.7
Over 73	22	25
Color		
White	65	73.9
Black	3	3.4
Other	20	22.7
Marital Status		
Married or in a stable union	29	33
Single, divorced, or widowed.	51	58
Education		
Illiterate	4	4.5
Complete elementary school	51	58
High school incomplete	1	1.1
High school complete	20	22.7
Higher education complete	2	2.3
Not recorded	10	11.3
Religion		
Evangelical	18	20.5
Catholic	47	53.4
Spiritualist	1	1.1
Data not recorded	11	12.5
Data illegible	11	12.5
Municipality of origin		
Uruguaiana	69	78.4
Other	19	21.6

Source: the authors (2019).

Table 3 shows which comorbidities, procedures, and invasive devices are risk factors for infection. The most prevalent comorbidities in patients diagnosed with infection or sepsis and septic shock were arterial hypertension (SAH) (36.4%) and diabetes mellitus (DM) (26.1%). The invasive devices most used in this group were delayed bladder catheter, peripheral venous catheter, orotracheal tube, invasive mechanical ventilation, gastric tube, central venous catheter, and enteric tube.

Table 3. Comorbidities and invasive devices used by patients diagnosed with infection and sepsis and/or septic shock in the Adult ICU between 2016 and 2018. Uruguaiana, RS, Brazil, 2019 (n=88)

Comorbidities	n	%	Invasive devices	n	%
Hypertension	32	36.4	Indwelling bladder catheter	79	89.8
Diabetes Mellitus	23	26.1	Peripheral venous catheter	77	87.5
Chronic obstructive pulmonary disease	14	15.9	Orotracheal tube	68	77.3
Heart failure	11	12.5	Invasive mechanical ventilation	58	65.9
Stroke	7	8	Gastric tube	57	64.8
Chronic renal failure	7	8	Central venous catheter	47	53.4
Acute renal failure	5	5.7	Enteric tube	44	50
Cancer	5	5.7	Tracheostomy	8	9.1
Acquired Human Immunodeficiency	4	4.5	Chest drain	4	4.5
Tuberculosis	3	3.4	Bladder relief tube	2	2.3
-	-	-	External ventricular drain	1	1.1

Source: the authors (2019).

The nature of hospitalizations is characterized by medical specialty. 44.3% (N=88) were pneumology patients. Regarding length of stay in the ICU, the majority stayed for a short period of up to two days (44.3%).

As for infection control mechanisms, culture collection from any site and antibiotic therapy were considered. 96.6% of patients received antibiotic therapy, but only 50% had some culture. This data is shown in Table 4.

Table 4. Clinical variables of patients admitted to the Adult ICU with a diagnosis of infection and/or sepsis and/or septic shock between 2016 and 2018. Uruguaiana. RS. Brazil. 2019 (n=88)

Variables	n	%
Specialty		
Pulmonology	39	44.3
Neurology	11	12.5
Cardiology	10	11.4
Renal	7	8
Gastroenterology	6	6.8
Oncology	4	4.5
Others	11	12.5
Days of hospitalization		
Up to 2 days	39	44.3
2 to 4 days	8	9.1
4 to 9 days	25	28.4
Over 9 days	16	18.2
Culture collection		
Yes	44	50
No	44	50
Antibiotic therapy		
Yes	85	96.6
No	3	3.4

Source: the authors (2019).

Considering the sepsis continuum (infection/sepsis/septic shock) and controlling for all the factors included in the model, the multivariate analysis showed a statistically significant association for the variables: enteric tube (PR=1.82 95%CI 1.27 - 2.59) and central venous catheter (PR=1.51 95%CI 1.01 - 2.26). There was a higher risk for individuals who used these devices (Table 5).

Mechanical ventilation was also associated with this outcome (PR=0.64, 95% CI 0.44 - 0.92), but it indicated a lower risk for those who used it.

The specialties of cardiology (PR=1.26 95%CI 1.02 - 5.00), pulmonology (PR=2.66 95%CI 1.43 - 4.92) and other (PR=2.52 95%CI 1.34 - 4.75) indicated a higher risk of the outcome than neurology, with statistical significance.

Table 4. Clinical variables of patients admitted to the Adult ICU with a diagnosis of infection and/or sepsis and/or septic shock between 2016 and 2018. Uruguaiana. RS. Brazil. 2019 (n=88)

Risk factors	Univariate			Multivariate		
	PR	CI (95%)		PR	CI (95%)	
		minimum limit	maximum limit		minimum limit	maximum limit
Age group (years)						
≥73 years	1.10	0.69	1.76	1.05	0.63	1.75
64 to 73 years	0.96	0.58	1.59	1.04	0.60	1.82
51 to 64 years	1.06	0.65	1.72	1.16	0.70	1.92
<51 years	1.00	-	-	1.00	-	-
Education						
Complete primary education	0.84	0.57	1.24	0.85	0.58	1.23
Above elementary school completed	1.00	-	-	1.00	-	-
Invasive devices						
Enteric tube						
Used	2.01*	1.45	2.79	1.82*	1.27	2.59
Not used	1.00	-	-	1.00	-	-
Central venous catheter						
Used	1.79*	1.28	2.51	1.51*	1.01	2.26
Not used	1.00	-	-	1.00	-	-
Peripheral venous catheter						
Used	1.47	0.85	2.54	1.71	0.95	3.08
Not used	1.00	-	-	1.00	-	-
Mechanical ventilation						
Used	0.51*	0.37	0.70	0.64*	0.44	0.92
Not used	1.00	-	-	1.00	-	-
Days of hospitalization						
Less than 2 days	1.76*	1.09	2.84	1.43	0.89	2.28
2 to 4 days	0.53	0.24	1.13	0.50	0.24	1.05
4 to 9 days	1.59	0.95	2.66	1.26	0.75	2.12
9 days or more	1.00	-	-	1.00	-	-
Specialty						
Cardiology	2.31*	1.09	4.93	2.26*	1.02	5.00
Pulmonology	4.19*	2.33	7.57	2.66*	1.43	4.92
Neurology	1.00	-	-	1.00	-	-
Comorbidity score						
One	0.89	0.57	1.38	0.75	0.45	1.25
Two	0.79	0.49	1.29	0.77	0.51	1.18
Three or more	1.02	0.64	1.65	1.01	0.63	1.64
Zero	1.00	-	-	1.00	-	-
Acute illness score						
One or two	1.57*	1.05	2.35	1.08	0.67	1.72
Zero	1.00	-	-	1.00	-	-

Prevalence Ratio; CI: Confidence Interval; *Statistically significant results.
Source: the authors (2019).

4. Discussion

Invasive procedures and devices are the main factors associated with developing the sepsis continuum in ICU.[1-6] This study identified an enteral tube and central venous catheter as risk factors for developing these complications. In addition, patients with clinical compromises involving the specialties of pneumology and cardiology are also more susceptible to sepsis and septic shock, as they have clinical compromises that intensify the systemic inflammatory response.[2,3]

Studies indicate that invasive devices should be used as a preventative measure for healthcare-related infections as quickly as possible to avoid infectious complications.[7,8] The use and manipulation of central venous catheters are associated with bloodstream infections, the primary cause of sepsis, and a significant prevalence in ICUs. Similarly, the use of an enteral tube can lead to gastrointestinal tract infections, to which critically ill patients are susceptible. Ventilator-associated pneumonia is also a routine complication in ICUs and a precursor to sepsis and septic shock among patients admitted to these units.[1-3]

Infection, sepsis, and septic shock were prevalent in almost 40% of the patients in this study. Despite being a latent problem in ICUs, these complications are still underdiagnosed, which delays treatment and increases mortality rates. Also, considering the updated concepts and criteria for diagnosis published in 2016[1], it is worth noting that few studies have developed the current definitions of infection, sepsis, and septic shock, which hinders research and discussion on the subject.[6]

In this sense, we have rectified the definitions used in a previous study to allow for a comparison of results. Previously, it was observed that 23.1% of ICU patients had an infection, 13.6% had sepsis, and 48.5% had septic shock. At the same time, the findings of this study indicate that the majority had an infection (19.3%), followed by sepsis (17%) and septic shock (10.8%). However, by considering only the explicit medical diagnosis written in medical records, disregarding nursing records and evolutions, for example, there is a possibility of underestimating the real burden of the sepsis continuum.[5]

The literature corroborates that females are more affected by the sepsis continuum[3-5] and shows that they are closer to the age group indicated in this study (51 and 64 years old).[3]

Comorbidities, mainly diabetes mellitus and hypertension, are present in most patients with sepsis[7], yet there was no association between the presence of comorbidities and sepsis. In addition, invasive procedures and devices are associated with the occurrence of health-related infections (AKIs), which increase the chance of patients dying in the ICU 2.6 times.[8] In addition, recently, during the COVID-19 pandemic, it has also become clear that patients are susceptible to secondary infections due to invasive procedures and devices necessary to treat severe and complex illnesses, which make up the clinical routine of ICUs.[9]

While this study found that most patients with sepsis had an ICU stay of up to two days, the literature shows an average ICU stay of 11.7 days.[7] In this sense, it is essential to emphasize that the patients admitted to this study often arrive in serious condition, with irreversible conditions, which results in a high mortality rate and, consequently, a short length of stay. Using the SOFA score would be an alternative to identifying sepsis in critically ill patients already in the ICU and predicting mortality. The QuickSOFA or qSOFA score would be a tool to help consider the possibility of sepsis outside the ICU, in the emergency room, for example, to optimize the time taken by health professionals.[10]

Once a patient with a suspected sepsis infection has been identified, laboratory tests and cultures should be taken from the alleged infectious focus. Broad-spectrum antibiotic therapy should be started, and then the treatment should be adjusted for the identified pathogen. Contrary to the recommendations, it was observed that while 96.6% of patients received antibiotic therapy, only 50% had some culture collected, leading to the inference that some patients may have received the wrong treatment.[1]

Strategies are needed at the global, national, and regional levels to reduce the high incidence and mortality rates of sepsis. These include investment in public health policies to prevent community infections, institutional actions to reduce nosocomial infections, such as hand washing[5], and protocols that address early diagnosis and appropriate treatment in institutions.[6]

In addition, the general population's knowledge of sepsis is still low and directly related to education and income. Only 64.2% know the correct definition of sepsis. Most (90%) relate the nomenclature "generalized infection" to a severe infectious condition.[11]

This deficit in access to information is also found among health professionals, with only 66.5% knowing the term sepsis.[11] Nursing is fundamental in recognizing sepsis since it is responsible for direct and uninterrupted patient care.[12] Therefore, these data show that there is also a need to implement educational actions that enable early identification and intervention.[11]

Despite the relevance of the findings, our study had limitations, such as not distinguishing between community and nosocomial sepsis and the lack of the SOFA score for diagnosing sepsis in hospitalized patients. The documentary analysis of medical records can also generate bias, given that this data collection technique depends on the quality of the records kept by the professionals involved in patient care.

5. Conclusions

The ICU in question had a prevalence of 33.9% of the sepsis spectrum continuum. Using an enteral tube, central venous catheter, mechanical ventilation, and cardiology and pulmonology specialties was associated with this outcome. Thus, the results of this study are expected to contribute to the institution involved and others in encouraging recognition of the risks of sepsis presented by patients and in the planning of infection surveillance, prevention, and control actions to increase the safety of critically ill patients.

Actions to control the sepsis continuum involve implementing infection prevention protocols, starting with establishing a culture of safety and good health practices. Likewise, protocols are necessary for monitoring infections, controlling diagnostic measures based on culture tests with antibiograms, rationally using antibiotics, and applying care packages to prevent organ dysfunction, progression to septic shock, and patient survival in the ICU.

Authors' contributions

The authors have dedicated themselves to the work, making substantial contributions in the conception or design of the research, the acquisition, analysis, or interpretation of data, and the writing or critical review of relevant intellectual content. All authors have approved the final version for publication and agreed to take public responsibility for all study aspects. Their dedication is evident in the quality of the research.

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