Factors Related to Sepsis in Critical Care Setting in Rwanda Selected Referral Hospital

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Abstract

BACKGROUND

Sepsis is described as potentially fatal organ failure induced by an unbalanced host response to infection. Annual estimates put the number of sepsis cases at over 19 million. The number of sepsis-related deaths is estimated to reach 5 million, with the vast majority happening in LMICs. However, such information is required to increase awareness of sepsis's global impact, especially in developing countries like Rwanda. The study aimed to evaluate the factors related to sepsis in a critical care setting in Rwanda's selected referral hospital.

METHODOLOGY

A cross-sectional study design with a quantitative approach was conducted and simple random sampling was used. Files of 191 study participants and a structured questionnaire were used in data collection, bivariate and multivariate logistic regression in SPSS version 21 was used in data analysis, and results were presented in tables.

RESULTS

The prevalence of sepsis was 40.3%. By plotting bivariate analysis the results showed that sepsis was significantly associated with the following variables; self-employed as an occupation with (OR=0.216, 95%CI:0.047-0.987) p 0.48 taking reference for unemployed; pneumonia with sepsis at (OR=1.993, 95%CI:0.657-6.043) p 0.023, systemic infection (OR=0.329, 95%CI:0.104-1.044) p 0.059; other procedure with(OR=4.735,95%CI:1.509-14.855); procedure timeframe not mentioned with (OR=0.123,95%CI:0.027-0.553) p 0.032; hospitalized 15 days and more with OR=6.697 (95%CI:0.809-59.863) and p 0.032.

CONCLUSION

The prevalence of sepsis was 40.3% and factors related to sepsis include; occupation, having pneumonia, systemic infection, timeframe for carrying out the procedure, and patient being hospitalized for 15 days and more.

Keywords: *Factors, Sepsis, Critical Care Setting, Intensive Care Unit, RMH*

Introduction

Sepsis is defined as life-threatening organ dysfunction caused by a dysregulated host response to infection(1). It is used interchangeably with systemic inflammatory response syndrome(SIRS), which includes both pathologic infection and physiological alterations(2). Sepsis is a prevalent condition in the intensive care unit (ICU). An audit of ICU patients from multiple continents revealed that roughly 30% of patients developed sepsis during their ICU stay(3). Globally, is a significant health burden. According to estimates, there are more than 19 million cases of sepsis (formerly known as severe sepsis) each year, and 5 million deaths are directly linked to this condition(4). In developed countries, in modern Intensive Care Units (ICUs), sepsis is a leading cause of morbidity and mortality(3). Like in the United

States of America(USA), Sepsis cases are not diagnosed until after admission, and those with increasing severity have a higher economic burden and mortality on a case-by-case basis over 970,000 sepsis cases are admitted annually, and the numbers have been rising year over year(5). In addition to this, at least 350,000 deaths annually have been attributed to sepsis(6). In the USA, for example, sepsis is the most common cause of in-hospital deaths and costs more than US$24 billion annually. Infection prevention efforts, including those targeting both community-acquired and healthcare-associated infections, can reduce sepsis incidence(7).In European Union(EU) countries, like France, it is estimated that sepsis is responsible for nearly 57,000 deaths each year and the average cost is around € 16,000 per hospitalization(8). The incidence and prevalence of sepsis have increased, probably due to the progressive ageing of the population, studies have demonstrated a relationship between age and incidence of sepsis and a larger number of people with disease comorbidities(9). Although various studies in the industrialized world have produced epidemiological data on sepsis in ICU patients, there is minimal information on the global burden of sepsis. Nonetheless, such data are critical in raising awareness of the global burden of sepsis, highlighting the need for additional study into potential preventive and therapeutic strategies, and guiding resource allocation(3,10).

Recent studies in developing nations have revealed a high population-based incidence of sepsis, and its prevalence in intensive care units remains quite high. Furthermore, the related death rate, which ranges from 30% to 60%, is extremely high when compared to other frequent disorders like myocardial infarction or breast cancer(11). At the American University of Beirut in Lebanon, while a significant portion of severe sepsis treatment takes place in the ICU, up to 500,000 cases initially undergo management in the emergency department. This underscores the crucial role of early recognition, proactive fluid administration, and prompt antibiotic intervention as fundamental pillars of sepsis therapy(12). And in a Jordanian study, the prevalence was around 23.3%, in addition to this sepsis patients exhibited significantly higher mortality rates and median ICU LOS than other ICU patients(13). Sepsis is a medical emergency and a global public health concern. While the developed world has the luxury of state-of-the-art medical care, the developing world struggles to achieve basic care. There is a clear shortage of resources related to the lack of human resources, lack of funding, and medical equipment(14). In African countries, sepsis is a major contributor to the global burden of disease. Barriers to reducing the global burden of sepsis include difficulty quantifying attributable morbidity and mortality, low awareness, poverty and health inequity, and under-resourced and low-resilience public health and acute health care delivery systems. Important differences in the populations at risk, infecting pathogens, and clinical capacity to manage sepsis in high and low-resource settings necessitate context-specific approaches to this significant problem (4). In addition, there are major demographic differences between patients with sepsis in higher-income compared to lower-income countries including age, prevalence of HIV co-infection and ecology of pathogenic organisms especially in Sub-Saharan countries(15,16). In Rwanda like in other Sub-Saharan African countries, sepsis is a major challenge in intensive care and emergency medicine, many recent studies have demonstrated that sepsis is associated with only a transient hyper-inflammatory phase(17). In addition to this, a study conducted in adult ICU resulted in sepsis prevalence of 42% of sepsis cases within 24 hours post ICU admission, 33% severe sepsis, and 21% septic shock(18). The researcher was triggered by this high prevalence and decided to exclude some factors related to sepsis in the intensive care unit in Rwanda and propose

strategies to overcome them(4). Stronger health systems, precise sepsis case identification and quantification, inclusive research, data-driven and context-specific management guidelines, and advocacy are some of these tactics.

Methodology

Study design

An analytical cross-sectional study design with a quantitative approach was used. The selected Rwanda referral hospital was Rwanda Military Hospital (RMH) which is one of the referral hospitals in Rwanda located in the City of Kigali, Kicukiro district. RMH provides health care services to the military staff and their immediate families as well as the general population.

Target population

The study population included male and female patients aged above 30 days, admitted to the intensive care unit at RMH during the period of data collection and presenting with hemodynamic instability and/or respiratory support that required the use of vasopressors and/or ventilator despite adequate fluid resuscitation and/or oxygen support respectively.

Sample size calculation

The sample size was calculated by using Cochran's formula(1977)(19,20).

$$n = \frac{Z^2\, pq}{e^2} = \frac{(1.96)^2 \text{ x } 0.42 \text{ xo. } 58}{(0.05)^2} = 191$$

n=191 participants

Where, n: sample size; Z^2: is the abscissa of the normal curve that cuts off an area α at the tails (1 - α equals the desired confidence level, e.g., 95% which equals 1.96); e: is the desired level of precision(0.05); p: is the estimated proportion of an attribute that is present in the population (42%)(18). q: is 1-p (1-0.42=0.58).Hence the calculated sample size for this study was 191 participants.

Validity and reliability of the tool

The instrument was developed based on an exhaustive review of the related literature, with deep analysis by the research investigators. The inclusion of items from this adopted tool had a logical connection with the first objective since the questions were about the factors related to sepsis in critical care settings. And were described in the context of adult and pediatric intensive care unit admission files. A pretesting was conducted on 20 files to test the instrument for validity, reliability as well as feasibility purposes, and the results showed a Cronbach's alpha of 0.66. To validate the content of the instrument for reliable data collection, the items used were enough, appropriate and adequately represented in each section to measure the factors related to sepsis in the Intensive Care Unit at RMH. The instrument validity was based on the constructs of the conceptual framework and reflection of relevant current research on the topic of sepsis in critical care settings. Identifying the types and factors associated with sepsis were added to criterion validity on the topic in Rwanda.

Data collection

A simple random sampling method was used in data collection, and a structured checklist was utilized for data collection where the researcher consulted each file for the variable under investigation and ticked on the sheet, the concerned variable. Each structured questionnaire was given a code and the researcher has established a list composed of patient's identities to avoid using the same file twice.

Data analysis

After data collection, data was entered, categorized, and analyzed by SPSS version 21. Frequencies were used to summarize the demographic characteristics of the study participants. For analytical analysis, Chi-square and logistic regression were computed to indicate the association between sepsis and primary diagnosis, sterility, intervening factors, and socio-demographic characteristics. By assessing the factors related to the sepsis bivariate and multivariate logistic regression were computed, and P values and odds ratios were displayed to

show the relationship between different variables and sepsis in RMH. Data was imported in Microsoft Excel, and tables, and graphs were used for study results presentation. A variable with a p-value below or equal to 0.05 was considered significant.

Ethical considerations

Permission and ethical clearance were obtained from the Rwanda Military Hospital (RMH) IRB committee with Ref.: RMH IRB/014/2021 and a formal approval obtained from RMF with REF: 048/RMH/COMDT/2021. Informed consent was obtained from all participants and their privacy and confidentiality ensured.

Results

The findings of this study are based on the total responses from 143 participants. Statistical Package for Social Sciences (SPSS) version 21 was used to generate frequencies, percentages and other parameters. The majority of the participants were 16 years old and above at 64.9% (n=124) and females were 61.3% (n=117), and most of them were single at 43.5% (n=83). Regarding religion, 61.8% (n=118) were catholic while the majority did secondary school about 39.8.1% (n= 76) finally regarding occupation the majority were unemployed and self-employed with 39.8 %(n=76). Table 1.

The prevalence of sepsis among the study participants was about 40.3 %(n=77) and were diagnosed with sepsis at least 24 hours post-admission in the ICU. On common ICU diagnosis, peritonitis had about 12.6%(n=18); pneumonia about 30.1% (n=43); meningitis 8.4%(n=12); ARDS about 40.6%(n=58), while systemic infection 49% (n=70) and other respiratory infection 38.5% (n=55) and finally other diverse infection was having about 47.6%(n=68). Table 2.

Table 1:

Socio-Demographic Characteristics of the Participants

Variables		Frequency(n=191)	Proportion (%)
Age in years	0-1 year	23	12.0
	2-15 years	44	23.0
	16 years old and above	124	64.9
Gender	Male	74	38.7
	Female	117	61.3
Marital status	Single	83	43.5
	Separated	16	8.4
	Married	66	34.6
	Cohabitant	19	9.9
	Divorced	7	3.7
Religion of the participants	Catholic	118	61.8
	Protestant	45	23.6
	Muslims	14	7.3
	Others	14	7.3
Education level	Illiterate	25	13.1
	Primary	67	35.1
	Secondary	76	39.8
	University and above	23	12.0
Occupation	Unemployed	76	39.8
	Self-employed	76	39.8
	Employed(Salaried)	39	20.4

Source: Primary data (2022)

Table 2:
Prevalence and Common ICU Diagnoses among Study Participants with Sepsis

Variables		Frequency(n=191)	Proportion (%)
Sepsis	No	114	59.7
	Yes	77	40.3
Peritonitis	No	164	78.5
	Yes	27	21.5
Pneumonia	No	162	67.5
	Yes	29	32.5
Meningitis	No	186	84.8
	Yes	5	15.2
ARDS	No	165	59.7
	Yes	26	40.3
Systemic infection	No	134	49.7
	Yes	57	50.3
Respiratory infection	No	174	59.2
	Yes	17	40.8
Other infection	No	161	58.6
	Yes	30	41.4

Source: Primary data (2022)

Table 3:
Factors Associated with Sepsis among Study Participants

Variables		Frequency(n=191)	Proportion (%)
Procedure Type	Central line insertion	115	60.2
	Other surgical procedure	63	33.0
	Not done	13	6.8
Sterile procedure	No	27	14.1
	Yes	164	85.9
Intubated patient	No	32	16.8
	Yes	159	83.2
Qualified specialist	No	30	15.7
	Yes	153	80.1
	I don't know	8	4.2
Consumables available	No	31	16.2
	Yes	159	83.2
	I don't know	1	.5
Procedure timeframe	No	37	19.4
	Yes	52	27.2
	I don't know (Not mentioned)	102	53.4
Hospitalization days in ICU	Less than 2 days	16	8.4
	2 to 14 days	141	73.8
	More than 14 days	34	17.8
Followed admission criteria	No	134	70.2
	Yes	57	29.8
IPC respected	No	27	14.1
	Yes	135	70.7
	I don't know(Not mentioned)	29	15.2

Source: Primary data (2022)

Many factors were associated with sepsis among the study participants. A majority had a central line catheter (115 participants, 60.2%), the sterile procedure was respected (164 participants, 85.9%), and 159 participants (83.2%) were intubated. Most procedures were performed by a qualified specialist (153 participants, 80.1%), with consumables available in 159 cases (83.2%). The procedure timeframe was not mentioned for 102 participants (53.4%). Most participants were hospitalized for 2 to 14 days (141 participants, 73.8%), admission criteria were not respected for 134 participants (70.2%), and IPC consumables were provided in 135 cases (70.7%). (Table 3).

Bivariate analysis revealed that sepsis was statistically significant and associated with several variables. Female gender was associated with higher odds of sepsis (OR=2.317, 95% CI: 1.273-4.214, p=0.006). Occupation as self-employed (private) and salaried were associated with lower odds of sepsis compared to unemployed individuals (OR=0.216, 95% CI: 0.093-0.502, p=0.000 and OR=0.160, 95% CI: 0.068-0.377, p=0.000, respectively). Pneumonia was strongly associated with sepsis (OR=4.857, 95% CI: 2.323-10.154, p=0.000). Systemic infection was associated with lower odds of sepsis (OR=0.481, 95% CI: 0.267-0.867, p=0.015), as was respiratory infection (OR=0.422, 95% CI: 0.233-0.765, p=0.004). Conversely, other infections were associated with higher odds of sepsis (OR=2.500, 95% CI: 1.350-4.628, p=0.004).

Table 4:
Bivariate Analysis of Variables Significantly Associated with Sepsis

Variables		Sepsis			
		OR	95% C.I. for OR		P value
			Lower	Upper	
Gender	Male	1			
	Female	2.317	1.273	4.214	0.006
Occupation	Unemployed	1			
	Self-employed(Private)	0.216	0.093	0.502	0.000
	Salaried	0.160	0.068	0.377	0.000
Pneumonia	No	1			
	Yes	4.857	2.323	10.154	0.000
Systemic infection	No	1			
	Yes	0.481	0.267	0.867	0.015
Respiratory infection	No	1			
	Yes	0.422	0.233	0.765	0.004
Other infection	No	1			
	Yes	2.500	1.350	4.628	0.004
Intubated patient	No	1			
	Yes	3.511	1.580	7.805	0.002
Procedure types	Central line insertion	1			
	Other invasive procedure	0.193	0.050	0.739	0.016
	Not done	0.161	0.040	0.646	0.010
Respected procedure timeframe	No	1			
	Yes	0.047	0.011	0.206	0.000
	I don't know(Not mentioned)	0.473	0.238	0.939	0.032
Hospitalization days	Less than 2 days	1			
	2-14 days	2.683	0.640	11.247	0.177
	15 days and more	3.272	1.125	6.592	0.001

Source: Primary data (2022)

Intubation was also associated with higher odds of sepsis (OR=3.511, 95% CI: 1.580-7.805). Other surgical procedures, compared to central line insertion, were associated with lower odds of sepsis (OR=0.193, 95% CI: 0.050-0.739, p=0.016). Not mentioning the procedure timeframe was significantly associated with sepsis (OR=0.473, 95% CI: 0.238-0.939, p=0.032). Finally, patients hospitalized for 15 days or more had significantly higher odds of developing sepsis compared to those hospitalized for less than 2 days (2-14 days: OR=2.683, 95% CI: 0.640-11.247, p=0.177; 15 days or more: OR=3.272, 95% CI: 1.125-6.592, p=0.001). (Table 4).

Multivariate analysis showed that employed participants had lower odds of developing sepsis compared to non-employed participants (OR=0.291). Participants with pneumonia were more likely to develop sepsis than those without pneumonia (OR=1.993). Systemic infection was associated with lower odds of sepsis (OR=0.329), while other infections were associated with higher odds (OR=4.735). A procedure timeframe that was not mentioned or not known was associated with lower odds of

sepsis compared to non-recorded ones (OR=0.123). Patients hospitalized for 15 days or more had significantly higher odds of sepsis compared to those hospitalized for less than 2 days (OR=6.697, 95% CI: 0.809-59.863, p=0.032). (Table 5).

Discussion

The study was conducted in the Intensive Care Unit(ICU) at Rwanda Military Hospital (RMH) and the majority of the participants were 16 years and above at 124(64.9%) and were female at 117(61.3%), single at 83(43.5%) as well as most of them did secondary school with about 76(39.8.1%); same study was conducted in Canada where the majority were aged above sixteen and contrary to this were married and male in addition to this the majority did not attended high school(21).

Regarding religion, 61.8% (n=118) were catholic, and finally, regarding occupation, the majority were unemployed and self-employed with 39.8 %(n=76), contrary to the study conducted in Ethiopia, the majority of the participants were employed and Orthodox at 67.7%(n=42)(22,23).

Table 5:

Multivariate Analysis of Risk Factors Associated with Sepsis

Variables		Sepsis			
		OR	95% C.I. for OR		P value
			Lower	Upper	
Occupation	Non employed	1			
	Self-employed	0.216	0.047	0.987	0.048
	Salaried	0.291	0.072	1.179	0.084
Pneumonia	No	1			
	Yes	1.993	0.657	6.043	0.023
Systemic infection	No	1			
	Yes	0.329	0.104	1.044	0.059
Other infection	No	1			
	Yes	4.735	1.509	14.855	0.008
Procedure timeframe	No	1			
	Yes	0.016	0.002	0.130	0.000
	I don't know(Not mentioned)	0.123	0.027	0.553	0.006
Hospitalization days	Less than 2 days	1			
	2-14 days	0.600	0.094	3.828	0.589
	15 days and above	6.697	0.809	59.863	0.032

Source: Primary data (2022)

Regarding the prevalence of sepsis in the study, participants were about 40.3%(n=77) and were diagnosed with sepsis at least 24 hours post-admission in ICU, contrary to this in many other various conducted studies showed a lower prevalence like the study conducted in Ethiopia where prevalence was 26.5%(n=303) of the total participants (1145)(22). In Germany, 2973 patients (29.5%) had sepsis, including 1808 (18.0%) with sepsis at admission to the ICU of the total participants (3). And in China, the prevalence was 28.7%(n=1407)(24). While on the common ICU diagnosis, peritonitis had about 18(12.6%); pneumonia about 43(30.1%); meningitis 12(8.4%); ARDS about 58(40.6%), while systemic infection 70(49%) and other respiratory infection 55(38.5%) and finally another diverse infection was having about 68(47.6%), same results were found in a study conducted in China where the most common diagnosis was pneumonia had followed by gastrointestinal related diseases and others diseases with lower proportion(24). In another study conducted in European countries, the most common diagnoses were pneumonia, bloodstream infection, and urinary tract infection(25).

Many factors were related to sepsis including; participants who were inserted in central line catheter at 115(60.2%), the sterile procedure was respected at 164(85.9%) and participants who were intubated at 159(83.2%), most of the procedure were performed by a qualified specialist at 153(80.1%), consumables were available at 159(83.2%) and procedure timeframe was not mentioned at 102(53.4%), the majority of the participants were hospitalized between 2 to 14 days at 141(73.8%) while admission criteria were not respected at 134(70.2%) and finally IPC consumables were provided at 135(70.7%), quite different results were found in a study conducted in western countries where, some factors were reported to be associated with sepsis and its mortality which

includes, diagnostic procedures, broad-spectrum antibiotics and aggressive supportive therapy(26). The results showed that sepsis was significantly associated with the following variables; female gender with (OR=317,95%CI:1.273-4.214) and p 0.006; self-employed as occupation and salaried with (OR=0.216,95%CI:0.093-0.502) and (0.160,95%CI0.068-0.377)and p 0.000 respectively taking reference for unemployed, same results were found in a study which was conducted in Sweden where occupation and higher level of education were associated with Sepsis (27). Pneumonia was associated with sepsis with (OR=4.857, 95%CI: 2.323-10.154) and p 0.000, systemic infection (OR=0.481, 95%CI: 0.267-0.867) and p 0.015; respiratory infection (OR=0.422, 95%CI; 0.233-0.765) p 0.004; and other infection (OR=2.500, 95%CI: 1.350-4.628) and p 0.004. intubated patient (OR=3.511, 95%CI:1.580-7.805); procedure type as other surgical procedure with (OR=0.193, 95%CI:0.050-0.739) and p 0.016 compared to central line insertion; not mentioned procedure timeframe was significantly associated with sepsis with (OR=0.473, 95%CI:0.238-0.939) p 0.032; hospitalized 15 days and more with (OR=3.272, 95%CI:1.125-6.592) and p 0.001, similar results was found in a study conducted in Brazil where Pulmonary infection and CVC were associated with sepsis(28). Admission days OR=2.534(95%CI: 1.089-5.899), Contrary to the study conducted in China, age was significantly associated with sepsis(29). As well as gender but also comorbidities(30,31). Multivariate analysis showed that; employed participants as occupation were 0.291 times of developing sepsis than those non-employed, A similar result was found in a study conducted in Canada where employed participants had little chance of developing sepsis compared to non-employed(21). Participants with pneumonia had 1.993 times of developing sepsis than those without pneumonia; while systemic infection was 0.329 times of developing

sepsis than those without it and those with other infections had 4.735 of developing sepsis than those without it. Procedure timeframe which was not mentioned or not known was 0.123 compared to none recorded ones; and finally, people with hospitalization days more than 14 were 6.697 times than those hospitalized less than 2 days with a p-value of 0.032, similar results were found in a study conducted in Beijing where participants with pneumonia were at high risk of developing sepsis than other diagnosis or those without pneumonia(24).

Conclusion

The study was conducted on the factors that contribute to sepsis in critical care settings in Rwanda, the case of RMH. The prevalence of sepsis was around 40.3% and many factors were related to sepsis, which include; self-employment, having pneumonia, systemic infection, timeframe for carrying out the procedure, and patient being hospitalized for more than 14 days. The above-mentioned factors were significantly associated with Sepsis in the Intensive care unit.

Study limitations

The study database was not sufficiently large, as it only contained information on demographics, related factors, and outcomes. As a result, we did not collect detailed information on all factors associated with sepsis in the ICU. Furthermore, data was acquired using files, and the researcher suggests conducting future studies that may be more accurate and provide more information on this topic.

Recommendations

Studies on sepsis particularly in ICU might be conducted to assess the outcomes and factors related to sepsis for being used by healthcare decision-makers in the prevention and management of sepsis especially in healthcare facilities.

Conflict of Interest. The authors declare no conflicts of interest.

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