SOFA SCORE FOR PREDICTING OUTCOME OF SEVERE FALCIPARUM MALARIA

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Abstract. *Plasmodium falciparum* malaria is a serious cause of morbidity and mortality. The System Organ Failure Assessment (SOFA) score was developed 20 years ago to predict outcome of severely illness patients. We aimed to assess the efficacy of SOFA score for discriminating between patients with severe and non-severe malaria; and fatal and non-fatal malaria in order to determine the usefulness of the SOFA score as a predictive tool for future patients with *P. falciparum* malaria infection. We retrospectively reviewed the medical records of *P. falciparum* malaria patients presenting to the Bangkok Hospital for Tropical Diseases, Thailand during 2005-2015. Inclusion criteria were patients aged $\geq$ 15 years with *P. falciparum* malaria mono-infection. Exclusion criteria were pregnant and lactating women or patients with missing medical records. Descriptive statistics were used to summarize baseline values and demographic data. Chi-square (χ^2) or Fisher's exact tests were used to compare proportions when appropriate. Sensitivity and specificity were calculated for score performance. A total of 642 subjects were studied, of whom 287 had severe malaria and there were 2 deaths (mortality rate=0.3%). A cut-off value of 0 could discriminate severe disease with sensitivity and specificity of 97.2% and 13.5%, respectively; and a cut-off value of 10 could discriminate mortality with sensitivity and specificity of 100% and 97.9%, respectively. In conclusion, SOFA score may be useful to discriminate severe disease and mortality in patients with *P. falciparum* malaria. However, since this study was retrospective, further prospective study is needed to determine if it is really useful in malaria patients in other hospitals.

Keywords: *falciparum*, malaria, SOFA, score

INTRODUCTION

Plasmodium falciparum malaria is a major cause of global public health problem, although the incidence of severe falciparum malaria is decreasing in Southeast Asia (WHO, 2018). The pathophysiology and management of falciparum malaria is known but in spite of this during 2017 there were an estimated 435,000 deaths due to malaria globally (WHO, 2018). With prompt diagnosis and appropriate treatment, the prognosis of malaria is good. Falciparum malaria is a life-threatening illness. Complications of falciparum malaria include cerebral malaria,

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acute kidney injury, severe anemia and pulmonary edema. These complications may happen within the first 24-48 hours (WHO, 2012; WHO, 2015).

Several prognostic scoring systems have been developed as management tools in evaluating the severity and progression of critically ill patients. These include the Acute Physiology and Chronic Health Evaluation II (APACHE II) (Knaus *et al*, 1985; Wilairatana and Looareesuwan, 1995), Simplified Acute Physiology Score (SAPS II) (Le Gall *et al*, 1993), Sequential Organ Failure Assessment score (SOFA score) (Vincent *et al*, 1998), Malaria Severity Assessment (MSA) score (Mishra *at al*, 2007), Malaria Severity Score (MSS) (Mohapatra and Das, 2009), GCRBS score (Mohapatra, 2014), Multiple Organ Dysfunction Score (MODS) (Marshall *et al*, 1995), Clinical Scoring Index (CSI) (Teaño *et al*, 2002) and Mortality Probability Model (MPM II) (Lemeshow *et al*, 1993). Many studies have used these scoring systems to predict disease outcomes and find the sensitivities of those scoring systems.

Although the SOFA score was introduced 2 decades ago, it is gaining interest (Minne *et al*, 2008; Kim *et al*, 2013; Nair *et al*, 2016; Boillat-Blanco *et al*, 2018). The SOFA score was recently used to determine the risk for having a more severe course of malaria, in a small study of 14 patients in Poland (Makowiecki *et al*, 2018).

The aims of this study were to evaluate SOFA score in discriminating severe and non-severe, fatal and non-fatal severe falciparum malaria patients in order to determine the usefulness of this score as a prognostic tool to manage future patients with falciparum malaria.

MATERIALS AND METHODS

This study was carried out at Bangkok Hospital for Tropical Disease (BHTD), Faculty of Tropical Medicine, Mahidol University, Thailand. The medical records of patients with falciparum malaria admitted to the BHTD were retrospectively reviewed from 2005 to 2015.

Study population

The charts of all patients admitted with a diagnosis of falciparum malaria were reviewed. Patients were diagnosed as having *P. falciparum* malaria by light microscopy and were treated with artemisnin-combination therapy (ACT) following the Thai national guidelines for treatment of malaria. Inclusion criteria for study subjects were patients aged $\geq$ 15 years with microscopically confirmed *P. falciparum* mono-infection. Exclusion criteria were pregnant and lactating women or patients with missing medical records. Demographic data, clinical presentations, complications, laboratory findings, severity of disease according to WHO criteria (2015) and clinical outcomes were studied.

Analysis of scoring system

The The Sequential Organ Failure Assessment (SOFA) score (0-24) was calculated on admission. In calculation of the score the worst values for each parameters in the 24-hour period were used. The total SOFA score was calculated as the sum of all daily SOFA scores during admission for each patients. The score is based on six different scores, one each for the respiratory, cardiovascular, liver, coagulation, renal and central nervous systems. The SOFA score tables were used to describe points-giving conditions (Anonymous, 2019). In cases where the physiological parameters did not match any row, zero points were given. Sensitivity and specificity were calculated to the score performance.

Data analysis

Data were expressed as means with

standard deviations (SD), or medians with interquartile range (IQR), and as numbers and percentages. Descriptive statistics were used to summarize baseline values and demographic data. All *p*-values were from 2 tailed-testing and the statistical significance was set at $p<0.05$. The chi-square (χ^2) or Fisher's exact tests were used to compare proportions where appropriate.

Ethical considerations

The study was approved by the Ethics Committee, Faculty of Tropical Medicine, Mahidol University, Thailand. (MUTM 2016-094-01).

RESULTS

The total of 642 patients were included in the study: 355 with uncomplicated falciparum malaria and 287 with severe falciparum malaria, of which 2 cases were fatal as defined by WHO (2015). The demographic data of study subjects are presented in Table 1. Out of the total of the total of 642 subjects, 519 (80.8%)

Table 1
Demographic data of study subjects.

Characteristics	Total subjects	Uncomplicated malaria (*n*=355)	Severe malaria (*n*=287)	*p*-value
	n (%)	*n* (%)	*n* (%)	
Gender				0.15
Male	519 (80.8)	299 (84.2)	220 (76.7)	
Female	123 (19.2)	56 (15.8)	67 (23.3)	
Age in years; median (IQR)	24.0 (19.0-32.0)	24.0 (20.0-32.0)	23.0 (19.0-32.0)	0.237
15-20	223 (34.8)	114 (32.1)	109 (38.0)	
21-30	235 (36.6)	137 (38.6)	98 (34.1)	
31-40	109 (17.0)	63 (17.7)	46 (16.0)	
41-50	49 (7.6)	25 (4.5)	24 (8.4)	
≥ 51	26 (4.0)	16 (4.5)	10 (3.5)	
Ethnicity				0.198
Thai	105 (16.4)	65 (18.3)	40 (13.9)	
Myanmar	300 (46.7)	168 (47.3)	132 (46.0)	
Karen	153 (23.8)	83 (23.4)	70 (24.4)	
Mon	59 (9.2)	26 (7.3)	33 (11.5)	
Cambodian	6 (1.0)	4 (1.1)	2 (0.7)	
Laotian	11 (1.7)	7 (2.0)	4 (1.4)	
Others[a]	8 (1.2)	2 (0.6)	6 (2.1)	

[a]Others: China, Congo, Ethiopia, Mozambique and Uganda.

were males. The median age of study subjects was 24 (IQR: 19-32 years); there was insignificant difference in median ages between those with and without and almost identical between two groups: uncomplicated and severe malaria.

The most patients in Thailand came from Tak (*n*=395, 61.5%), followed by Kanchanaburi (*n*=109, 17.0%), Bangkok (*n*=22, 3.4%), Ratchaburi (*n*=8, 1.2%), and other rural provinces (*n*=82, 12.9%). The most international patients came from Myanmar (*n*=9, 1.4%) followed by Lao PDR (*n*=7, 1.1%), Cambodia (*n*=4, 0.6%) and other countries (China, Congo, Ethiopia, Mozambique, and Uganda, *n*=6, 1.4%). The admitting clinical presentations and laboratory results are summarized in Tables 2 and 3.

Complications in severe malaria patients were shown in Table 4. Acute renal failure was the most predominant complication (*n*=186, 65.9%) in this study.

Glucose-6-phosphate dehydrogenase (G6PD) deficiency was detected in 11 of 642 patients (1.7%); but results were not available in 15 patients (2.3%). One hundred and thirty-six cases (21.2%) had hemoglobinuria; the results was not recorded in 1 case (0.2%). Central venous pressure (CVP) and continuous positive airway pressure (CPAP) were not performed in any of the patients.

Treatment and outcomes

The median of duration of stay in hospital was 8 days in severe malaria group (IQR: 6-12), and 6 days (IQR: 5-7) in uncomplicated group. All patients were

Table 2
Clinical presentations on admission.

	Total subject (*n*=642) Median (IQR)	Uncomplicated malaria (*n*=355) Median (IQR)	Severe malaria (*n*=287) Median (IQR)	*p*-value
Temperature (°C)	38 (37.3-38.5)	37.9 (37.2-38.5)	38.1 (37.5-38.7)	0.003*
Pulse rate (/min)	92 (82-100)	88 (80-98)	96 (88-104)	<0.001*
RR (/min)	22 (20-24)	22 (20-22)	22 (20-24)	<0.001*
SBP (mmHg)	110 (100-120)	110 (102-120)	107 (97-117)	<0.001*
DBP (mmHg)	70 (60-72)	70 (60-76)	65 60-70)	<0.001*
GCS	15 (15-15)	15 (15-15)	15 (15-15)	<0.001*
UO (ml/24h)	800 (550-1200)	800 (520-1,100)	870 (550-1,220)	0.91
SpO_2 (%)	98 (97-99.25)	99 (98-99.75)	98 (96-99.25)	0.56
Pallor	147 (22.9)	55 (15.5)	92 (32.1)	<0.001*
Jaundice	143 (22.3)	45 (12.7)	98 (34.1)	<0.001*
Abdominal pain	118 (18.4)	45 (12.7)	73 (25.4)	<0.001*
Hepatomegaly	165 (25.7)	55 (15.5)	110 (38.3)	<0.001*

* $p<0.05$. IQR, interquartile range; SpO_2, saturation oxygen; SBP, systolic blood pressure; DBP, diastolic blood pressure; RR, respiratory rate; UO, urine output.

Table 3
Laboratory results on admission

Laboratory test	Total results				*p*-value
	Uncomplicated malaria (*n*=355)		Severe malaria (*n*=287)		
	n	Median (IQR)	*n*	Median (IQR)	
Hematology					
WBC (10^3/mm^3)	355	5.8 (4.5-7.4)	287	5.9 (4.3-8.0)	0.515
RBC (10^6/mm^3)	355	4.68 (4.07-5.14)	287	4.51 (3.7-5.13)	0.013*
Hb (g/dl)	355	12.6 (10.7-14.1)	286	12.0 (9.47-13.8)	0.002*
Hct (%)	355	37.5 (32.7-41.1)	287	35.5 28.1-40.4)	0.001*
Reticulocyte (%)	84	1.5 (1.1-2.1)	36	1.05 (0.8-1.8)	0.014*
Neutrophil (/μl)	355	66.0 (54.0-73.0)	287	67 (58-75)	0.06
Lymphocyte (/μl)	353	22.0 (15.0-29.0)	286	20 (13-29)	0.132
Platelet count (/cu.mm)	355	87.0 (56.0-145.0)	287	42.0 (26.5-69.0)	<0.001*
Prothrombin time (sec)	3	11.6 (2.27-12.2)	31	13.3 (12.0-14.4)	0.064
Asexual parasite density (/μl)	355	23,400 (3,780-10,875)	287	105,660 (17,700-315,900)	<0.001*
Biochemistry					
Total bilirubin (mg/dl)	352	1.2 (0.74-1.82)	284	2.47 (1.3-4.74)	<0.001*
Direct bilirubin (mg/dl)	342	0.45 (0.28-0.76)	278	1.14 (0.56-3.15)	<0.001*
AST (IU/l)	352	31 (23.0-48.0)	285	47 (31-97)	<0.001*
ALT (IU/l)	350	30.0 (20.0-50.25)	285	39 (24-76)	<0.001*
BUN (mg/dl)	354	14 (11.17-17.12)	287	24.3 (17.9-35.0)	<0.001*
Creatinine (mg/dl)	351	0.8 (0.7-1.0)	287	1.1 (0.8-1.4)	<0.001*
Serum HCO_3 (mEq/l)	346	25 (23-26)	287	22 (20-24)	<0.001*
Blood glucose (mg/dl)	287	119 (103-135)	253	119 (103-137)	0.981
Arterial pH	0	NA	12	7.34 (7.29-7.42	NA
Others					
PCT (h)	348	53 (41-69)	285	58 (44-75.5)	0.006*
FCT (h)	353	28 (16-40	257	48 (28-86)	<0.001*

*$p < 0.05$; WBC, white blood cell; RBC, red blood cell, Hb, hemoglobin; Hct, hematocrit; AST, aspartate transaminase; ALT, alanine transaminase; BUN, blood urea nitrogen; PCT, parasite clearance time, FCT, fever clearance time; NA, not available.

Table 4
Complications among study subjects with severe falciparum malaria.

Symptoms	Subjects with severe malaria (n=287)	p-value
	n (%)	
Cerebral malaria	21 (7.3)	<0.001*
Severe anemia	33 (11.5)	<0.001*
Hyperparasitemia	42 (14.6)	<0.001*
Acute renal failure	189 (65.9)	0.002*
Hyperbilirubinemia	119 (41.5)	<0.001*
Pulmonary edema	8 (2.8)	0.02*
Metabolic acidosis	8 (2.8)	0.002*
Abnormal bleeding	1 (0.3)	0.26

*$p < 0.05$; cerebral malaria with GCS < 11; severe anemia with Hb < 5g/dl; hyperparasitemia with parasite density > 10% or 500,000/μl; acute renal failure with creatinine > 3mg/dl; hyperbilirubinemia with total bilirubin >3mg/dl; metabolic acidosis with serum bicarbonate <15mmol/l or pH_a <7.35.

treated with ACT. There were 2 fatalities (0.6%) among the 287 severe malaria patients. The fatal complications of these 2 patients were cerebral malaria, acute renal failure and hyperparasitemia.

Analysis of scoring system

The study subjects were divided into two study groups, Group A (uncomplicated *vs* severe patients) and Group B (severe non-fatal *vs* fatal outcomes). Clinical characteristics of the subjects with severe malaria according to the SOFA score are shown in Table 5. Six organ systems are used as parameters in the SOFA score: respiratory, central nervous system (CNS), cardiovascular, hepatic, hematological and renal.

SOFA score in falciparum malaria patients

The mean score of each parameter was used for the SOFA score (Table 6). In Group A, the mean (±SD) score for the hepatic system was 0.7 (± 0.9) for the uncomplicated group and 1.66 (± 1.11) for the severe group. The mean score for the hematological system was 1.5 (± 1.07) in uncomplicated group and 2.48 (± 1.07) in the severe group. The mean score was <1 for respiratory, CNS, cardiovascular and renal systems in severe group while the mean score was <1 for the respiratory, CNS, cardiovascular, hepatic and renal systems in uncomplicated group. There were significant differences in all parameters in Group A, $p < 0.001$, except the respiratory system ($p = 0.89$). Total SOFA score in uncomplicated group was 2.48 ± 1.65, and 5.07 ± 2.54 in severe group. In Group B, the score of non-fatal group was similar to fatal group except CNS and liver parameter scores. The total SOFA score of the fatal group was 11.5 ± 0.7.

Sensitivity and specificity of SOFA score (Tables 7 and 8)

For Group A (Table 7), the higher the score, the lower the sensitivity and the higher the specificity for discriminating

Table 5
Clinical characters of severe falciparum malaria using SOFA score.

Parameter	Group A		*p*-value	Group B		*p*-value
	Severe malaria	Uncomplicated malaria		Fatal severe malaria	Non-fatal severe malaria	
	n=287 (%)	*n*=355 (%)		*n*=2 (%)	*n*=285 (%)	
PaO_2/FiO_2 (mmHg)			0.26			0.93
≥ 400	287 (100)	355 (100)		2 (100)	285 (100)	
< 400	0	0		0	0	
< 300	0	0		0	0	
< 200 with respiratory support	0	0		0	0	
< 100 with respiratory support	0	0		0	0	
Glasgow coma scale			<0.001*			<0.001*
15	267 (93.0)	352 (99.2)		0	267 (93.7)	
13–14	5 (1.7)	3 (0.8)		1 (50)	4 (1.4)	
10–12	12 (4.3)	0		0	12 (4.2)	
6–9	2 (0.7)	0		0	2 (0.7)	
< 6	1 (0.3)	0		1 (50)	0	
Mean arterial pressure (MAP mmHg)			<0.001*			0.61
No hypotension	254 (88.5)	331 (93.2)		2 (100)	252 (88.4)	
MAP < 70 mm/Hg	33 (11.5)	24 (6.8)		0	33 (11.6)	
dopamine ≤ 5 or dobutamine (any dose)**	0	0		0	0	
dopamine > 5 or epinephrine ≤ 0.1 or norepinephrine ≤ 0.1	0	0		0	0	
dopamine > 15 or epinephrine> 0.1 or norepinephrine > 0.1	0	0		0	0	
			<0.001*			0.03*

Table 5
(Continued)

Parameter	Group A		*p*-value	Group B		*p*-value
	Severe malaria	Uncomplicated malaria		Fatal severe malaria	Non-fatal severe malaria	
	n=287 (%)	*n*=355 (%)		*n*=2 (%)	*n*=285 (%)	
Bilirubin (mg/dl)						
< 1.2	54 (18.8)	177 (49.9)		0	54 (18.9)	
1.2 –1.9	62 (21.6)	97 (27.3)		0	62 (21.8)	
2.0 –5.9	113 (39.4)	70 (19.7)		0	113 (39.6)	
6.0 –11.9	39 (13.6)	6 (1.7)		1 (50)	38 (13.3)	
≥ 12.0	19 (6.6)	5 (1.4)		1 (50)	18 (6.3)	
Platelets ($\times 10^3/\mu l$)			<0.001*			0.12
>150	27 (9.4)	81 (22.8)		0	27 (9.5)	
≤ 150	16 (5.6)	70 (19.7)		0	16 (5.6)	
≤ 100	66 (23.0)	129 (36.3)		0	66 (23.2)	
≤ 50	145 (50.5)	72 (20.3)		1 (50)	144 (50.5)	
≤ 20	33 (11.5)	3 (0.8)		1 (50)	32 (11.2)	
Creatinine (mg/dl)			<0.001*			0.46
< 1.2	162 (56.4)	332 (93.5)		1 (50)	161 (56.5)	
1.2–1.9	83 (28.9)	23 (6.5)		0	83 (29.1)	
2.0–3.4	30 (10.5)	0		0	30 (10.5)	
3.5–4.9 (or < 500 ml/day)	4 (1.4)	0		0	4 (1.4)	
> 5.0 (or < 200 ml/day)	8 (2.8)	0		1 (50)	7 (2.5)	

* $p < 0.05$; ** adrenergic agents administered for at least 1 hour (doses were in $\mu g/kg/min$); No hypotension with mean arterial pressure ≥ 70 mmHg.

Table 6
The mean score of SOFA score of falciparum malaria patients.

Organ system measurement	Group A		*p*-value	Group B		*p*-value
	Severe malaria (n=287) mean score±SD	Uncomplicated malaria (n=355) mean score±SD		Fatal severe malaria (n=2) mean score±SD	Non-fatal severe malaria (n=285) mean score±SD	
Respiratory	0 ± 0.05	0 ± 0.0	0.89	0 ± 0.0	0 ± 0.05	0.93
CNS	0.11 ± 0.48	0.0 ± 0.09	<0.001*	2.5 ± 2.12	0.11 ± 0.48	<0.001*
Cardiovascular	0.11 ± 0.32	0.06 ± 0.2	<0.001*	0 ± 0.0	0.11 ± 0.32	0.61
Liver	1.66 ± 1.11	0.7 ± 0.9	<0.001*	3.5 ± 0.70	1.66 ± 1.11	0.03*
Coagulation	2.48 ± 1.07	1.5 ± 1.07	<0.001*	3.5 ± 0.70	2.48 ± 1.07	0.12
Renal	0.64 ± 0.90	0.06 ± 0.2	<0.001*	2 ± 2.82	0.64 ± 0.90	0.46
Total SOFA score	5.07 ± 2.54	2.48 ± 1.65	<0.001*	11.5 ± 0.7	5.03 ± 2.49	0.01*

*$p < 0.05$ (calculated using Mann-Whitney U test); CNS: central nervous system.

between uncomplicated and severe malaria was shown. The cut-off value of 0 in Group A showed the highest sensitivity of 97.2% with the lowest specificity of 13.5%. This cut-off value may be used during management of malaria although the cut-off value of 0 provides very low specificity to discriminate between uncomplicated and severe malaria. According to Table 6, total SOFA scores in uncomplicated and severe groups were 2.48 ± 1.65 and 5.07 ± 2.54, respectively, selecting the cut-off values between these 2 values, either 3 or 4, was not good because they showed low sensitivities of 75.6% and 61.7% for cut-off values of 3 and 4, respectively in discriminating uncomplicated and severe malaria patients.

For Group B (Table 8), the SOFA scores of both 11 and 12 had sensitivities of 50% and specificities of 99.6% and 100%, respectively. The two fatalities had the sum of SOFA score of 11. The cut-off value of 10 showed sensitivity and specificity of 100% and 97.9%, respectively to discriminate fatal and non-fatal patients.

DISCUSSSION

In this study, the cut-off value for SOFA score to identify risk for mortality was 10 with a sensitivity and a speci-

Table 7
Sensitivity and specificity of the SOFA score in Group A.

SOFA score	Uncomplicated *n*=355 (%)	Severe *n*=287 (%)	Sensitivity %	Specificity %
0	48 (13.5)	8 (2.8)	97.2	13.5
1	63 (17.7)	16 (5.6)	91.6	31.3
2	70 (19.7)	19 (6.6)	85.0	82.3
3	74 (20.8)	27 (9.4)	75.6	71.8
4	62 (17.5)	40 (13.9)	61.7	89.3
5	23 (6.5)	49 (17.1)	44.6	95.8
6	12 (3.4)	51 (17.8)	26.8	99.2
7	3 (0.8)	24 (8.4)	18.5	100
8	0	13 (4.3)	13.9	100
9	0	10 (3.5)	10.5	100
10	0	12 (4.5)	6.3	100
11	0	9 (3.1)	3.1	100
12	0	8 (2.8)	0.3	100
13	0	1 (0.3)	0	100

SOFA, Sequential Organ Failure Assessment score.

Table 8
Sensitivity and specificity of the SOFA score in Group B.

SOFA score	Non-fatal severe malaria *n*=355 (%)	Fatal severe malaria *n*=287 (%)	Sensitivity %	Specificity %
0	9 (3.2)	0	100	3.2
1	17 (6.0)	0	100	9.1
2	21 (7.4)	0	100	16.5
3	25 (8.8)	0	100	25.3
4	44 (15.4)	0	100	40.7
5	50 (17.4)	0	100	58.2
6	51 (17.9)	0	100	76.1
7	24 (8.4)	0	100	84.6
8	19 (6.7)	0	100	91.2
9	10 (3.5)	0	100	94.7
10	9 (3.2)	0	100	97.9
11	5 (1.8)	1 (50)	50	99.6
12	1 (0.4)	1 (50)	50	100

SOFA, Sequential Organ Failure Assessment score.

ficity of 100% and 97.9%, respectively. This cut-off value showed that it is a very good tool to predict mortality outcome of severe disease since both sensitivity and specificity were high. However the cut-off value to identify risk for severe malaria was 0 with a sensitivity and a specificity of 97.2% and 13.5%, respectively. This cut-off value of 0 showed a high sensitivity but a very low specificity which indicated that some severe malaria patients might have low SOFA score. In Table 6, the SOFA scores between severe (5.07±2.54) and non-severe malaria (2.48±1.65) were not much different but there was a statistical difference between these 2 scores. We selected the cut-off value of 0 in order to avoid missing any severe patients, thus preferred a cut-off value with a high sensitivity rather than a high specificity. This made clinicians to pay more attention to and provide intensive care for the non-severe patients similar to the severe patients. However, it was justified since falciaprum malaria infection may have a potential to be a severe disease with unproper management.

The SOFA score was reported to be useful to identify malaria patients at risk for severe disease in a small study (n=14) from Poland (Makowiecki *et al*, 2018). Although our study had more subjects (n=642), this study had limitations because of missing data and the fact it was retrospective. The small number of fatalities makes our fatality association data less applicable. Our study was conducted at only a single center, so it is not applicable to other institutions.

In our study, the SOFA score was somewhat useful in predicting risk for severe malaria and fatality. Further study using the score prospectively is needed to confirm those findings.

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