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Research Article

Does Being Transported by Emergency Medical Services Improve Compliance with the Surviving Sepsis Bundle and Mortality Rate? A Retrospective Cohort Study

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ABSTRACT

Background: This study aimed to investigate the relationship between patients with severe sepsis or septic shock being transported to the Emergency Department (ED) by Emergency Medical Services (EMS) and the compliance with the 3-h sepsis resuscitation bundle [Surviving Sepsis Campaign (SSC)], and to compare the management and laboratory results of patients transported by EMS or non-EMS transport.

Methods: A retrospective cohort study was conducted using data from a quality-improvement project at King Abdulaziz Medical City in Riyadh. The data for patients who presented to ED with sepsis (severe sepsis or septic shock) was categorized as being transported with EMS or non-EMS. The two groups were compared in terms of compliance with the SSC bundle and 30-day mortality.

Results: In a sample of 436 patients with severe sepsis or septic shock presented at the ED during the study period, EMS transported almost one-third of the patients (134, 31%) and 302 patients (69%) used non-EMS transport. For the EMS group, adherence to intravenous fluid was 91.4% compared with 87% for the non-EMS group ($p = 0.19$), antibiotics (EMS 50.7% vs non-EMS 52%, $p = 0.81$), blood cultures before antibiotics (EMS 53% vs non-EMS 47.4%, $p = 0.21$), and measuring lactate levels (EMS 73.1% vs non-EMS 57%, $p = <0.01$). The mortality rate was 48.5% for the EMS group and 54% for the non-EMS group, which was not statistically significant.

Conclusion: Whether transported with or without EMS did not result in a statistically significant difference in patients presenting with sepsis, in terms of the adherence to the SSC bundle elements or the 30-day hospital mortality rate. The only statistically significant difference was the time to lactate measurement.

1. INTRODUCTION

Sepsis is considered as a major cause of mortality due to infection. To prevent sepsis from progressing to severe sepsis or septic shock, early recognition and management are pivotal [1]. It is difficult to determine the prevalence of sepsis globally and it is estimated that annually there are 30 million newly diagnosed patients with sepsis with 6 million deaths [2]. The Surviving Sepsis Campaign (SSC) 2012 data showed mortality rates from sepsis in Europe and United States to be 41% and 28.3%, respectively [3]. A meta-analysis study reported that of a total of 14,418 patients with severe sepsis who were treated with the standard care, the 28-day mortality rate was 33.2% [4]. The same study indicated that the mortality decreased 3% annually, reducing from 46.9% to 29% in 20 years starting from 1991 [4]. In Australia and New Zealand, 101,064 sepsis patients were studied and reported that the mortality rate decreased from 35% to 20% in 12 years [5].

To reduce morbidity and mortality from sepsis, early diagnosis and intervention are recommended [3,6,7]. According to the SSC, the 3-h bundle of sepsis resuscitation, early management include blood cultures, lactate level, intravenous fluids, and antibiotics to improve the mortality rate in sepsis [7,8]. As documented in literature, Emergency Medical Services (EMS) play a major role in the diagnosis and early management of patients with severe sepsis [9–11]. Patients transported with EMS had a better outcome and survival rates, especially for acute stroke care, cardiac arrest and trauma cases [9–11]. The latest evidence-based clinical practice guidelines for sepsis management and treatment highlighted the timely management of the patient [8]. Management of sepsis by the EMS personnel could be early intravenous fluid resuscitation depending on the

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initial blood pressure measurement, administrating antibiotics, and transporting patients to a suitable level of care center [12]. In a study with 1350 patients admitted with sepsis, prehospital intravenous fluid was administered to 23% with the majority (67%) receiving no prehospital intervention. Participants who received prehospital care had a lower hospital mortality rate [13]. Another multicenter study compared the effects of early antibiotic administration and in-hospital management. Of 2698 patients, 1535 received an early dose of antibiotics and 1137 received the usual hospital care. After 28 days, the mortality rate was the same in the intervention group and the usual in-hospital care group (8%) [14]. A systemic review reported that limited literature is available focusing on the skills of paramedics to recognize patients with sepsis and the required treatment [13].

In Saudi Arabia, EMS is still developing. The goal of the current study was to study the relationship between being transported by EMS and non-EMS transport and the outcomes of patients presenting at the ED with severe sepsis and septic shock and the improvement in the compliance with the SSC bundle, as well as to compare the laboratory values of the EMS group with the non-EMS group.

2. MATERIALS AND METHODS

As part of a quality-improvement project by the Intensive Care and Emergency Medicine Departments, a retrospective cohort study was conducted at King Abdulaziz Medical City (KAMC) on patients presented with severe sepsis or septic shock between January 2011 and February 2013. KAMC is considered as one of the largest medical cities in Saudi Arabia with a bed capacity of 1501 beds. Annually, more than 200,000 patients present at the ED. The QuadraMed Healthcare Information System was used in all departments of KAMC at the time of this study. For patients in ED levels I or II, vital signs are monitored in the system every 60 min according to the Canadian triage method. For patients in levels III or IV, the vital signs are monitored and registered in the system every 120 min [15]. KAMC ED has its own laboratory with a 60-min turnaround time for white blood cell and lactate levels. The ED staff manages all the patients before they are transferred to the intensive care unit or to other specialties, as required.

The following criteria were used to categorize patients as severe sepsis: having systemic inflammatory response syndrome (having two or more of the following: temperature >39°C or <36°C, heart rate >90 beats/min, respiratory rate >20 beats/min or $PaCO_2$ <32 mmHg, and white blood cell count >12,000/mm^3, <4000/mm^3, or >10% band neutrophilia) with suspected or confirmed infection and associated organ dysfunction or hypotension (organ dysfunction included presence of lactic acidosis, oliguria, and/or altered mental status). Patients were categorized as septic shock if they had severe sepsis with hypotension despite adequate fluid resuscitation requiring vasopressor support.

All the following data for patients above 13 years old (those who were 13 years old and below were excluded as per the cutoff adult age in the hospital) and diagnosed with severe sepsis or septic shock were extracted from the database of the project: mode of arrival to ED, source of infection, vital signs, physical exam and laboratory findings, interventions, and the 30-day mortality. Institutional Review Board approval was obtained for this study, and informed consent was not required.

The participants were divided into two groups: an EMS group and a non-EMS group (private transportation, wheel chair, or walking). Information was retrieved from the hospital information system (QuadraMed, Reston, VA, USA); the triage nurse manually entered the mode of transport into the system and the information was confirmed by reviewing the scanned copy of the EMS patient care record.

Data analysis and interpretation were done using the Statistical Package for Social Sciences for Windows (version 22.0, IBM Corp, Armonk, NY, USA). Chi-square test was used to compare the categorical variables; the EMS and non-EMS groups in term of signs, symptoms, organ dysfunction indicators, intervention, complains with 3-h sepsis bundles, 30-day in-hospital mortality. Significance was considered at a p-value of <0.05.

3. RESULTS

In total, 436 patients with severe sepsis or septic shock presented to the ED. Almost a third (30.7%) arrived by EMS and the remaining (69.3%) arrived with non-EMS transportation. The suspected infection of the septic patients was pneumonia (49.8%), urinary tract infection (15%), abdominal infection (8%), infection due to a blood stream catheter (4.1%), and other infections (37.4%). The EMS group had more abdominal infections (11.2%) compared with the non-EMS group (6.6%, $p = 0.11$) However, there were more patients with blood stream catheter infection in the non-EMS compared with the EMS group (5% vs 2.2%, $p = 0.19$).

Hyperthermia was equally distributed between the EMS or non-EMS groups (26.9% and 25.8%, $p = 0.82$). A decreased mental status was more prevalent in the EMS group than the non-EMS group (44.8% vs 32.1%, $p = 0.01$). The remaining Systemic Inflammatory Response Syndrome (SIRS) criteria were not statistically significant between the two groups. Table 1 displays the SIRS criteria between the EMS and non-EMS groups.

None of the organ dysfunction indicators was statistically significant between the EMS and non-EMS groups (Table 1). Patients with Systemic Blood Pressure (SBP) <90 mmHg or mean arterial pressure <65 mmHg constituted 83.1% and 79.1% of non-EMS and EMS groups, respectively. A reduction of >40 mmHg in the SBP occurred in 11.9% of the non-EMS and in 13.4% of the EMS group. Similarly, an increase in creatinine was observed in 20.1% and 26% of EMS and non-EMS groups, respectively. The interventions implemented during admission were investigated and are presented in Table 2.

Lactate was measured in 91.7% of non-EMS and 96.3% of EMS groups ($p = 0.08$). All the non-EMS patients received antibiotics compared with 97.1% of the EMS patients ($p = 0.01$). Other intervention parameters were not statistically significant between the two groups. Adherence to the 3-h SSC bundle elements was as follows: intravenous fluid (EMS 91.4% vs non-EMS 87%, $p = 0.19$), antibiotics (EMS 50.7% vs non-EMS 52%, $p = 0.81$), blood cultures before antibiotics (EMS 53% vs non-EMS 47.4%, $p = 0.21$), measurement of lactate levels (EMS 73.1% vs non-EMS 57%, $p \leq 0.01$). The mortality rate was 48.5% for EMS and 54% for non-EMS groups, with no statistically significant difference.

4. DISCUSSION

Previous studies have shown that EMS interventions improved the outcome for different health conditions [9–11,16–18]. The

Table 1 | The association between suggested suspected infection SIRS criteria and organ dysfunction upon arriving to emergency department by EMS vs non-EMS among sepsis patients

Variables	Non-EMS vs EMS (*N* = 436)		*p*-value
	Non-EMS (*N* = 302), *N* (%)	EMS (*N* = 134), *N* (%)	
Suggested/suspected infection			
Pneumonia	149 (49.3)	68 (50.7)	0.79
Urinary tract infection	47 (15.6)	21 (15.7)	0.98
Abdominal	20 (6.6)	15 (11.2)	0.11
Meningitis	2 (0.7)	1 (0.7)	0.92
Skin/soft tissue	3 (1)	3 (2.2)	0.30
Bone/joint	4 (1.3)	1 (0.7)	0.60
Wound	4 (1.3)	1 (0.7)	0.60
Blood stream catheter	15 (5)	3 (2.2)	0.19
Endocarditis	3 (1)	0 (0)	0.25
Implantable device	3 (1)	0 (0)	0.25
Others	113 (37.4)	50 (37.3)	0.98
SIRS criteria			
Hyperthermia	78 (25.8)	36 (26.9)	0.82
Hypothermia	26 (8.6)	8 (6)	0.34
Mental status	97 (32.1)	60 (44.8)	0.01
Chills/rigors	10 (3.3)	1 (0.7)	0.12
Tachycardia	240 (79.5)	114 (85.1)	0.17
Tachypnea	258 (85.4)	110 (82.1)	0.38
Leukocytosis	166 (55)	71 (53)	0.70
Leukopenia	23 (7.6)	13 (9.7)	0.47
Hyperglycemia	5 (1.7)	3 (2.2)	0.68
Organ dysfunction indicators			
SBP <90 or MAP <65	251 (83.1)	106 (79.1)	0.32
SBP drop of >40	36 (11.9)	18 (13.4)	0.66
Creatinine	80 (26.5)	27 (20.1)	0.16
Bilirubin	36 (11.9)	8 (6)	0.06
Platelets	29 (9.6)	11 (8.2)	0.64
Lactate	108 (35.8)	60 (44.8)	0.07
Coagulopathy	47 (15.6)	20 (14.9)	0.87
SpO_2	64 (21.2)	37 (27.6)	0.14

EMS, emergency medical services; SBP, systemic blood pressure; MAP, mean arterial pressure; SpO_2, peripheral capillary oxygen saturation; SIRS, systemic inflammatory response syndrome.

Table 2 | The association between interventions and compliance with 3-h sepsis bundles upon arriving to emergency department by EMS vs non-EMS among sepsis patients

Variables	Non-EMS vs EMS (*N* = 436)		*p*-value
	Non-EMS (*N* = 302), *N* (%)	EMS (*N* = 134), *N* (%)	
Met criteria for			
Severe sepsis	81 (26.8)	26 (19.4)	0.10
Sepsis shock	221 (73.2)	108 (80.6)	
Interventions			
Lactate done	277 (91.7)	129 (96.3)	0.08
Antibiotic given	232 (100)	100 (97.1)	0.01
Culture done	160 (53)	78 (58.2)	0.31
Hypotensive	270 (89.4)	122 (91)	0.60
SBP < 90	234 (86.7)	109 (89.3)	0.46
MAP < 65	248 (91.9)	114 (93.4)	0.58
SBP decrease >40	70 (25.9)	32 (26.2)	0.95
Fluid resuscitation	272 (97.8)	127 (99.2)	0.32
MAP raise after fluid	63 (23.2)	25 (19.7)	0.44
Vasopressor given	202 (96.7)	97 (95.1)	0.50
MAP raise after pressor	0 (0)	1 (1)	0.15
Ventilated	178 (58.9)	87 (64.9)	0.24
Compliance with 3-h sepsis bundles			
Lactate	172 (57)	98 (73.1)	<0.01
Blood culture	143 (47.4)	71 (53)	0.28
Antibiotic	157 (52)	68 (50.7)	0.81
Fluid	247 (87)	117 (91.4)	0.19
CVP	47 (19.3)	24 (21.2)	0.66
$ScvPO_2$	40 (16.4)	25 (22.1)	0.19
Resuscitation bundle	17 (5.6)	7 (5.2)	0.86
Steroid	122 (55.2)	59 (54.6)	0.92
Glucose	122 (40.4)	54 (40.3)	0.99
Plateau P	154 (86.5)	78 (89.7)	0.47
Management bundle	75 (24.8)	30 (22.4)	0.58
30-Day mortality	163 (54)	65 (48.5)	0.29

EMS, emergency medical services; SBP, systemic blood pressure; MAP, mean arterial pressure; CVP, central venous pressure; SpO_2, peripheral capillary oxygen saturation.

hypothesis in this study was that the EMS-transported patients would have improved process outcomes in the ED; however, only the lactate measurement was statistically significant between the two groups. There was no difference in the other parameters of the SSC or in the overall mortality.

Other studies that investigated the same research question have reported improved ED processes in the management of severe sepsis and septic shock by reducing the time required to administer medication and intravenous fluid [19–22] with no change in mortality [19–21]. Seymour et al. [23] concluded that patients with sepsis who received interventions by paramedics had a significantly lower mortality rate. However, another study [24] reported that EMS provider management of sepsis patients increased on-scene time. Three papers reported limited support for blood pressure by paramedics even though hypotension was measured and documented [23,25,26]. A reason for the nonsignificant difference between the EMS and non-EMS groups, except for the lactate measurement, in the current study may be that the time to triaging in the ED critical care unit was similar for both groups or the small sample size. A concerning finding is that patients presenting via EMS were not prioritized compared with the non-EMS group, which is in contrast to other studies. Patients presenting via EMS had a reduced time, possibly due to the awareness of health care providers of the sepsis syndrome. Another possible factor could be the age of the patients because it has been reported as a significant factor in the refusal of intensive care [27].

A limitation of the study is the fact that there are several EMS agencies with a notable variation in the level of training and certification (basic life support vs advanced life support). The initiation of intravenous fluid by EMS could have caused a delay in the fluid initiation in the ED, although this should not affect the time to antibiotic initiation, blood cultures, or the remaining sepsis bundle elements. Finally, the study was conducted in a single center, which limits the generalizability of the findings.

5. CONCLUSION

There were no significant differences in the outcomes of the EMS and non-EMS groups between patients with severe sepsis and septic shock. There were also no significant differences in the adherence to

the SSC bundle elements or the mortality rate. The only significant difference found was the time to the lactate measurement. These findings reflect the lack of sepsis awareness of prehospital care providers and management protocols may be a potential area for improvement.

CONFLICTS OF INTEREST

The authors declare they have no conflicts of interest.

AUTHORS' CONTRIBUTION

NA, YA and Sami A, designed the study and reviewed the manuscript. NA supervised the study. HA, AA, AB and Sarah A, collected data and wrote the manuscript. FA analyzed and interpreted data, wrote and edited the manuscript.

ETHICAL APPROVAL

The Institutional Review Board, King Abdullah International Medical Research Centre, Ministry of National Guard Health Affairs, Riyadh, Saudi Arabia approved this study.

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