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Original Research Article

Utility of sequential organ failure assessment score in predicting outcome for patients with peritoneal sepsis

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ABSTRACT

Background: Severe complicated intra-abdominal sepsis (SCIAS) is a worldwide challenge with increasing incidence. The sequential organ failure assessment (SOFA) score numerically quantifies the number and severity of failed organs. We examined the utility of the SOFA score for assessing outcome of patients with severe peritoneal sepsis.
Methods: This is a prospective observational study. A total of 100 patients who presented to emergency department of Victoria hospital with features suggestive of peritoneal sepsis from January 2018 to August 2018 were included in the study. The presence of organ dysfunction was assessed using a sequential organ failure assessment (SOFA). Clinical, microbiologic, and laboratory factors were considered for assessing the outcome.
Results: Forty-two patients had two or more sites of infection on admission. Bacteraemia was confirmed in 20 patients. 88 patients were surgical. The median age of patients was 69 years. Males being more commonly affected than females. Twenty-eight days survival rate was 41%. The incidence of organ dysfunction on day 1 was noted more frequently for renal, cardiovascular, and neurological systems. SOFA score on day 1 and day 3 were significantly higher in non-survivors than those in survivors. Patients with three and higher number of organ systems with dysfunction had a lower survival rate than the subgroups of patients with one or two organ systems with dysfunction.
Conclusions: The SOFA score provides potentially valuable prognostic information on in hospital survival when applied to patients with severe peritoneal sepsis.

Keywords: Abdominal sepsis, Scoring system, Sequential organ failure assessment, Survival

INTRODUCTION

Sepsis, defined as infection-induced systemic inflammatory response syndrome (SIRS), is the leading cause of death in critically ill patients.[1-3] Although sepsis is a systemic process, the pathophysiological cascade of events may vary from region to region. It is associated with significant morbidity and mortality rates, and is the second most common cause of sepsis-related mortality.[2]

Sepsis involves multiple mechanisms, including the release of cytokines and the activation of the complement, coagulation and fibrinolytic systems. The severity of inflammatory response and impairment of organ function are the major determinants of the outcome in critically ill septic patients.[4]

The severe sepsis is defined as the presence of sepsis and related organ dysfunction.[5,6] Clinical trials and observational studies usually use a scoring system for the assessment of the severity of organ function impairment.

There are several outcome prediction models that are currently available for use in clinical practice.[7] Among

them are the acute physiology and chronic health evaluation IV score, the simplified acute physiology score III, the logistic organ dysfunction score, and the mortality probability model III, which were derived and validated on large groups of intensive care unit (ICU) patients and require historical data.[8-11] Previous investigations have shown that most of these scores possess inadequate predictive abilities when adapted to ED populations.[12]

The assessment of the impact of each organ dysfunction to the outcome of the patients with a diagnosis of severe sepsis was undertaken in this study applying a set of reliable statistical methods. The choice of the SOFA system was made because it was created to describe a sequence of complications in septic patients. The SOFA score is a simple and objective score that allows for calculation of both the number and the severity of organ dysfunction in six organ systems (respiratory, coagulation, liver, cardiovascular, renal, and neurologic) and the score can measure individual or aggregate organ dysfunction.

Objectives

- The objectives of the study were to evaluate the impact of organ dysfunction in severe sepsis and to determine the effectiveness of organ dysfunction score to discriminate outcome.
- This study was designed to identify prognostic factors of in-patient deaths of surgical, critically ill patients with sepsis and to evaluate the effects of treatments for sepsis on in-patient deaths.
- To asses whether an increase of 2 or more points in sequential [Sepsis-related] organ failure assessment (SOFA) score have greater prognostic accuracy in patients who are critically ill with suspected infection.

METHODS

Sepsis was defined as an infection with SIRS, defined as the occurrence of at least two of the following criteria:[1-5]

- Body temperature >38˚C or <36˚C,
- Heart rate >90 beats per minute,
- Respiratory rate >20 breaths a minute or PaCO2 <32 mmHg,
- WBC count >12,000/ mm^3 or <4000/ mm^3 or <10% immature forms.
    - Blood samples were drawn when patients first fulfilled the criteria for SIRS.
    - Septic shock was defined as sepsis induced hypotension, consisting of systolic blood pressure below 90 mmHg, which persisted despite adequate fluid resuscitation.
    - Ileus was defined as any impairment, arrest, or reversal of the normal flow of intestinal contents toward the anal canal

Source of data

Patients of both sexes with a diagnosis of severe peritoneal sepsis admitted in department of General Surgery, BMCRI and hospitals attached to BMCRI.

This was prospective observational study. The study was carried out at Hospitals attached to BMCRI (Victoria Hospital) during January 2018 to August 2018.

Sample size

It is a hospital based study of 100 patients.

Inclusion criteria

Inclusion criteria were patients with a diagnosis of peritoneal sepsis (hollow viscus perforation, gangrenous bowel or severe peritonitis due to any other cause) and at least one organ dysfunction on the first day; suspected infection, two or more criteria of systemic inflammation, and a diagnosis of severe peritoneal sepsis either systolic blood pressure <90mm Hg after a fluid bolus or lactate >4mmol/L.

Exclusion criteria

Exclusion criteria were age <18 year; absolute contraindication for a chest central venous catheter.

Demographic and clinical data retrieved from the medical records which included sex, age, underlying disease, location of the primary infection, blood cultures and pus cultures.

The presence of 6 organ dysfunctions (cardiovascular, neurological, respiratory, renal, hepatic, coagulation) was assessed using a SOFA score (Table 1). The presence of each organ dysfunction was defined when degree of dysfunction was equal to 1 and more. The most abnormal value for each clinical and laboratory parameter included in the SOFA system was recorded daily and then transformed into the score of dysfunctions, graded from 0 to 4. Organ dysfunction on day 1 and maximum score of dysfunctions for all the six organ systems were found. SOFA scores on day 1 and day 3 were selected for the assessment of prognosis. The length of stay in the ICU or hospital was measured as number of days from admission to the ICU to discharge from the ICU and hospital, respectively. The main outcome was the survival status on day 28 after the admission to the ICU.

Statistical analysis

Quantitative normally distributed variables were presented as means, standard deviation (SD) and non-normally distributed variables (age, length of stay) as medians and the 25th-75th quartiles range. The organ dysfunction scores were compared using the unpaired t-

test. In all comparisons, $p<0.05$ was considered statistically significant.

Table 1: SOFA -sequential [sepsis- related] organ failure assessment score.[a,13]

System	Score				
	0	1	2	3	4
Respiration					
Pa02/FiO2,	≥400	<400	<300	<200	<100
mm hg (kPa)	(53.3)	(53.3)	(40)	(26.7) with respiratory support	(13.3) with respiratory support
Coagulation					
Platelets x 10^3/µL	≥150	<150	<100	<50	<20
Liver					
Bilirubin,	<1.2	1.2-1.9	2.0-5.9	6.0-11.9 (102-	>12.0
mg/dl (µmol/L)	(20)	(20-32)	(33-101)	204)	(204)
Cardiovascular					
MAP	≥70 mm hg	<70 mm hg	DA<5 or Db (any dose)[b]	DA 5.1-15 or E-≤0.1 or NE≤0.1[b]	DA>15 or E>0.1 or NE >0.1[b]
CNS					
GCS	15	13-14	10-12	6-9	<6
Renal					
1.Creatinine, mg/dl (µmol/L)	<1.2 (110)	1.2-1.9 (110-170)	2.0-3.4 (171-299)	3.5-4.9 (300-440)	>5.0 (440)
2.Urine Output, mL/d				<500	<200

Abbreviations- MAP- Mean Arterial Pressure; FiO2- Fraction of inspired oxygen; PaO2- Partial Pressure of oxygen
a - Adapted from Vincent et al[13]. b - Catecholamines are given as µg/kg/min for atleast 1 hr. c - Glasgow coma scale ranges from 3-15; higher score indicates better neurological function.

RESULTS

Among 100 patients admitted with a diagnosis of severe peritoneal sepsis, 42 patients had two or more sites of infection on admission. Bacteraemia was confirmed in 20 patients. The median age of patients was 69 years (25th-75th quartiles range, 57-77 years) (Figure 1). Males being more in number compared to females. M:F = 5:1 (Figure 2). Abdominal surgery was most common among surgical interventions (n=52) performed (Table 2). The median length of stay in the ICU was 4 (3-7) days, in the hospital 8 (4-25) days. Twenty-eight days survival rate was 41%. There were 85% of the patients who had two or more organ dysfunctions on day 1. The incidence of organ dysfunction on day 1 was noted more frequently for renal, cardiovascular, and neurological systems (67%, 66%, and 61% of cases, respectively). The abnormalities in respiratory, hepatic, and coagulation function were less common (42%, 41%, and 25% of cases, respectively). During the whole stay in the ICU, cardiovascular (80%), renal (78%), and neurological (76%) dysfunction was the most common (Figure 3). The lowest scores and small contribution of the coagulation and hepatic systems to the overall SOFA score was noted. SOFA score on day 1 and day 3 were significantly higher in non-survivors than those in survivors (Figure 4 and 5). Significant changes in the course of organ dysfunction were observed during the stay in ICU. The non-survivors compared with the survivors had higher organ dysfunction scores for all organ systems ($p<0.01$), except hepatic (Figure 4). The best discrimination results were shown for cumulative scores with the highest for the SOFA score on day 3, less for the SOFA score on day 1. Patients with three and higher number of organ systems with dysfunction had a lower survival rate than the subgroups of patients with one or two organ systems with dysfunction.

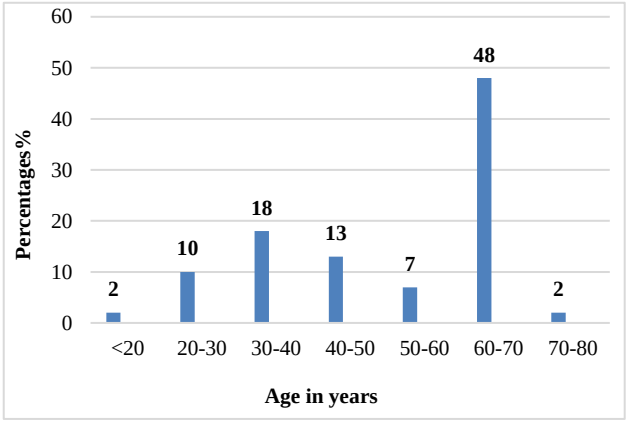


Figure 1: Age distribution.

Maximum number of cases were seen in the age range of 57-77 years, with median age of 69 years. Maximum cases were seen among males with M:F ratio 5:1.

Conservative management included bowel rest, ryles tube insertion and aspiration, and nil by mouth; Intravenous antibiotics as per total counts and differential counts; correction of nutritional deficiency, improving nutrition by total parenteral nutrition, blood transfusions and enteral nutrition; intravenous fluid therapy; adequate analgesia; correction of electrolyte abnormalities.

The incidence of organ dysfunction was noted more frequently for renal, cardiovascular, and neurological systems. The abnormalities in respiratory, hepatic, and coagulation function were less common. The lowest scores and small contribution of the coagulation and hepatic systems to the overall SOFA score was noted.

The trends in daily sequential organ failure assessment (SOFA) scores for the patients with a diagnosis of severe sepsis over the first seven days in the intensive care unit. The SOFA scores were significantly higher in non-survivors on day 1 ($p=0.001$), and on each subsequent day ($p<0.001$).

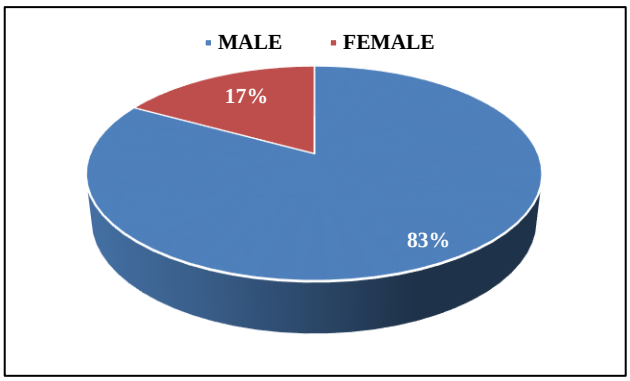


Figure 2: Gender distribution.

Table 2: Causes of peritoneal sepsis and types of treatment in surgical critically ill patients with peritoneal sepsis.

Cause of sepsis	Number of patients	Treatment modality		
		Surgery	Drainage	Conservative
Hollow viscus perforation	36	32	2	2
Acute cholecystitis	8	2	-	4
Acute cholangitis	5	2	-	3
Ileus	15	-	5	10
Ruptured liver abscess	24	14	6	4
Post-op acute enteritis	6	-	-	6
Post-op bowel anastomosis leak	2	2	-	-
Abdominal compartment syndrome secondary to blunt trauma	4	-	-	4

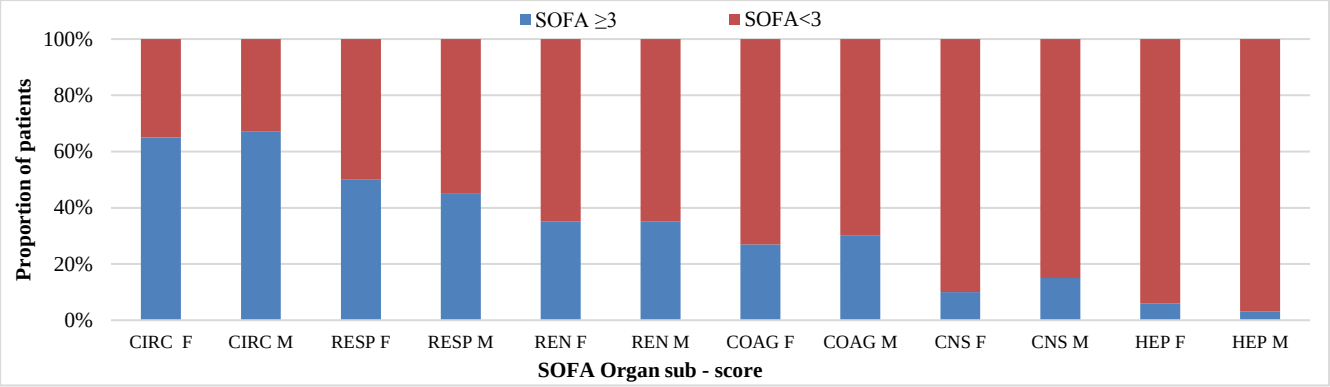


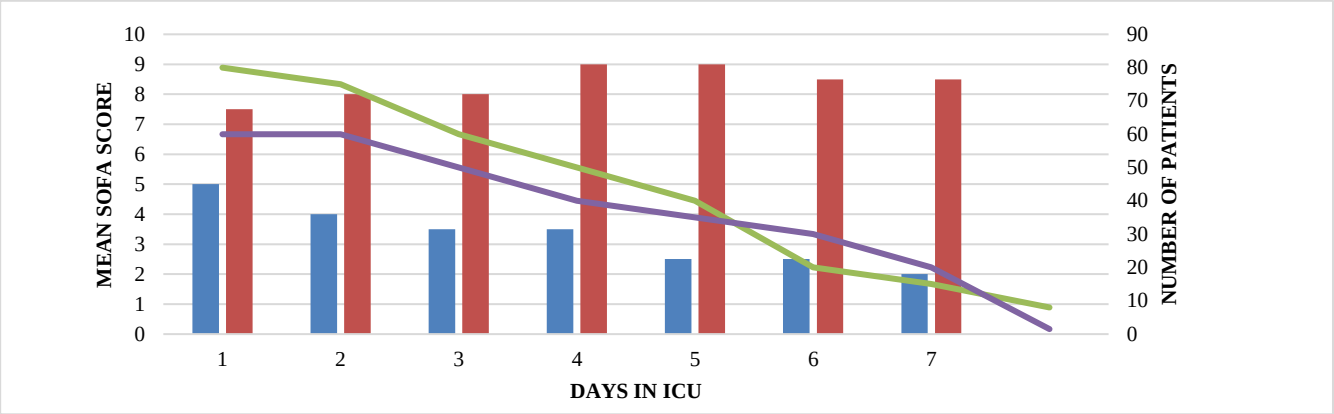
Figure 3: Proportion of patients with SOFA organ sub-score ≥3 as a sign of organ failure (females and males) and proportion of patients with SOFA organ sub-score <3 (females and males).

SOFA sub-scores: circ= circulatory; resp=respiratory; renal=renal; coag=coagulation; CNS=central nervous system; hep = liver function. F=Female; M=Male.

DISCUSSION

The results of the present study showed that the changes in the severity of organ dysfunction were closely related to the outcome of the patients admitted with diagnosis of severe peritoneal sepsis. Initial and daily scores outlined the baseline and evolution in the severity of disease. Increasing organ dysfunction scores and cumulative

SOFA scores reflected the worsening function in organ systems during the course of severe sepsis.



BLUE BARS – SOFA score, survivors; RED BARS – SOFA score, non-survivors; GREEN LINE – number of survivors; PURPLE LINE – number of non-survivors

Figure 4: Sequential organ failure assessment score as the determinant of outcome for patients with severe sepsis.

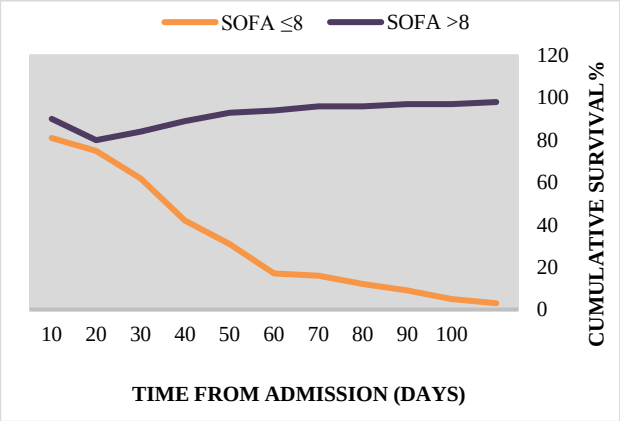


Figure 5: Kaplan-Meier survival curves of surgical, critically ill patients with sepsis having SOFA scores ≤8 and >8. Patients with SOFA score >8 had a significantly higher in-hospital death rate than the patients with SOFA score ≤8 (p=0.0039).

The SOFA score on day 3 was better compared with SOFA score on day 1 as the tool for outcome prediction. Some degree of organ dysfunction necessitating active treatment is frequently present in a majority of critically ill patients. The assessment of organ dysfunction scores are often used to determine the baseline severity of illness and the pattern of changes in organ function over the course of various critical illnesses.

In this study we evaluated organ dysfunction using the SOFA system. This system was developed as a tool for sepsis-related organ failure assessment and was comparable to other studies. When comparisons were made among organ dysfunction systems in the predictive ability of outcome, SOFA system showed highest values (18-20). The results of our study confirmed that the SOFA score is a good tool for assessing the impact of organ dysfunction in severe sepsis, as compared to study done by Vincent et al.[13]

An initial wave of dysfunction due to the presence of infection on admission to the ICU is most commonly observed in main vital organ functions (cardiovascular, respiratory, and neurological). All our patients with severe sepsis had at least one organ dysfunction. An inflammatory response to new acquired infection episodes additionally to the initial septic insult or inadequate resuscitation is the most likely mechanism causing a second wave of organ dysfunction. The emergence of more severe organ dysfunction was strongly associated with mortality, as compared with study done by Ferreira et al.[14] The incidence of organ dysfunctions varies according to the definition and the case-mix. For the patients with severe sepsis cardiovascular, respiratory, neurological, and renal dysfunctions were most common. Haematological and hepatic dysfunction was less common. Respiratory dysfunction, especially its mild form, was found less frequently than expected in our study.

In accordance with Timsit et al, the primary study outcome was in-hospital mortality with a composite secondary outcome of in-hospital mortality or an ICU length of stay of 3 days or longer.[15] SOFA system was successfully applied and helped to assess morbidity in severe sepsis. However, the initial degree of individual organ dysfunction scores were less useful for outcome analysis compared with discriminative capability of increasing severity of acquired organ dysfunction during intensive care. The measurement of organ dysfunction daily during the ICU stay provided additional prognostic information compared to baseline measures. The discriminative capability of the SOFA score was the

highest on day 3. Similarly, Ferreira et al, determined that, regardless of the initial score, an increase in SOFA score during the first 48 hours in the ICU predicts a mortality rate of at least 50%.[14,15]

CONCLUSION

In summary, the severity of organ dysfunction proved to be a good factor in discriminating outcome for the patients with severe sepsis. The SOFA scores showed high accuracy describing the course of organ dysfunction in these patients. Evolving organ dysfunction following admission to the ICU strongly affected the outcome. Cumulative SOFA scores, particularly on day 3, were better in predicting outcome compared to single organ dysfunction score. The assessment of organ dysfunction should be used for risk stratification in clinical trials including critically ill patients with severe sepsis.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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