Original Article

Accuracy of SOFA Score to Predict Outcome in Community-Acquired Sepsis

Chutima Cheranakhorn MD[1], Thanva Teeratpatcharakun MD[1]

[1] Department of Internal Medicine, Hatyai Hospital, Songkhla, Thailand

Background: The new definition of Sepsis-3 defines sepsis as life-threatening organ dysfunction, demonstrated by an increase in the Sequential Organ Failure Assessment (SOFA) of 2 or more points, caused by a dysregulated host response to infection. The performance of SOFA score data in a setting of a tertiary public hospital in a middle-income country remains limited.

Objective: To determine the accuracy of the SOFA score to predict the 28-day mortality in community-acquired sepsis patients.

Materials and Methods: A retrospective study enrolled community-acquired sepsis and septic shock patients admitted between January and December 2015 in Hatyai Hospital, a tertiary public Hospital in Southern Thailand. All variables for calculating the SOFA and qSOFA scores were collected. The primary outcome was the 28-day mortality.

Results: Three hundred seventy-nine patients were enrolled. Eighty-seven patients (23%) died. The median (IQR) SOFA score was 6 (3, 9) points. The SOFA score had a fair predictive performance (AUROC 0.71, 95% CI 0.65 to 0.77), which was higher than qSOFA score (AUROC 0.67, 95% CI 0.62 to 0.73). The SOFA score of 2 points associated with mortality (13%) and higher score patients had an incremental increase mortality rate. The hazard ratio (HR) was 4.59 (95% Cl 1.3 to 15.78, p=0.02) for SOFA Score 6 to 7 points.

Conclusion: Among patients presenting with community-acquired infection, the SOFA score indicated the fair predicting ability for the 28-day mortality and performed better than qSOFA score.

Keywords: SOFA, qSOFA, Sepsis, Accuracy, Mortality, Community-acquired infection, Thailand

Received 31 May 2020 | Revised 30 September 2020 | Accepted 30 September 2020

J Med Assoc Thai 2021;104(4):544-51

Website: http://www.jmatonline.com

The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3) newly define sepsis as a life-threatening organ dysfunction caused by infection[1]. The Systemic Inflammatory Response Syndrome (SIRS) criteria, which was used in the previous definition[2] had a limitation and low validity for diagnosed sepsis[3]. The new definition[1] uses the Sequential [Sepsis-related] Organ Failure Assessment (SOFA) score[4] instead of SIRS to represent organ dysfunction by an increase of 2 points or more of the SOFA score. A new term, Quick SOFA (qSOFA), is a bedside score used for identifying patients with suspected infection who presented with more than two of three criteria are high risk for a poor outcome. The criteria are low blood pressure as systolic blood pressure (SBP) of 100 mmHg or less, high respiratory rate of 22 breaths or more per minute, and alteration of conscious using the Glasgow Coma Scale of less than 15. In a previous study, Seymour et al demonstrated that the predictive validity for in-hospital mortality among intensive care unit (ICU) encounters was lower for SIRS (AUROC 0.64, 95% CI 0.62 to 0.66), qSOFA (AUROC 0.66, 95% CI 0.64 to 0.68, p<0.01 versus SOFA (AUROC 0.74, 95% CI 0.73 to 0.76, p<0.001)[5]. Similarly, Raith et al's study demonstrated that the SOFA score had significantly greater discrimination for in-hospital mortality than SIRS criteria and qSOFA[6].

However, the accuracy of the scoring system needs to be evaluated by implementing it in different clinical settings and resources. The new definition developed based on the large database in the USA and small data in Germany[4] may not represent the other region's healthcare system, especially in the low- and middle-income countries[7]. The Extended Prevalence of Infection in Intensive Care (EPIC II) study demonstrated the significant geographic regional differences in organism isolated and mortality rate, which might be caused by the

Correspondence to:

Cheranakhorn C.

Department of Internal Medicine, Hatyai Hospital, Songkhla 90110, Thailand.

Phone: +66-81-5993377

Email: waitfor027@gmail.com

How to cite this article:

Cheranakhorn C, Teeratpatcharakun T. Accuracy of SOFA Score to Predict Outcome in Community-Acquired Sepsis. J Med Assoc Thai 2021;104:544-51.

doi.org/10.35755/jmedassocthai.2021.04.11555

Table 1. Sequential [Sepsis-Related] Organ Failure Assessment Score[a]

System	Score				
	0	1	2	3	4
Respiration					
PaO_2/FiO_2 (mmHg)	≥400	<400	<300	<200 with respiratory support	<100 with respiratory support
SpO_2/FiO_2[b]	≥512	<512	<357	<214	<89
Coagulation					
Platelet ($10^3/\mu L$)	≥150	<150	<100	<50	<20
Liver					
Bilirubin (mg/dL)	<1.2	1.2 to 1.9	2.0 to 5.9	6.0 to11.9	>12.0
Cardiovascular	MAP ≥70 mmHg	MAP <70 mmHg	Dopamine <5 or dobutamine (any dose)[c]	Dopamine 5.1 to 15 or epinephrine ≤0.1 or norepinephrine ≤0.1[c]	Dopamine >15 or epinephrine >0.1 or norepinephrine >0.1[c]
Central nervous system					
Glasgow Coma Scale score[d]	15	13 to 14	10 to 12	6 to 9	<6
Renal					
Creatinine (mg/dL)	<1.2	1.2 to 1.9	2.0 to 3.4	3.5 to 4.9	>5.0
Urine output (mL/day)				<500	<200

FiO_2=fraction of inspired oxygen; PaO_2=partial pressure of oxygen; SpO_2=pulse oximetry saturation; MAP=mean arterial pressure

[a] Adapted from Vincent et al[4]; [b] Adapted from Pandharipande et al[12]; [c] Catecholamine dose are given as µg/kg/minute for at least 1 hour; [d] Glasgow Coma Scale scores range from 3 to 15, higher score indicates better neurological function

difference in patients' characteristics and variability in the health care system[8]. Although, there were some studies in Southeast Asia countries and Thailand[9,10], the data sources were mostly from the university-based hospital. There was a difference in resources, a proportion of patients to the health care personals, and the number of specialty doctors compared with the tertiary public hospitals, which may influence the mortality. According to the limited data in real public health system in Thailand, the present study aimed to determine the accuracy of the SOFA score to predict outcome in community-acquired sepsis patients in this setting.

Materials and Methods

A cross-sectional retrospective study was performed in the medical department of Hatyai Hospital, a 700-bed tertiary public hospital in Southern Thailand. The protocol was approved by the Hatyai Hospital Ethics Committee (protocol number 36/2560).

Study population

The medical records from the community-acquired infection patients who admitted in the medical department between January and December 2015 were eligible for inclusion if they were older than 18 years old and had sepsis or severe sepsis or septic shock defined according to the SCCM/ESICM/ACCP/ATS/SIS International Sepsis Definitions Conference[2]. Septic shock was defined as sepsis induced hypotension, with a SBP of less than 90 mmHg or reduction of 40 mmHg or more from baseline, despite adequate fluid resuscitation, along with the presence of hypoperfusion abnormalities. Community-acquired infection defined as an infection that developed before or within 48 hours after hospitalization. The exclusion criteria included patients with "Do not resuscitate" orders, other types of shock such as cardiogenic or neurogenic shock, post-cardiac arrest, or incomplete medical record.

Data collection

The well-trained nurses in the sepsis care team manually reviewed the electronic medical record to ensure the accuracy of diagnosis and data recorded. The investigators counter checked all collected data. The data collected were demographic variable as age, gender, and co-morbidities, infection site, organ failure, laboratory data, length of ICU and hospital stay, discharge status, and 28-day mortality.

SOFA score and quick SOFA score

The SOFA score variable definition is shown in Table 1[4]. All variables were calculated using the worse physiological and laboratory parameters recorded in the initial 24 hours of hospital admission. Each organ system was assigned a point value from 0 for normal to 4 for a high degree of dysfunction

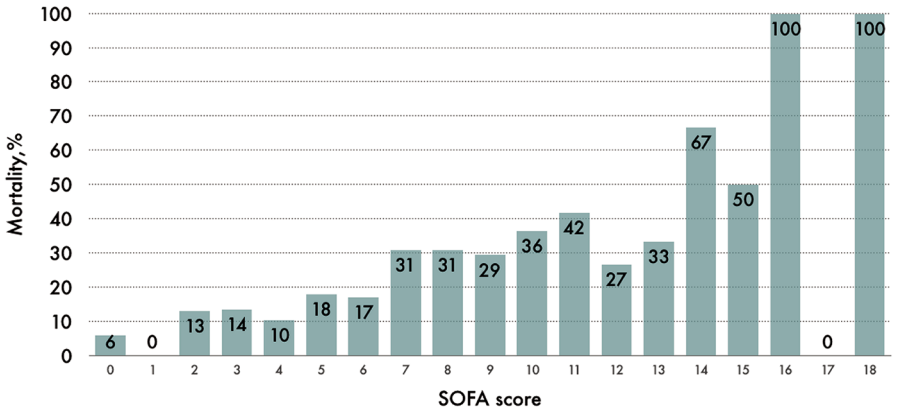

Figure 1. Correlation between mortality rate of community-acquired sepsis patients and SOFA score.

or failure. The SOFA score ranges from 0 to 24, and a baseline of 0 was assumed for all patients. The respiratory parameter used the partial pressure of oxygen to fraction of inspired oxygen ratio (PaO_2/FiO_2) when arterial blood gas data were available. In cases where PaO_2 was not available, the pulse oximetry saturation to FiO_2 ratio (SpO_2/FiO_2) used instead, which was previously validated with high correlation[11,12]. The qSOFA score was based on three criteria, which consisted of 1) low blood pressure of SBP of 100 mmHg or less, 2) high respiratory rate of 22 breaths per minute or more, 3) using the Glasgow Coma Scale, alteration of consciousness of less than 15. The qSOFA score ranged from 0 to 3. For both scoring systems, the standard threshold of 2 points or more was determined for a positive SOFA and qSOFA scores[1].

Outcome

The primary outcome was to determine the accuracy of the SOFA score to predict 28-day mortality in community-acquired sepsis patients. The secondary outcome was to compare the prognostic performance of SOFA and qSOFA.

Statistical analysis

The continuous variables expressed with mean (standard deviation [SD]) in parametric distribution and median (interquartile range [IQR]) for non-parametric distribution. Categorical variables presented with percent. Differences between survived and non-survived groups were analyzed with Student t-test or Mann Whitney U test depended on distribution of continuous data. Chi-square tests were used for comparing category variables. The predictive performance of SOFA, qSOFA, and SIRS defined by constructed a receiver operating characteristic (ROC) curve and calculated area under the ROC curve (AUROC). Statistical significance defined as p-value of less than 0.05. Stata, version 11 (StataCorp LP, College Station, TX, USA) was used for statistical analyses in the present study.

Results

Three hundred seventy-nine patients participated in this study. Most patients (74.4%) had co-morbidity, which 35.6% had more than one disease. Most found co-morbidities were hypertension (32.2%) and diabetes mellitus (22.9%). Respiratory system was the commonest site of infection (33.5%), followed by the urinary tract (27.7%), and gastrointestinal tract 14.2%. Of the 187 (49.3%) patients whose causative pathogen was identified, 125 (66%) was gram-negative organism, and 111 (29.3%) had blood culture positive. Non-survivors group had significant higher proportion of organism identified (65.5% versus 44.5%, p=0.001), positive hemoculture (42.5% vs. 25.3%, p=0.002), septic shock (75.9% versus 58.9%, p=0.004), and ICU admission (41.4 versus 17.3, p<0.001).

Three hundred sixty-three patients (95.8%) developed organ failure, which cardiovascular failure was the most common (55.4%), followed by renal failure (54.8%) and respiratory failure (45.1%). The median (IQR) length of hospital stay was 6 (4, 12) days. The overall 28-day mortality rate was 23%. Baseline characteristics and clinical outcomes are summarized in Table 2.

Score performance

The median (IQR) of the SOFA, qSOFA scores were 6 (3, 9) and 2 (1, 3). As shown in Figure 1,

Table 2. Baseline characteristic and clinical outcomes of sepsis patients in the survivors and non-survivors group

Characteristic	All (n=379); n (%)	Survivors (n=292); n (%)	Non-survivors (n=87); n (%)	p-value
Age (year); median (IQR)	61 (42, 76)	60 (45, 76)	64 (48, 78)	0.09
Sex: male	193 (50.9)	144 (49.3)	49 (56.3)	0.25
Number of co-existing illness				
None	110 (25.6)	85 (29.1)	25 (28.7)	0.53
1	134 (35.4)	104 (35.6)	30 (34.5)	0.85
2 or more	135 (35.6)	103 (35.3)	32 (36.8)	0.80
Co-existing illness				
Alcohol used	4 (0.1)	1 (0.3)	3 (3.4)	0.01
Asthma/COPD	30 (7.9)	26 (8.9)	4 (4.6)	0.19
Chronic renal disease	23 (6.1)	19 (6.5)	4 (4.6)	0.51
Congestive heart failure	9 (2.4)	7 (2.4)	2 (2.3)	0.96
Coronary disease artery	17 (4.5)	13 (4.5)	4 (4.6)	0.95
Diabetes mellitus	87 (22.9)	60 (20.5)	27 (31.0)	0.04
Dyslipidemia	37 (9.8)	27 (9.2)	10 (11.5)	0.54
HIV infection	17 (4.5)	14 (4.8)	3 (3.4)	0.60
Hypertension	122 (32.2)	91 (3.2)	31 (35.6)	0.43
Liver disease	23 (6.1)	15 (5.1)	8 (9.2)	0.16
Malignancy	7 (1.8)	6 (2.1)	1 (1.1)	0.58
Neurological disease	42 (11.0)	33 (11.3)	9 (10.3)	0.80
Other pulmonary disease	21 (5.5)	18 (6.1)	3 (3.4)	0.33
Other	44 (11.6)	38 (13.)	6 (6.9)	0.12
Site of infection				
Cardiovascular	2 (0.5)	1 (0.3)	1 (1.1)	0.36
Central nevous system	6 (1.6)	2 (0.7)	4 (4.6)	0.01
Gastrointestinal tract	54 (14.2)	42 (14.4)	12 (13.8)	0.89
Genitourinary tract	105 (27.7)	90 (30.6)	15 (17.2)	0.01
Respiratory tract	126 (33)	84 (28.8)	42 (48.3)	0.00
Soft tissue	30 (7.9)	23 (7.8)	7 (8)	0.96
Tropical infection	35 (9.2)	29 (9.8)	6 (6.9)	0.39
Other	30 (7.9)	26 (8.8)	4 (4.6)	0.19
Organism identified				
Gram negative	125 (32.9)	88 (30.1)	37 (42.5)	0.03
Gram positive	43 (11.3)	29 (9.9)	14 (16.1)	0.11
Positive blood culture	111 (29.3)	74 (25.3)	37 (42.5)	0.00
Septic shock	238 (63.0)	172 (58.9)	66 (75.9)	0.00
Organ failure				
None	16 (4.2)	15 (5.1)	1 (1.1)	0.10
Cardiovascular	210 (55.4)	169 (57.9)	41 (47.1)	0.08
Central nervous system	158 (41.7)	96 (32.9)	62 (71.3)	<0.001
Coagulation	160 (42.2)	116 (39.7)	44 (50.6)	0.07
Liver	150 (39.6)	106 (36.3)	44 (50.6)	0.09
Renal	208 (54.8)	145 (49.7)	63 (72.4)	<0.001
Respiratory system	171(45.1)	110 (37.7)	61 (70.1)	<0.001
ICU admission	87 (23.0)	51 (17.3)	36 (41.4)	<0.001
Length of hospital stay; median (IQR)	6 (4, 12)	4 (2, 8)	7 (4, 14)	<0.001

IQR=interquatile range; COPD=chronic obstructive pulmonary disease; HIV=human immunodeficiency virus; ICU=intensive care unit

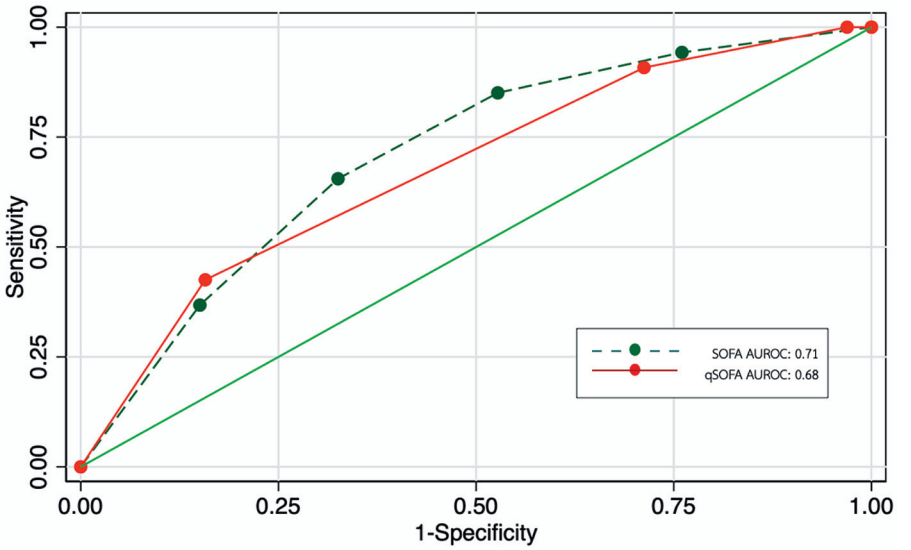

Figure 2. Comparison the area under receiver operating characteristic curve (AUROC) to discriminate 28-day mortality in community-acquired sepsis patients for SOFA and qSOFA scores.

Table 3. Hazard ratio and 95% CI of community-acquired sepsis mortality according to the SOFA score range

Variables	Hazard ratio (95% CI)	p-value
SOFA score 3 to 5	2.61 (0.74 to 9.17)	0.13
SOFA score 6 to 7	4.59 (1.3 to 15.78)	0.02
SOFA score 8 to 9	5.48 (1.56 to 19.26)	0.01
SOFA score >9	9.29 (2.82 to 30.59)	<0.001

SOFA=Sequential Organ Failure Assessment; CI=confidence interval

patients with a SOFA score of 2 had a mortality rate of 13% and rising according to the incremental of SOFA score. SOFA score 7 presented the mortality of 31%, and no survivor at scores of 16 or higher. The hazard ratio for death among the sepsis patients (Table 3) with SOFA score 6 to 7 was 4.59 (95% Cl 1.3 to 15.78, p=0.02). Whereas the qSOFA score of 2 exhibited a 20% mortality rate.

The AUROC of 28-day mortality in community-acquired sepsis patients of SOFA and qSOFA is shown in Figure 2. The predictive ability of the SOFA score was fair (AUROC 0.71, 95% CI 0.65 to 0.77). In comparison to qSOFA (AUROC 0.67, 95% CI 0.62 to 0.73), the SOFA score had a better performance.

Discussion

The present study determined the SOFA score's ability to predict the 28-day mortality of community-acquired sepsis patients in tertiary public, non-university-based hospital setting. The SOFA score had a fair predictive performance and was superior to the qSOFA score.

The SOFA score of 2 had an approximated mortality risk of 13%, which is close to the Sepsis-3 consensus reported at 10%[5]. Median (IQR) SOFA score of 6 (3, 9) was high for most of the non-ICU population[9,13]. The overall 28-day mortality was 23%, higher than the global reported (19.7%)[14], but similar to the studies in Southeast Asia (22%)[9] and Thailand (21% to 37%)[11,15]. Demographic data, the proportion of male (50.9%), the median age of 61 years, and pneumonia as the most common infection were similar to the Raith et al[6] and Khwannimit et al[10] studies.

The discriminative ability of the SOFA score from the previous studies demonstrated varied results as defined in each group. Among the intensive care patients, the SOFA score exhibited the discriminative ability with an AUC of 0.69 to 0.88[5,6,10,13,16], whereas the non-ICU patients represented an AUC ranging from 0.69 to 0.83[17,18]. The present study participants consisted of both groups, intensive care (24%) and general (76%) patients, with an agreement of AUC (0.71) value in the range of the previous one.

The previous studies demonstrated that the amount and severity of organ dysfunctions correlated to mortality[19,20]. Nevertheless, sequential evaluation to monitor the dynamic change or response to the therapeutic intervention provided a better prognostic indicator[21]. Ferreira et al exhibited an increase of SOFA score during the first 48 hours predicted a

mortality rate of at least 50%, independent of the initial score[22]. Levy et al showed that the continued improvement in cardiovascular function before 48 and 72 hours after admission associated with more chance to survive ($p<0.0001$), with odds ratios of 0.15 (0.06 to 0.39) and 0.11 (0.04 to 0.31) for patients who improved compared with those who worsened[23]. That supported the present study finding, which more than half of patients had a cardiovascular system failure (55.4%) in the first 24 hours but almost reverse shock shortly from early fluid resuscitation and vasopressor. According to the thrombocytopenia in sepsis, it usually is a manifestation of disseminated intravascular coagulation (DIC), a serious condition associated with multi-organ dysfunction syndrome (MODS) and mortality[4,24]. Lie et al conducted a study in Southeast Asia and reported the limitation of SOFA coagulation score for sepsis in tropical countries, where causes of infections were diverse such as leptospirosis and dengue fever, which might not provide a prediction of mortality as in other settings[9]. Low platelet, commonly found in leptospirosis patients[25], which is caused by various mechanisms and not only from DIC, had a significantly different mortality rate[26]. The present study also had a tropical infection rate of 9.2%, which was mostly leptospirosis.

For the SOFA respiratory score, 61% of the patients used SpO_2/FiO_2 instead of PaO_2/FiO_2. Although previous trials reported highly correlated SOFA scores in various patient groups, all were not in the shock stage[12,13]. The hypo-perfusion provided a false low SpO_2/FiO_2 ratio resulting from low pulse oximetry signal quality. Nevertheless, these reflect a real practice that arterial blood gas is not always available, especially in the rural hospital setting. For this reason, the SpO_2/FiO_2 needs to be validated in this setting before implementation.

The qSOFA showed a limited predictive ability for the outcome, consistent with the previous studies[5,6,10,16,18]. However, it was not surprising because of the qSOFA is designed to be a bedside early warning tool using only three clinical elements, hypotension, altered consciousness, and tachypnea[1]. Therefore, the SOFA score, which evaluates the function of six organ systems provided more accuracy.

In the middle-income countries, the clinical use of the SOFA score provided some concerning issues. There were additional costs, specific laboratory test not available in all rural hospitals, and time-consuming. Furthermore, most patients (74.4%) in the present study had a pre-existing chronic disease. These were not the result of the acute infection but always made the patients baseline scores more than zero. Future studies for these subgroup populations are needed to confirm the accuracy of a scoring system.

There were some limitations to the present study. First, the nature of the retrospective study was missing data. The most missing variable was a liver function test (LFT), which needed bilirubin to calculate the SOFA score. The LFT was not routinely performed in real practice if there was no clinical clue of infection. Secondly, this was a single-center study conducted only in medical patients, which may not represent the other patient groups such as surgical patients, emergency department setting, and university-based hospital outcomes. Thirdly, the ICU vervus non-ICU patients' selection depended on the availability of ICU beds and attending staff. Therefore, it may cause a selective bias. Finally, the present study included only the community-acquired infection, which had fewer drug-resistance organisms and lowers mortality than hospital-acquired sepsis.

Conclusion

The SOFA score demonstrated a fair predictive ability for 28-day mortality in community-acquired sepsis patients and superior performance than qSOFA score. In the setting of a tertiary public hospital in a middle-income country, modification of the required laboratory variables such as the PaO_2/FiO_2 and LFT and cut-point adjustment may improve the feasibility and accuracy of the score. From the new Sepsis-3 definition, the SOFA and qSOFA provided better high-risk patients identification. However, the outcomes improvement still depended on the clinician, who promptly responded to the assessed result.

What is already known on this topic?

The Sepsis-3 definition used the SOFA score for identifying the organ dysfunction and the score of 2 points or more associated with the higher in-hospital mortality. The qSOFA score was a bedside score for the patients with suspected infection outside ICU, as the early risk assessment. Evidence supported the outcome predictive validity of SOFA and qSOFA in the various setting. However, most of the data were from the developed country healthcare system.

What this study adds?

In a tertiary public hospital setting in a middle-income country, the SOFA score demonstrated a fair predictive ability to predict mortality in community-acquired sepsis and was better than

qSOFA. The scoring system needed to be validated before application in a different clinical setting and resource. Some clinical points that may decrease the accuracy of the score in this setting were the patients' comorbidities such as tropical infection and pre-existing disease, the availability of laboratory tests, and the treatment protocol such as early vasopressor. Furthermore, organ dysfunction was not static. Sequential scoring may better represent a dynamic change and will improve the scoring system's predictive ability.

Acknowledgement

The authors would like to acknowledge Hatyai Hospital Sepsis Care Team for the data collection and their support. Special thank for Dr. Sarayuth Geater, who provided expertise and constructive feedback.

Conflicts of interest

The authors declare no conflict of interest.

References

1. Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, et al. The third international consensus definitions for sepsis and septic shock (Sepsis-3). JAMA 2016;315:801-10.
2. Bone RC, Balk RA, Cerra FB, Dellinger RP, Fein AM, Knaus WA, et al. Definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. The ACCP/SCCM Consensus Conference Committee. American College of Chest Physicians/Society of Critical Care Medicine. Chest 1992;101:1644-55.
3. Kaukonen KM, Bailey M, Pilcher D, Cooper DJ, Bellomo R. Systemic inflammatory response syndrome criteria in defining severe sepsis. N Engl J Med 2015;372:1629-38.
4. Vincent JL, Moreno R, Takala J, Willatts S, De Mendonça A, Bruining H, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. On behalf of the Working Group on Sepsis-Related Problems of the European Society of Intensive Care Medicine. Intensive Care Med 1996;22:707-10.
5. Seymour CW, Liu VX, Iwashyna TJ, Brunkhorst FM, Rea TD, Scherag A, et al. Assessment of clinical criteria for sepsis: for the third international consensus definitions for sepsis and septic shock (Sepsis-3). JAMA 2016;315:762-74.
6. Raith EP, Udy AA, Bailey M, McGloughlin S, MacIsaac C, Bellomo R, et al. Prognostic accuracy of the SOFA score, SIRS criteria, and qSOFA score for in-hospital mortality among adults with suspected infection admitted to the intensive care unit. JAMA 2017;317:290-300.
7. Rello J, Leblebicioglu H. Sepsis and septic shock in low-income and middle-income countries: need for a different paradigm. Int J Infect Dis 2016;48:120-2.
8. Vincent JL, Rello J, Marshall J, Silva E, Anzueto A, Martin CD, et al. International study of the prevalence and outcomes of infection in intensive care units. JAMA 2009;302:2323-9.
9. Lie KC, Lau CY, Van Vinh Chau N, West TE, Limmathurotsakul D. Utility of SOFA score, management and outcomes of sepsis in Southeast Asia: a multinational multicenter prospective observational study. J Intensive Care 2018;6:9.
10. Khwannimit B, Bhurayanontachai R, Vattanavanit V. Comparison of the accuracy of three early warning scores with SOFA score for predicting mortality in adult sepsis and septic shock patients admitted to intensive care unit. Heart Lung 2019;48:240-4.
11. Pandharipande PP, Sanders N, Jacques P, Ely EW, Shintaini A. Calculating SOFA scores when arterial blood gasses are not available: Validating SpO2/FiO2 ratios for imputing PaO2/FiO2 ratios in the SOFA scores. Crit Care Med 2006;34:A1.
12. Pandharipande PP, Shintani AK, Hagerman HE, St Jacques PJ, Rice TW, Sanders NW, et al. Derivation and validation of Spo2/Fio2 ratio to impute for Pao2/Fio2 ratio in the respiratory component of the Sequential Organ Failure Assessment score. Crit Care Med 2009;37:1317-21.
13. Cheng B, Li Z, Wang J, Xie G, Liu X, Xu Z, et al. Comparison of the performance between sepsis-1 and sepsis-3 in ICUs in China: A retrospective multicenter study. Shock 2017;48:301-6.
14. Rudd KE, Johnson SC, Agesa KM, Shackelford KA, Tsoi D, Kievlan DR, et al. Global, regional, and national sepsis incidence and mortality, 1990-2017: analysis for the Global Burden of Disease Study. Lancet 2020;395:200-11.
15. Rudd KE, Hantrakun V, Somayaji R, Booraphun S, Boonsri C, Fitzpatrick AL, et al. Early management of sepsis in medical patients in rural Thailand: a single-center prospective observational study. J Intensive Care 2019;7:55.
16. Said MA, Wangari-Waweru S, Mung'ayi V, Shah R. Comparison of the Sequential Organ Failure Assessment (SOFA) and Quick SOFA Scores in predicting in-hospital mortality among adult critical care patients with suspected infection. Int J Crit Care Emerg Med 5:084.
17. Szakmany T, Pugh R, Kopczynska M, Lundin RM, Sharif B, Morgan P, et al. Defining sepsis on the wards: results of a multi-centre point-prevalence study comparing two sepsis definitions. Anaesthesia 2018;73:195-204.
18. Gaini S, Relster MM, Pedersen C, Johansen IS. Prediction of 28-days mortality with sequential organ failure assessment (SOFA), quick SOFA (qSOFA) and systemic inflammatory response syndrome (SIRS) - A retrospective study of medical patients with acute

infectious disease. Int J Infect Dis 2019;78:1-7.
19. Vincent JL, de Mendonça A, Cantraine F, Moreno R, Takala J, Suter PM, et al. Use of the SOFA score to assess the incidence of organ dysfunction/failure in intensive care units: results of a multicenter, prospective study. Working group on "sepsis-related problems" of the European Society of Intensive Care Medicine. Crit Care Med 1998;26:1793-800.
20. Marshall JC, Cook DJ, Christou NV, Bernard GR, Sprung CL, Sibbald WJ. Multiple organ dysfunction score: a reliable descriptor of a complex clinical outcome. Crit Care Med 1995;23:1638-52.
21. Moreno R, Vincent JL, Matos R, Mendonça A, Cantraine F, Thijs L, et al. The use of maximum SOFA score to quantify organ dysfunction/failure in intensive care. Results of a prospective, multicentre study. Working Group on Sepsis related Problems of the ESICM. Intensive Care Med 1999;25:686-96.
22. Ferreira FL, Bota DP, Bross A, Mélot C, Vincent JL. Serial evaluation of the SOFA score to predict outcome in critically ill patients. JAMA 2001;286:1754-8.
23. Levy MM, Macias WL, Vincent JL, Russell JA, Silva E, Trzaskoma B, et al. Early changes in organ function predict eventual survival in severe sepsis. Crit Care Med 2005;33:2194-201.
24. Gando S, Shiraishi A, Yamakawa K, Ogura H, Saitoh D, Fujishima S, et al. Role of disseminated intravascular coagulation in severe sepsis. Thromb Res 2019;178:182-8.
25. Sharma J, Suryavanshi M. Thrombocytopenia in leptospirosis and role of platelet transfusion. Asian J Transfus Sci 2007;1:52-5.
26. Turgut M, Sünbül M, Bayirli D, Bilge A, Leblebicioğlu H, Haznedaroğlu I. Thrombocytopenia complicating the clinical course of leptospiral infection. J Int Med Res 2002;30:535-40.