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Evaluating the outcomes of Sudanese septic patients who necessitated invasive mechanical ventilation

Abstract

Background: Sepsis is a complicated disorder highlighted by the concurrent acceleration of coagulation and inflammation as a consequence of microbial assault. It has an important influence on hospitalized patients' need for mechanical ventilation and ICU admission.

Objectives: The study's primary goal is to determine whether septic patients who require invasive mechanical ventilation fared well and whether their clinical condition improved or worsened after being connected to mechanical ventilation. The research also attempts to evaluate how additional medical interventions and other comorbidities affect the patient's prognosis.

Material and methods: From November 2017 to May 2018, 160 patients with severe sepsis or septic shock were taken part in a prospective cross-sectional trial. The information was gathered using a straightforward, standardized questionnaire that included questions regarding the admission, progress, and outcome of septic patients who received mechanical ventilation in an intensive care unit.

Results: 58 (36%) of the 160 patients were female, with 102 (64%) of the patients being male. In the age range of 60 to 70 years, 41 of them (or 25.6%) were detected. The majority of patients (59/369) had sepsis from a chest infection. Most of the patients, 87 (54.4%), got a combination of midazolam and fentanyl for sedation and analgesia. The majority of the patients, 85 (53%) had SIM/PS ventilation. Ultimately, 71 patients (44.4%) died, 80 patients (50%) were extubated, and 9 patients (5.6%) remained stationary and had a tracheostomy. Additionally, age, reasons, sedative type, and duration of stay were all substantially linked with the MV consequences (P 0.05).

Conclusion: The better the outcome, the earlier septic patients who need IMV were identified and attached to IMV. It has been demonstrated that receiving IMV decreased mortality in septic patients by around 50%. The findings suggest that this intervention should be made more widely available and more reasonably priced by the authorities, along with the training of additional staff and the development of standard protocols for treating patients with such a condition. Focusing on health education awareness, establishing a focused outpatient department, and promptly screening patients who necessitate early referral to a tertiary care facility are the three most crucial aspects.

Keywords: Septic Patients, Mechanical Ventilation, ICU, Sudan

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Abbreviations: ICU, *Intensive Care Unit;* IMV, Intermittent Mechanical Ventilation; MODS, Multiple Organ Dysfunction Syndromes; ARDS, Acute Respiratory Distress Syndrome; VAP, Ventilator-Associated Pneumonia; DM, Diabetes Mellitus; HTN, Hypertension; COPD, Chronic Obstructive Pulmonary Disease; CKD, Chronic Kidney Disease; CPR, Cardiopulmonary Resuscitation; CNS, Central Nervous System; IV, Intravenous; RHD, Rheumatic Heart Disease; IHD, Ischemic Heart Disease; CVA, Cerebrovascular Accident; SIM/PS, Synchronized Intermittent Mandatory Ventilation/ Pressure Support; CPAP/PS, Continuous Positive Airway Pressure/ Pressure Support ; UTI, Urinary Tract Infection.

Introduction

The term "sepsis" refers to the systemic inflammatory reaction to infection. The revised definition of sepsis for 2017 is catastrophic organ dysfunction spurred on by an unbalanced host response to infection. Ten out of every 1000 hospitalized patients have sepsis, and of these, thirty percent develop multiple organ dysfunction syndromes (MODS). Twenty percent of sepsis patients die compared to sixty to eighty percent of septic shock patients. Given the high fatality rates, early detection and treatment are crucial.[1]

Most pathologic processes that occur in sepsis are now well understood because of advancements in molecular biology. Understanding sepsis pathogenesis is crucial for breakthroughs in the diagnostic, follow-up, and therapy phases. Systemic inflammation, coagulation, and disorganized fibrinolysis make up the sepsis trilogy. Following by the research, the humoral system in the body was excited and various cytokines were produced as a consequence of an infection in tissues and traumatic injury. Organ damage, hemostatic alterations, and a generalized inflammatory response are the consequences.[2] Studies on the management of sepsis have been published recently. Most of these strategies attempt to change or reverse the physiopathology of sepsis and avoid multiple organ failure. There have been reports of several innovative methods to lower fatality rates in severe sepsis. These include goal-oriented treatment (central venous pressure, mean arterial pressure, hourly urine output, and central venous oxygen saturation) started early (in emergency services), plasma glucose control, use of corticosteroids at average doses, and the use of low tidal volumes in the treatment of acute respiratory distress syndrome (ARDS). In addition to pharmaceutical treatment modalities, timely and suitable antibiotics as source control and cardiovascular support are crucial in the management of sepsis.[3] Despite a recent relative decline in sepsis frequency in the general population, the rise in the

number of hospitalized sepsis patients remains. The incidence of sepsis in hospitals is steadily rising. Sepsis occurs more frequently as a result of the elderly population, the prolonging of chronic illness patients' existence, the widespread use of immunosuppressive medications, and the widespread use of invasive procedures for either diagnosis or treatment. In hospitals with more beds, critical care units, and where more invasive procedures are carried out, hospital-based sepsis is more frequently reported.[4]

According to reports, 250,000 of the 35 million Americans admitted to hospitals annually eventually develop sepsis. The average death rate is 35%, and it ranges from 12% to 80%.[4] Hacettepe University carried out the biggest sepsis research in Turkey. This research evaluated patients with negative bacteremia throughout a seven-years (1983–1989) but did not offer data on sepsis prevalence.[5] Sepsis can arise from bacterial, viral, fungal, or parasitic infections as well as non-infectious intra-abdominal events such as severe trauma, pneumonia, pancreatitis, and other situations including urinary tract infection. The sepsis-causing microorganism frequency indicates whether sepsis will emerge inside or outside of a hospital. In the population, Escherichia coli, Streptococcus pneumonia, and Staphylococcus aureus are the most frequently recognized active bacteria in sepsis patients. The bacteria that cause sepsis to develop in a hospital have been modified throughout time.[6] Before the widespread use of antibiotics in the 1950s, gram-positive bacteria predominated, and sepsis etiologies like Staphylococcus aureus and Streptococcus pyogenes were frequently attributed to pathogens.[6] Eventually, gram-positive bacterial infections proved curable due to the introduction of antibiotics, and in the 1960s, 1970s, and 1980s, gram-negative bacterial isolates started to cause sepsis more often (in more than 50% of patients).

Gram-positive bacteria were documented in sepsis patients 27–74% of the time, relative to gram-negative bacteria, which were found 20–64% of the time. Based on the frequency of their identification, the most common causes of gram-negative bacterial sepsis comprise E. coli, Enterobacter, Pseudomonas, Proteus, Acinetobacter, Klebsiella, and other uncommon gram-negative bacteria. Contrarily, the most common causes of gram-positive bacterial sepsis were revealed to be coagulase-negative staphylococcus, S. aureus, and Enterococcus. Sepsis might not involve the entry of microorganisms into the circulation for them to emerge. Sepsis may be brought on by the pathogen's signal products and toxins spreading locally or throughout the body.[7] Some sepsis patients may be affected by several microorganisms.[8] Sepsis can have the same manifestations as severe rickettsial, viral (such as Hantavirus pulmonary syndrome, Ebola virus disease, Lassa fever, Marburg virus disease, Crimean-Congo hemorrhagic fever), fungal, or certain parasites such as malaria.[8]

Material & methods

Study design, area, and duration: In the period from November 2017 to May 2018, a descriptive cross-sectional hospital study was conducted in the intensive care units of Khartoum state government hospitals, specifically Omdurman Military Hospital, Omdurman Teaching Hospital, Academic Charity Hospital, Ibrahim Malik Hospital, and Soba Teaching Hospital.

Study population and inclusion criteria: In the critical care units of state-run hospitals in Khartoum, this study was carried out on patients with severe sepsis or septic shock who necessitated invasive mechanical ventilation. Patients over the age of 18, patients with complications from sepsis as their significant reason for ICU admission, patients who underwent mechanical ventilation as a result of a sepsis complication, and patients who acquired ventilator-associated pneumonia (VAP).

Sample and data collection tools: It relies on a standard random sample of all septic patients in the ICU who were connected to IMV and met the study's admission requirements. Simple standardized questionnaires were used to gather information concerning the admission, course, and outcome of septic patients who had mechanical ventilation in the intensive care unit. The researcher, who adhered to all ICU safety regulations and instructed ICU residents during their downtime, filled this position.

Study variables and data analysis: Demographic factors for the patient include age and gender. The source of sepsis, the sepsis complication that led to the need for mechanical ventilation, the type of mechanical ventilation used, the presence of co-morbid conditions like DM and HTN, COPD, asthma, and CKD, as well as the type of sedation, analgesia, and use of muscle relaxants were reported as objective clinical indicators. The length of time spent on mechanical ventilation, the course during mechanical ventilation (improving, static, or deteriorating), and the outcome (extubation, tracheostomy ward, or death). The statistical package for social science (SPSS) programming software, version 22, was used to classify and interpret all the data. The outcomes were presented in tables, and the level of significance was established at a P value of <0.05.

Results

The participants in the current study were 160 septic patients who underwent IMV, 102 of whom (64%) were male and 58 of whom (36%) were female. Of these, 41 (25.6%) were reported to be between the ages of 60 and 70 (Table 1). Sepsis was mostly caused by chest infection in 59 patients (36.9%), followed by UTI in 30 patients (18.8%), CNS infection in 23 patients (14.4%), and abdominal infection in 19 patients (11.9%). In terms of IMV indications in septic patients, the majority of the patients (71; 44.4%) had a deteriorating state of consciousness, followed by respiratory failure (30; 18.8%), severe metabolic acidosis (29; 18.1%), and ARDs (13; 8.1%).The majority of the patients had comorbid conditions, with 34 (21.3%) having hypertension, 33 (20.6%) having diabetes, 23 (14.4%) having renal illness, and 16 (10%) having asthma . In respect of sedative methods, 87 patients (54.4%) received a combination of midazolam and fentanyl, 38 patients (23.8%) received midazolam, and 17 patients (10.6%) received a combination of midazolam and propofol. Most patients in 107 cases (66.9%) stayed for 1-6 days, 50 cases (31.3%) stayed for 1-4 weeks, and 3 cases (1.8%) stayed for a month. Regarding the MV outcomes, 71 (44.4%) of the patients passed away, 80 (50%) required extubation, and 9 (5.6%) required further care strategies (Table 2).

Table 1 Description of the study population

Gender	Frequency	Percent %	Age group/ Years	Frequency	Percent %
Male	102	64	20 - 30	21	13.1
			31 - 40	17	10.6
			41 - 50	21	13.1
			51 - 60	33	20.6
Female	58	36	61 – 70	41	25.6
			More than 70	27	16.8

When age and MV outcomes were compared, the majority of those over 70 years old (70.4%) died (P=0.012). Additionally, gender has a substantial impact on the results of MV, with men accounting for the bulk of fatalities (51%). (P= 0.008) (Table 3). IMV outcomes in septic patients were not significantly linked with sepsis etiology (P=0.328) (Table 4). The fates of IMV among the septic patients were strongly influenced by the MV indications, with the majority of ARDS patients

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(76.9%) dying and 15 patients (100%) requiring MV after CPR (P=0.000) (Table 5). The consequences of IMV for patients who were septic were not significantly correlated with the MV modes among those patients (P=0.209) (Table 6). The outcomes of IMV in septic patients were not independently associated with comorbidities among those patients (P=0.209) (Table 7). All patients sedated with propofol and a combination of midazolam, fentanyl, and ketamine died (P = 0.000), and the forms of sedation were substantially linked with the outcomes of IMV among the septic patients (Table 8). In septic patients, the duration of the MV stay was appreciably related to the outcomes of IMV, and all patients who stayed for a month or longer eventually died (P=0.000) (Table 9).

Table 2 Characteristics according to the source of sepsis, comorbidities, sedation types, stay duration, and outcomes

Variable	Characteristics	Number	Percent %
Sources of sepsis	Chest	59	36.9
	Urinary tract	30	18.7
	Skin	13	8.1
	CNS infections	23	14.4
	Abdomen	19	11.9
	IV catheter	2	1.3
	Postsurgical	5	3.1
	Osteomyelitis	3	1.9
	Endocarditis	1	0.6
	Ventilator acquired pneumonia	5	3.1
MV indications	post CPR	15	9.4
	ARDS	13	8.1
	Deteriorated level of consciousness	71	44.4
	Respiratory failure	30	18.8
	Severe metabolic acidosis	29	18.1
	Neuromuscular disease	2	1.3
Comorbidities	Hypertension	34	21.3
	DM	33	20.6
	Renal diseases	23	14.4
	Asthma	16	10.0
	RHD	2	1.3
	IHD	7	4.4
	CVA	7	4.4
	Epilepsy	6	3.8
	Hepatic diseases	6	3.8
	Connective tissue diseases	2	1.3
	COPD	34	21.3
	None	33	20.6
Types of sedations	Midazolam and fentanyl	87	54.4
	Midazolam	38	23.8
	Midazolam and propofol	17	10.6
	Propofol and fentanyl	3	1.9
	Propofol	1	0.6
	Midazolam and fentanyl and ketamine	2	1.3
	No sedation	12	7.5
MV stay duration	1-6 Days	107	66.9
	1-4 Weeks	50	31.3
	A month or more	3	1.8
MV stay Outcomes	Death	71	44.4
	Extubation	80	50
	Further plans	9	5.6

Table 3 Association between the MV outcomes with age and gender

	Outcome			
	Extubated	Static	Died	P. value
Age				
20 – 30	14(66.7%)	1(4.8%)	6(28.6%)	
30 – 40	11(64.7%)	1(5.9%)	5(29.4%)	
40 – 50	12(57.1%)	0(0%)	9(42.9%)	
50 – 60	19(57.6%)	0(0%)	14(42.4%)	
60 – 70	20(48.8%)	3(7.3%)	18(43.9%)	0.012
>70	4(14.8%)	4(14.8%)	19(70.4%)	
Gender				
Male	42(41.2%)	8(7.8%)	52(51%)	
Female	38(65.5%)	1(1.7%)	19(32.8%)	0.008

Table 4 Association between the MV outcomes and sources of sepsis

	Outcome			
Sepsis sources	Improved	Static	Dead	P. value
Chest	29(49.2%)	3(5.1%)	27(45.8%)	
Urinary infection	18(60%)	3(10%)	9(30%)	
Skin	2(15.4%)	0(0%)	11(84.6%)	
CNS infection	13(56.5%)	2(8.7%)	8(34.8%)	
Abdomen	12(63.2%)	1(5.3%)	6(31.6%)	
IV catheter	1(50%)	0(0%)	1(50%)	
Osteomyelitis	1(33.3%)	0(0%)	2(66.7%)	0.328
Endocarditis	0(0%)	0(0%)	1(100%)	
VAP	3(60%)	0(0%)	2(40%)	

Table 5 Association between the MV outcomes and indications

	Outcome			
MV indications	Improved	Static	Dead	P. value
post CPR	0(0%)	0(0%)	15(100%)	
ARDS	3(23.1%)	0(0%)	10(76.9%)	
Deteriorated level of consciousness	41(57.7%)	3(4.2%)	27(38%)	
Respiratory failure	20(66.7%)	2(6.7%)	8(36.7%)	
Severe metabolic acidosis	14(48.3%)	4(13.8%)	11(37.9%)	0.000
Neuromuscular disease (VAP)	2(100%)	0(0%)	0(0%)	

Table 6 Association between the outcomes and Modes of MV

	Outcome			
Modes of MV	Improved	Static	Dead	P. value
ACV	23(46%)	2(4%)	25(50%)	
SIM/PS	41(48.2%)	7(8.2%)	37(43.5%)	0.209
CPAP/PS	16(64%)	0(0%)	9(36%)	

Table 7 Association between the MV outcomes and comorbidities

	Outcome			
Comorbidities	Improved	Static	Dead	P. value
None	14(66.7%)	1(4.8%)	6(28.6%)	
Hypertension	13(38.2%)	4(11.8%)	17(50%)	
DM	17(51.5%)	1(3%)	15(45.5%)	
RHD	0(0%)	0(0%)	2(100%)	
IHD	3(42.9%)	0(0%)	4(57.1%)	
Asthma	11(68.8%)	0(0%)	5(31.3%)	
Renal diseases	11(47.8%)	3(13%)	9(39.1%)	
CVA	3(42.9%)	0(0%)	4(57.1%)	
Epilepsy	3(50%)	0(0%)	3(50%)	0.424
Hepatic diseases	4(66.7%)	0(0%)	2(33.3%)	
Connective tissue diseases	0(0%)	0(0%)	2(100%)	
COPD	1(33.3%)	0(0%)	2(66.7%)	

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Table 8 Association between the MV outcomes and types of sedation

Types of sedations	Outcome			P. value
	Extubated	Static	Died	
Midazolam and fentanyl	45(51.7%)	4(4.6%)	38(43.7%)	
Midazolam	24(63.2%)	0(0%)	14(35.3%)	
Midazolam andpropofol	7(41.2%)	4(23.5%)	6(35.3%)	
Propofol and fentanyl	0(0%)	1(100%)	0(0%)	
Propofol	0(0%)	0(0%)	1(100%)	0.000
Fentanyl	2(100%)	0(0%)	0(0%)	
Midazolam + fentanyl + ketamine	0(0%)	0(0%)	2(100%)	
No sedation	2(16.7%)	0(0%)	10(83.3%)	

Table 9 Association between the MV outcomes and stay duration

MV stay duration	Outcome			P. value
	Improved	Static	Dead	
1-6 Days	58(54.2%)	0(0%)	49(45.8%)	
1-4 Weeks	22(44%)	9(18%)	19(38%)	0.000
A month or more	0(0%)	0(0%)	3(100%)	

Discussion

ICU admissions and in-hospital mortality are known to rise due to sepsis, which accounts for around 31.28% of the IMV need.[9] According to data from a previous study, the majority of sepsis patients in our study were between the ages of 60 and 70.[10] As was previously published, men made up the majority of patients gaining mechanical ventilation.[11] Additionally, Rashmi D. et al. showed that more than half of patients undergoing mechanical ventilation were male, with a mean age of 78.77 ± 0.14 years, overall septic patients.[12] The majority of our patients had sepsis of chest etiology, pertaining to our study. Corresponding to this, Rashmi D, et al. study indicated that the majority of patients' primary cause of sepsis was chest infections.[12] Based on the current study, 44.4% of septic patients who received IMV died. Our conclusions concurred with those of Rashmi D. et al. (41.3%) and Deep A, et al. (43%) publications,[13,14] significantly more than the result (32.5%) reported by Aziz K, et al.[15]

The majority of patients (66.9%) who underwent MV remained for 1-6 days. According to Rashmi D. et al., IMV-required septic patients had a 9.72± 0.17-day longer duration of stay.[12] Males and elderly age (>70 years) were substantially linked to higher death rates among our patients. Additionally, Aziz K. et al. indicated that geriatric (> 60 years) and male patients had higher fatality rates.[15] Furthermore, our findings revealed that long-term patients had a significant death rate; these observations were validated by other publications.[16-20] While Meng JB. et al. established that there were no significant changes in the duration of MV, length of stay in the ICU, and mortality between the groups concerning the mortality in septic patients on MV.[14,19] The present study also noted that patients who received post-CPR had a considerably greater death rate.

Propofol and the midazolam, fentanyl, and ketamine combinations have greater death rates than midazolam or the midazolam and fentanyl combination when it pertains to the impacts of sedation and analgesia (P>0.05). However, there was no statistically significant correlation between causes of sepsis, MV modes, or comorbidities and mortality (P> 0.05);[21] That is contrasted to meta-analysis findings from previous randomized controlled trials, which indicated no disparities between early goal-directed therapy and the matched control in respect of the length of ICU or hospital stays, ventilation rate, ventilation days, or vasopressor support.[19] Twenty of the patients required hemodialysis (HD), but only thirteen of them received it. The difference was attributable to the other patients' intolerance of the very ill patients or the procedure's unavailability, and those who had HD had a favorable prognosis while the others died. Similarly, only six of the fifteen patients who necessitated surgical intervention achieved so, and the effects were better. Here, it is evident that without full attention to other necessary therapies, the IMV alone will not improve the fate of septic patients.

Conclusion

From this study's streamlined observations of septic patients experiencing invasive mechanical ventilation in settings with abundant resources and skilled staff in the medical ICUs of Khartoum state governmental hospitals, we arrived at the conclusion that; the better the outcome, the earlier septic patients who need IMV are identified and attached to IMV. It has been demonstrated that using IMV reduces mortality in septic patients by about 50%.The findings suggest that; this intervention should be made more widely available and more competitively affordable by the authorities, along with the training of additional staff and the creation of standard standards for managing individuals of (add a) such particular strain. Relying on health education awareness, establishing a specialized outpatient department, and promptly screening patients who necessitate early referral to a tertiary care center are the three most crucial aspects.

Recommendations

In accordance with the results of our study, we advise: IMV from the emergency department to detect septic patients promptly and intubate them when they necessitate immediate connectivity to an IMV. To ensure that mechanical ventilation is started correctly the first time, hospitalized septic patients should be closely monitored and frequently reevaluated for the need for intubation, especially if they are male, geriatric, or have another co-morbid condition. Supplemental mechanical ventilation devices will be donated by the government, and more professionals will be educated and prepared to pursue these responsibilities. The ease of access to other procedures that augment the IMV but are unrelated to it, such as hemodialysis and surgical interventions, in order to enhance these patients' outcomes. The an impending necessity for relevant studies to be performed in order to encourage and formulate more alternative suggestions for this aspect of IMV intervention.

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Conflicts of interest

Authors declare that there is no conflict of interest.

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