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ORIGINAL RESEARCH

The Use of qSOFA, SOFA, and Ramathibodi Early Warning Score (REWS) to Predict Severe Complications in Hematologic Malignancy Patients

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Background: Sepsis causes high mortality in vulnerable groups such as hematologic malignancy (HM) patients. There are various early warning scores of sepsis, eg, qSOFA, SOFA, and Ramathibodi Early Warning Score (REWS). This study aimed to compare REWS, qSOFA, and SOFA in predicting severe complications in hematologic malignancy patients visiting ED.

Methods: The study was conducted as a retrospective cohort study at the ED of Ramathibodi Hospital, Bangkok, Thailand. Adult HM patients suspected of sepsis and have visited ED between March 2016 and December 2019.

Results: Among 124 patients in our cohort, 51 (41%) had serious complication in ED and 20 (16%) died within 28 days after admission. The AUROCs of SOFA and qSOFA indicate significantly higher predicting in serious complication in ED than REWS (SOFA, 0.81 [95% CI, 0.73–0.89], qSOFA, 0.73 [95% CI, 0.65–0.81], REWS, 0.62 [95% CI, 0.52–0.72] p=0.004) while the predicting in 28-day mortality is not statistically significantly different (SOFA, 0.73 [95% CI, 0.60–0.85], qSOFA, 0.69 [95% CI, 0.58–0.80], REWS, 0.60 [95% CI, 0.44–0.75] p=0.25).

Conclusion: The SOFA score is highest in predicting severe complications among hematologic malignancy patients.

Keywords: sepsis, qSOFA, SOFA, early warning score, hematologic malignancy

Introduction

Sepsis is a life-threatening condition, the common cause of death in the USA, and estimated to affect above 1 million patients, bringing up 250,000–350,000 in-hospital deaths.[1,2] In Thailand, the emergency department (ED) was overcrowded due to insufficient available beds for in-patient admission. The mortality of sepsis was approximately 25–50%.[3] Despite the high mortality, the screening tool to diagnose sepsis in ED was not widely used. Among sepsis patients admitted to ICU, the high mortality relatively increased in immunocompromised patients, so oncologic patients, which are usually inevitably treated by chemotherapy and immunosuppressive agents, increase 2.32 times mortality.[4–7]

Oncologic patients increasingly live longer and have visited the ED more frequently in the past decade.[7,8] Hence, oncologic patients who have signs and symptoms of sepsis or presented with febrile neutropenia are highly suspicious of sepsis and require immediate evaluation and treatment.[9] Early recognition and administration of antibiotics in patients with suspected sepsis is the pearl for emergency care, especially cancer patients.

Developing a better prediction score to accelerate patients' identification and treatment with highly suspicious sepsis status is still challenged. There was a new diagnostic tool to predict sepsis in ED, eg, Quick Sequential Organ Failure Assessment (qSOFA) score, Sequential Organ Failure Assessment (SOFA) score, Systemic Inflammatory Response Syndrome (SIRS) criteria.[10] SIRS criteria have been criticized for their low sensitivity and specificity.[11] The predicting

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of in-hospital mortality among critically ill cancer patients of the qSOFA, SOFA was significantly better than SIRS.[12,13] However, recent articles discovered a lower sensitivity of qSOFA and difficulty using SOFA score.[14,15]

Many researchers adopted the early warning score and promoted it in their hospitals.[16] According to Sutherasarn et al, Ramathibodi Early Warning Score (REWS) was used to predict the outcome of in-hospital mortality. So, we used the REWS score in the outpatient setting to improve the early recognition of sepsis patients, so every suspected sepsis patient who visited the ED of Ramathibodi hospital always implies a REWS score at triage.[17]

In hematologic malignancy patients, the comparison of early warning scores is still unclear. Lee et al compared the MASCC score, which was stratified for the low-risk oncologic patient, with qSOFA, and described that some factors might be affected by the physician's subjective judgment. Therefore, it is not suitable for the ED setting if compared with qSOFA.[18] The objective of this study was to compare REWS, qSOFA, and SOFA in predicting severe complications in hematologic malignancy patients visiting ED.

Methods

Study Design

This study was a prognostic, retrospectively cohort study conducted in the ED of Ramathibodi Hospital, a university-affiliated supertertiary care hospital in Bangkok, Thailand. We included hematologic malignancy patients with the following ICD-10-CM final diagnosis: ICD-10-CM section C81-C96 (malignant neoplasm of lymphoid, hematopoietic, and related tissue), and we collected the data from the review of the Emergency Medical Record (EMR).

Sample Size

We performed a pilot study collecting the data from the ED sepsis database patient and then stratified the sepsis patients diagnosed with hematologic malignancy between January and December 2016. Forty hematologic malignancy patients visited ED during that period. Nine hematologic malignancy patients had serious complications (23%), and 31 without serious complications (77%). The ratio of hematologic malignancy patients suspected sepsis with serious complication per without serious complication was 1:3. Then, qSOFA and SOFA scores that were calculated by standard criteria were applied. According to further articles and guidelines, qSOFA of 2 or higher had increased the in-hospital mortality 3–14 times.[10,12,13.]

For the SOFA score, a threshold of 4 or more points was the significant predictive factor of death within 14 days after admission in cancer patients.[20] Pearson's chi-squared test compared two independent proportions alpha of 0.05 (two-sided test), power of sample size of 0.9 and the ratio of sample size of 1:3. We obtained sample size of 9 in hematologic malignancy patients suspected of sepsis with a serious complication group. According to the formula and ratio obtained, the sample size of 31 in hematologic malignancy patients suspected of sepsis without serious complication population groups. Finding that if we use SOFA $\geq$ 4, the most reasonable sample size was 124 patients. However, using qSOFA $\geq$2, the most reasonable sample size was 40 patients. Finally, we chose 124 sample sizes for our research.

Participants

We included the adult patients (age more than 18) who visited the ED, were diagnosed with hematologic malignancy and suspected sepsis. We excluded the diagnosed hematologic malignancy patients suspected of sepsis with prior treatment from another hospital or another department, referred from other hospitals, do not resuscitate patients, and incomplete medical records. The protocol is illustrated in Figure 1.

Data Collection and Study Variables

We collected the data of hematologic malignancy patients suspected of sepsis visiting the ED of Ramathibodi hospital between January 2017 and December 2019.

All of the variables were collected by reviewing the medical record, and all eligible patients were interpreted into two tables, including, First, demographics and clinical characteristics such as age, gender, comorbidities, types of

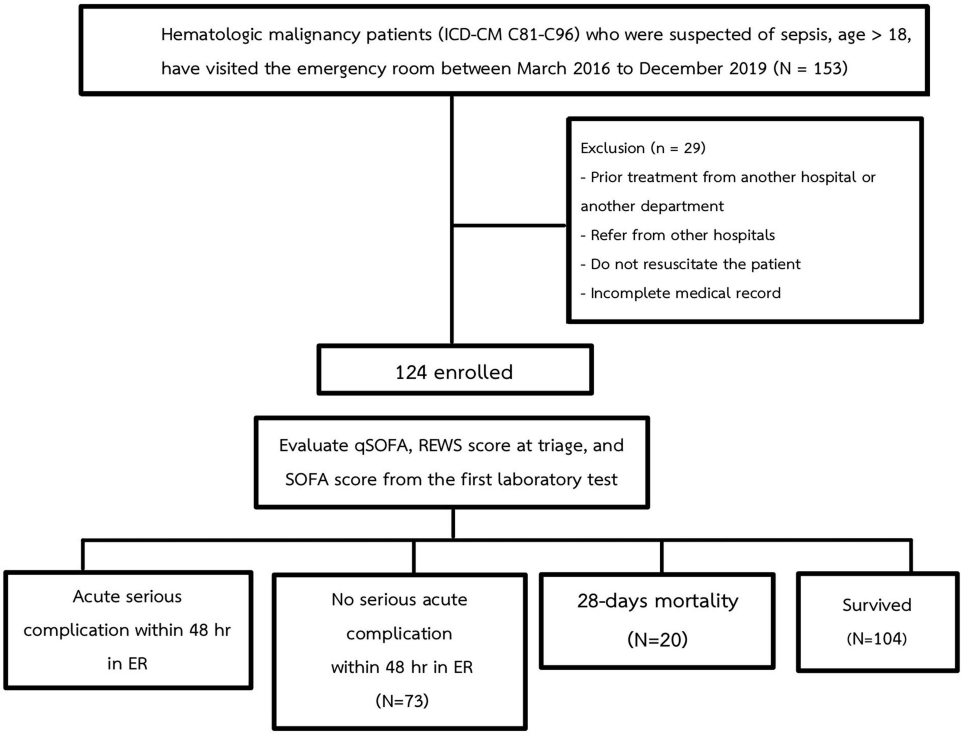

Figure 1 The protocols of data collection.

hematologic malignancy, previous admission history, previous serious complication at ED and type of chemotherapy. Second, we recorded vital signs and mental status at triage, laboratory tests, imaging, suspected infection site, hemoculture status, and other potential physiological, afterward calculating these factors to qSOFA, REWS, and SOFA. Other factors from the literature review, such as lactate,[10] albumin, blood glucose, and positive chest x-ray finding,[19] were also collected.

Definition

qSOFA variable included respiratory rates (RR) ≥22/min, systolic blood pressure (SBP) <100 mmHg, and Glasgow Coma Score <15.

The SOFA score variable included laboratory parameters, and vital organ systems included PF ratio, platelets, total bilirubin, cardiovascular, creatinine, and Glasgow coma scale1.

Table 1 Parameter of REWS (Ramathibodi Early Warning Score)

Score	RR	SpO_2	Temp	SBP	HR	AVPU
3	≤10	≤84	≤33.9	≤89	≤39	U
2		85–89	34–34.9			P
1		90–92	35–35.9	90–99	40–49	V
0	11–20	≥93	36–37.9	100–199	50–99	A
1	21–30		38–38.9		100–109	
2	31–35		≥39	≥200	110–129	
3					≥130	

Abbreviations: SpO_2, estimate of arterial oxygen saturation; SBP, systolic blood pressure; A, Alert; V, Verbal; P, pain; U, Unresponsive.

REWS variables included RR, oxygenation saturation, body temperature, SBP, heart rate, and consciousness level (Table 1).

Suspected sepsis included the patients who met SIRS criteria. However, suppose patients' characteristics do not meet SIRs in ED situations. In that case, the chief complaint of patients such as alteration of consciousness, fever, dysuria or diarrhea, or some chief complaints that can be suspected of infection can be identified as suspected sepsis patients.

We defined the serious complication as the patients who needed intensive resuscitation, hypotension (SBP <90 mmHg), required high-flow oxygen supplement (BiLevel Positive Airway Pressure), or endotracheal tube intubation (ETI).[10,21,22]

Outcomes of Interest

We compared the qSOFA, REWS, and SOFA scores predicting serious complications and 28-day mortality, emphasizing the quality of screening and treatment among hematologic malignancy patients at high risk of sepsis.

Statistical Analysis

Data were analyzed by STATA version 14.2. We compared all prognostic factors between hematologic malignancy patients suspected sepsis with severe complications and without severe complications by *t*-test for continuous variables and exact probability test for categorical variables. We used sensitivity, specificity, and the area under the receiver-operating characteristic curve (AUROC) to discriminate the prediction score. The P values less than 0.05 were statistically significant.

Ethical Considerations

The Faculty approved this study of Medicine, Committee on Human Rights Related to Research Involving Human Subjects, of Mahidol University's Ramathibodi Hospital (COA. No. MURA2020/1005). As patient consent to review their medical records was not required by the ethics committee, the reason for the waiver was retrospective chart review. Data acquired must be kept anonymized and compliant with the Declaration of Helsinki.

Results

A total of 153 hematologic malignancy patients suspected of sepsis were visited in ED from March 2016 to December 2019. Twenty-nine patients were excluded, 20 patients had referred and prior treatment from another hospital or another department, 7 were not resuscitated, and 2 were incomplete medical records. Finally, 124 patients enrolled in our criteria.

First, we compared severe complications, 51 patients with severe complications and 73 patients who were not. Second, comparing 28-day mortality, 20 patients who died within 28 days after visiting ED (including those who died in ED, ward, and ICU) and 104 patients survived and were discharged. Table 2 shows the demographic data and baseline characteristics. The mean age of the patient was 56 years. Acute myeloid leukemia (AML) was the most common hematologic malignancy diagnosed (50%), lymphoma, and multiple myeloma (33% and 9%, respectively). Surprisingly, 50% had a history of febrile neutropenia at ED or during hospitalization for the patient history parts. Twenty-four percent have a previous history of positive blood culture within 1 year. Regarding previous hospital complications, vasopressor use in any prior visit to ED was the most frequent.

Vital Signs and Laboratory Findings

Patients who had a severe complication of ED and who were not survived 28 days after admission had a significantly higher respiratory rate than those in the control group and had lower mean arterial blood pressure (mABP), SBP, and diastolic blood pressure (DBP) but not significantly different. However, the temperature in both groups is similar (mean 38.5 °C). For mental status, 90% of the patients were alert. Concerning complete blood cell counts, according to hematologic malignancy status, hematocrit level and platelet counts are both lower than the normal population (27% and 83.2×10^3), but no difference was observed between the groups. About WBC count, 50% of the population among both groups were diagnosed with febrile neutropenia. Furthermore, the death and serious complication group had

Table 2 The Patient's Characteristic and Outcome of the Cohort

Variables	Total, N = 124	Serious Complication		P-value	Death, N = 20	Survive N = 104	P-value
		Yes, N = 51	No, N = 73				
Age, years	56 ± 16.8	59.8 ± 15.7	54.07 ± 17.3	0.060	61.8 ± 17.2	55.4 ± 16.7	0.123
Gender, male %	58 (46.8)	23 (45.1)	35 (47.9)	0.855	13 (65)	45 (43.3)	0.093
Comorbidities, N (%)							
DM	26 (21)	8 (15.7)	18 (24.7)	0.865	3 (15)	23 (22.2)	0.562
HT	43 (34.7)	20 (39.2)	23 (31.5)	0.444	8 (40)	35 (33.6)	0.613
CKD	10 (8.06)	4 (7.84)	6 (8.22)	1.00	1 (5)	9 (8.65)	1.00
Type of hematologic malignancies, N (%)							
AML	36 (29)	14 (27.45)	22 (30.14)	0.253	7 (35)	29 (27.88)	0.746
ALL	8 (6.45)	5 (9.8)	3 (4.11)		1 (5)	7 (6.73)	
CML	10 (8.06)	2 (3.92)	8 (10.96)		1 (5)	9 (8.65)	
CLL	2 (1.61)	1 (1.96)	1 (1.37)		1 (5)	1 (0.96)	
DLBCL	12 (9.68)	5 (9.8)	7 (9.59)		1 (5)	11 (10.58)	
Relapse/refractor DLBCL	3 (2.41)	1 (9.8)	2 (2.74)		0	3 (2.88)	
T-cell lymphoma	8 (6.45)	6 (11.76)	2 (2.74)		2 (10)	6 (5.77)	
Multiple myeloma	12 (9.68)	4 (7.84)	8 (10.96)		2 (10)	10 (9.62)	
Refractory/relapse multiple myeloma	9 (7.26)	6 (11.76)	3 (4.11)		3 (15)	6 (5.77)	
Non-Hodgkin lymphoma	5 (4)	0	5 (6.85)		0	5 (4.81)	
Another lymphoma	13 (10.48)	5 (9.8)	8 (10.96)		1 (5)	12 (11.54)	
Another leukemia	6 (4.83)	2 (3.92)	4 (5.1)		1 (5)	5 (4.81)	
Previous admission history – N (%)							
History of ICU admission within 3 months	19 (15.32)	11 (21.57)	8 (10.96)	0.131	5 (25)	14 (13.46)	0.190
History of positive hemoculture	30 (24.2)	16 (31.37)	14 (19.18)	0.139	7 (35)	23 (22.12)	0.256
History of febrile neutropenia	62 (50)	24 (47.06)	38 (52.05)	0.715	9 (45)	53 (50.96)	0.823
Vital signs							
Temp (C^0)	38.5 ± 1	38.6 ± 1.26	38.4 ± 0.95	0.456	38.42 ± 1.06	38.47 ± 1.1	0.873
Heart rate beats/min	110 ± 24	109 ± 27	111 ± 22	0.585	118 ± 27	109 ± 23	0.122
RR breaths/min	23 ± 5	25 ± 6	21 ± 4	0.001	28 ± 7	22 ± 4	<0.001
mABP mmHg	83 ± 17	79 ± 19	86 ± 15	0.010	81 ± 19	84 ± 17	0.553
SBP mmHg	118 ± 25	110 ± 26	122 ± 24	0.010	113 ± 23	118 ± 26	0.454
DBP mmHg	66 ± 15	62 ± 17	68 ± 13	0.043	65 ± 18	66 ± 14	0.745
Mental status – N (%)							
A	112 (90)	44 (86.27)	68 (93.15)	0.404	18 (90)	94 (90)	0.417
V	5 (4)	3 (5.8)	2 (2.7)		2 (10)	3 (2.8)	
P	7 (6)	4 (7.8)	3 (4)		0	7 (6.7)	

(*Continued*)

Table 2 (Continued).

Variables	Total, N = 124	Serious Complication		P-value	Death, N = 20	Survive N = 104	P-value
		Yes, N = 51	No, N = 73				
Laboratory test							
WBC $\times 10^3$	10.61±28.9	13.98 ± 37.9	8.26 ± 20.31	0.285	26.52 ± 58.66	7.55 ± 17.37	0.006
Absolute neutrophil /mm^3 × 10^3	3.35±5.07	3.14±4.23	3.50±5.60	0.767	2.52±3.00	3.51± 2.46	0.433
Febrile neutropenia	65 (52.4)	26 (51)	39 (53.4)	0.855	10 (50)	55 (52.8)	1.00
Hct %	27% ± 6%	26.3 ± 6.3%	27.32± 5.7%	0.354	24.8 ± 6.2%	27.3 ± 5.9%	0.083
PLT × 10^3	83.2 ± 96.8	80.2 ± 101.7	85.3 ± 93.9	0.775	76.9 ± 117.1	84.41 ± 93.0	0.753
Cr mg/dl	1.12± 0.78	1.29 ± 0.78	1.06 ± 0.82	0.070	1.52 ± 10	1.05 ± 0.75	0.023
Total bilirubin (mg/dl)	1.5 ± 2.16	1.4 ± 1.4	1.6 ± 2.6	0.756	2.01 ± 1.9	1.4 ± 2.20	0.254
Direct bilirubin (mg/dl)	0.82± 1.53	0.82 ± 1.06	0.82 ± 1.8	0.994	1.26 ± 1.5	0.73 ± 1.53	0.155
INR	1.21± 0.45	1.33 ± 0.5	1.14 ± 0.37	0.016	1.56 ± 0.6	1.15 ± 0.37	0.001
Alb (mg/dl)	28.2 ± 6.1	25 ± 5.6	30 ± 5.6	<0.001	22.5 ± 4.1	29.3 ± 5.8	<0.001
Glucose (mg/dl)	157 ± 100	183 ± 142	138 ± 49	0.013	178 ± 87	153 ± 103	0.334
Lactate	2.4 ± 2.2	3.1 ± 3.1	1.8 ± 0.9	0.001	3.8 ± 4	2.0 ± 1.50	0.001
Imaging N (%)							
Chest X-ray New infiltration	39 (31.45)	29 (56.8)	10 (13.7%)	<0.001	15 (75%)	24 (23%)	<0.001
Site of infection – N (%)							
Pulmonary	41 (33.06)	25 (49.02)	16 (21.92)	0.005	12 (60)	29 (27.90)	0.145
Skin	13 (10.48)	4 (7.84)	9 (12.33)		3 (15)	10 (9.62)	
Score							
qSOFA ≥ 2	20 (16.1)	16 (31.4)	4 (5.5)	<0.001	7 (35)	13 (12.5)	0.023
SOFA ≥ 4	84 (67.7)	44 (86.3)	40 (54.8)	<0.001	17 (85)	67 (64.4)	0.115
REWS ≥ 4	51 (41.1)	26 (51)	25 (34.2)	0.067	11 (55)	40 (38.5)	0.216

Abbreviations: AML, acute myeloid leukemia; ALL, acute lymphoid leukemia; CML, chronic myeloid leukemia; CLL, chronic lymphoid leukemia; DLBCL, diffused large B-cell lymphoma; A, Alert; V, response by Verbal; P, response by Pain; Hct, hematocrit; PLT, platelet; INR, International Normalized Ratio; Alb, albumin.

a significantly lower albumin level and a higher lactate level and platelet count than the other group (both serious complication and 28-day mortality in a similar way).

Source of Infection and Outcome of Patients

Respiratory tract infection was common in patients who had severe complications or died in 28 days. The emergency physician significantly found and interpreted the abnormal chest radiograph according to the respiratory tract infection. Skin infection was the second. Concerning clinical outcomes, 16.9% of the patients indicated applying a vasopressor, and 22.6% were ED intubated.

Performance of the Models

SOFA score better than qSOFA and REWS in predicting both serious complication including those occurring in profound hypotension patients who require inotropic agents and require high-flow oxygen supplement or ETI (AUC [95% CI]: 0.81 [0.73, 0.89], 0.73 [0.65, 0.81] and 0.62 [0.52, 0.72] and 28-day mortality (AUC [95% CI]: 0.73 [0.6, 0.85], 0.69

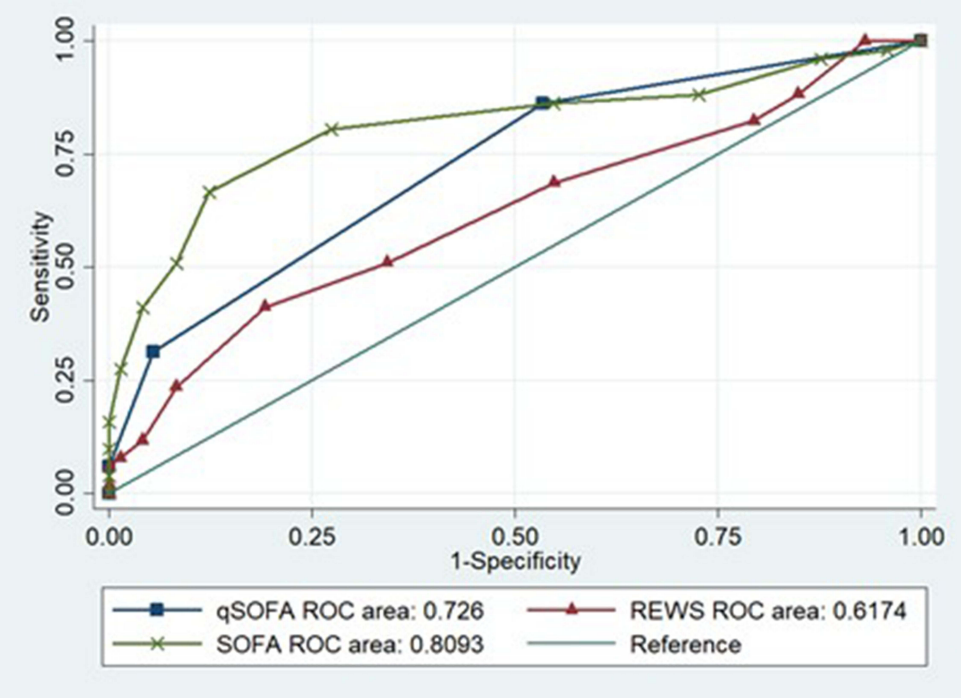

Figure 2 ROC curves and AUROC of qSOFA, SOFA and REWS score for predicting serious complications at ER (P-value of difference between three AUCs: qSOFA vs SOFA vs REWS 0.004).

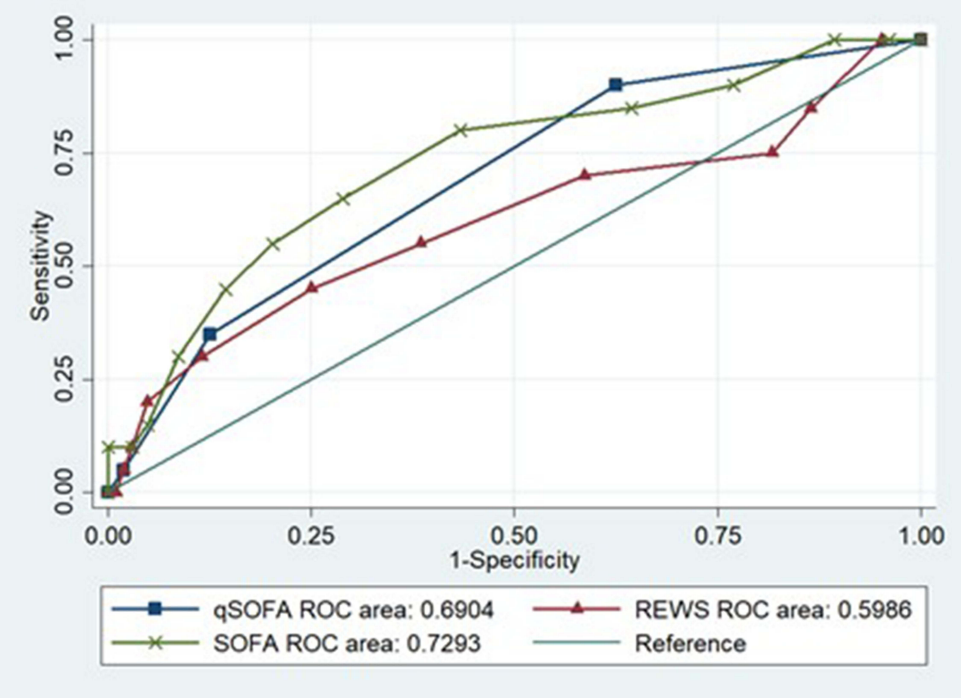

Figure 3 ROC curves and AUROC of qSOFA, SOFA and REWS score for predicting 28-day mortality (P-value of difference between three AUCs: qSOFA vs SOFA vs REWS 0.253).

[0.58, 0.8] and 0.6 [0.44, 0.75] respectively) (Figures 2 and 3). When comparing the ROC curves of these three illness severity scores (qSOFA, SOFA, and REWS) showed significant differences in predicting serious complication (P=0.004), but not significantly different in predicting 28-day mortality (P =0.253).

Table 3 Sensitivities and Specificities for qSOFA, SOFA and REWS

Score	Serious Complication		28-Days Mortality	
	Sensitivity (%)	Specificity (%)	Sensitivity (%)	Specificity (%)
qSOFA				
≥1	86.3	46.6	90	37.5
≥2†	31.4	94.5	35	87.5
≥3	5.9	100	5	98.1
SOFA				
≥1	96.1	12.3	100	3.8
≥2	88.2	76.1	100	10.6
≥3	86.3	45.2	90	23.1
≥4†	80.4	72.6	85	35.6
≥5	66.7	87.7	80	56.7
≥6	51.0	91.8	65	71.2
≥7	41.2	95.9	55	79.8
≥8	27.5	98.6	45	85.6
≥9	15.7	100	30	91.3
REWS				
≥1	88.2	15.1	85	13.5
≥2	82.4	20.5	75	18.3
≥3	68.6	45.2	70	41.3
≥4†	51.0	65.8	55	61.5
≥5	41.2	80.8	45	75
≥6	23.5	91.8	30	88.5
≥7	11.8	95.9	20	95.2
≥8	7.8	98.6	10	97.1
≥9	5.9	100	5	98.1

Note: †The standard threshold cut-off points were cited from previous research.

Sensitivity Analyses

The optimal cut-off points of severe complications were qSOFA ≥2, SOFA ≥4, and REWS ≥4, qSOFA was the highest specificity, followed by SOFA and REWS. The highest sensitivity was SOFA, followed by REWS and qSOFA. However, for 28-day mortality, using the same optimal cut-off points, qSOFA showed the highest specificity, followed by REWS and SOFA, which are different in the previous population. SOFA was highest for sensitivity, followed by REWS and qSOFA, similar to the previous population group (Table 3), but the sample size is inadequate to predict mortality.

Discussion

Our study indicated that the SOFA score and qSOFA were more accurate than the REWS criteria to predict ED serious complications in hematologic oncology patients concordant with the study of Costa and Probst et al that SOFA scores more accurate than qSOFA and SIRS.[12,13]

On the other hand, the performance of REWS in our study was underperformed in predicting severe complications. In the author's opinion, fever was the common presentation of hematologic malignancies in patients. From our cohort, 50% of the hematologic malignancies presented with fever (mean 38.5 ± 1), which contrasts to previous novels.[7] The high temperature present in the cancer cohort, neoplastic fever, may represent the non-infectious acute inflammatory disorders that mimic sepsis. Furthermore, many types of neoplasms such as renal cell carcinoma, lymphoma, and leukemia can invoke a febrile response which also mimics sepsis. Nonetheless, hematologic malignancy patients mostly have neutropenia and immunodeficiency; thus, 37% had no fever and other symptoms of infection from previous novels.[13] This controversial issue about fever can decrease the predicting in serious complications and 28-day in-hospital mortality for REWS.

Compared to qSOFA, which included variables such as respiratory rates (RR), systolic blood pressure (SBP), and consciousness (evaluated by Glasgow Coma Score). These variables can apply bedside to discriminate the suspected infection patients with poor outcomes, leading to end-organ failure, severe complications, and ICU admission.[1] For 28-day in-hospital mortality, our secondary outcome, the AUROC of these scores, is still the same way; SOFA performed substantially better than qSOFA and REWS but not statistically significant. Previous studies also have similar outcomes in SOFA score but not for REWS compared to qSOFA. In the author's opinion, the small number of non-survived groups can be the main factor, leading to the disassociation of outcomes from other studies. Some previous novels suggested that improving prediction in 28-day in-hospital mortality is the change in score, which can offer an important additional essential prognostic factor, especially when patients become worse or deteriorate during admission in both general ward or ICU settings.[17]

Discrimination of sensitivity and specificity of these scores, compared to the cut-off points as shown in Table 3, qSOFA ≥2 has 94.5% and 87.5% for predicting serious complications in ED and 28-day in-hospital mortality, respectively, which much higher than other 2 scores. In a previous study, the meta-analysis is comparing SIRS and qSOFA in ED also showed the higher specificity but lower sensitivity of qSOFA.[26] SOFA ≥4 has 80.4% and 85% sensitivity but very low specificity, especially in 28-day in-hospital mortality. For REWS ≥4 is in the average of both sensitivity and specificity, for underperformed was described in the preceding paragraph. Thus, qSOFA and SOFA are good combinations to treat sepsis patients.

After screening the higher specificity patient to be more attention, the SOFA score applicable after interpreted laboratory test can help physicians prioritize the treatment among sepsis patients out of the ICU setting. High SOFA combined with high qSOFA should receive immediate treatment and decision, especially in the crowded ED setting. Moreover, a previous study has revealed that although NEWS and MEWS have higher predicted in-hospital mortality than qSOFA, there is no benefit to changing the early warning score.[11]

Choosing the scoring system may depend on various factors. The scoring system is only one of the tools for prioritizing and predicting sepsis patients. Back to the basics, the principle of history taking and physical examination are still the main pearls for treatment for all patients. All of the above elements were gathered up, then brought to the physicians' decisive decision, thus improving the outcome of sepsis in each subgroup of patients. Further research still requires developing a more accurate scoring system for oncologic patients or other highly suspicious sepsis patients.

There was some limitation in this study. First, this paper analyzes these scores, qSOFA, SOFA, and REWS performed in the subgroup of hematologic malignancy patients with sepsis. Our data came from a single-center, supra-tertiary care medical school, Ramathibodi hospital, in which the demographics of patients may not be diverse. Although the data came from the supra-tertiary care hospital, a small number of hematologic malignancy patients are our limitation; multicenter analysis may obliterate this limitation of the small number and non-diverse cohort. Also, the scoring system, REWS score, is used only in Ramathibodi hospital which threshold of variables are not similar to the national scoring system,

eg, NEWS or MEWS, so, as the prior discussion, the outcome of predicting severe complications and 28-day mortality was distinguished from other studies.

Furthermore, this study was a retrospective cohort and medical record review in a single center, the inaccuracy of medical record reviews in some variables used in the REWS score. The quality of data abstraction, the missing data, and other limitations about statistical analyses, such as discrimination, calibration plots, net benefit, overall utility (ex with Brier's score), pair-wise comparison of AUROC. Other factors that may correlate with predicting serious complications or in-hospital mortality were not identified due to the study's small sample size and type. We suggested that further study in the multicenter cancer centers, which may attribute to a more extensive and varied population than ours and obliterate this limitation.

Conclusion

The SOFA score is highest in predicting severe complications among hematologic malignancy patients.

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Disclosure

The authors declare that they have no conflicts of interest for this work.

References

1. Singer M, Deutschman CS, Seymour C, et al. The third international consensus definitions for sepsis and septic shock (sepsis-3). *JAMA*. 2016;315:801–810. doi:10.1001/jama.2016.0287
2. Greenberg JA, David MZ, Churpek MM, Pitrak DL, Hall JB, Kress JP. Sequential organ failure assessment score modified for recent infection in patients with hematologic malignant tumors and severe sepsis. *Am J Crit Care*. 2016;25:409–417. doi:10.4037/ajcc2016281
3. Angkasekwinai N, Rattanaumpawan P, Thamlikitkul V. Epidemiology of sepsis in Siriraj Hospital 2007. *J Med Assoc Thai*. 2009;92(Suppl 2):S68–S78.
4. Wang Y-G, Zhou J-C, Wu K-S. High 28-day mortality in critically ill patients with sepsis and concomitant active cancer. *J Int Med Res*. 2018;46 (12):5030–5039. doi:10.1177/0300060518789040
5. Diwura K, Owolabi RR. A comparison of ED and direct admission care of cancer patients with febrile neutropenia. *Am J Emerg Med*. 2015;43:966–969.
6. Engels EA, Mahale P, Liu Z. Sepsis and risk of cancer among elderly adults in the United States. *Clin Infect Dis*. 2018;68(5):717–724.
7. Abou Dagher G, El Khuri C, Chehadeh AA, et al. Are patients with cancer with sepsis and bacteraemia at a higher risk of mortality? A retrospective chart review of patients presenting to a tertiary care centre in Lebanon. *BMJ Open*. 2017;7(3):e013502. doi:10.1136/bmjopen-2016-013502
8. Long B, Koyfman A. Oncologic emergencies: the fever with too few neutrophils. *J Emerg Med*. 2019;57(5):689–700. doi:10.1016/j.jemermed.2019.08.009
9. Wasithep Limvorapitak TK, Khawcharoenporn T. Incidence, risk factors, and outcomes of febrile neutropenia in Thai hematologic malignancy patients receiving chemotherapy: a 6-year retrospective cohort study. *Asian Pac J Cancer Prev*. 2015;16:5945–5950. doi:10.7314/APJCP.2015.16.14.5945
10. Seymour CW, Liu VX, Iwashyna TJ, et al. Assessment of clinical criteria for sepsis: for the third international consensus definitions for sepsis and septic shock (Sepsis-3). *JAMA*. 2016;315(8):762–774. doi:10.1001/jama.2016.0288
11. Churpek MM, Snyder A, Han X, et al. Quick sepsis-related organ failure assessment, systemic inflammatory response syndrome, and early warning scores for detecting clinical deterioration in infected patients outside the intensive care unit. *Am J Respir Crit Care Med*. 2017;195(7):906–911. doi:10.1164/rccm.201604-0854OC
12. Costa RT, Nassar AP, Caruso P. Accuracy of SOFA, qSOFA, and SIRS scores for mortality in cancer patients admitted to an intensive care unit with suspected infection. *J Crit Care*. 2018;45:52–57. doi:10.1016/j.jcrc.2017.12.024
13. Probst L, Schalk E, Liebregts T, et al. Prognostic accuracy of SOFA, qSOFA and SIRS criteria in hematological cancer patients: a retrospective multicenter study. *J Intensive Care*. 2019;7(1):41. doi:10.1186/s40560-019-0396-y
14. Askim Å, Moser F, Gustad LT, et al. Poor performance of quick-SOFA (qSOFA) score in predicting severe sepsis and mortality - a prospective study of patients admitted with infection to the emergency department. *Scand J Trauma Resusc Emerg Med*;2017. 25. doi:10.1186/s13049-017-0370-4
15. Kim M, Ahn S, Kim WY, et al. Predictive performance of the quick sequential organ failure assessment score as a screening tool for sepsis, mortality, and intensive care unit admission in patients with febrile neutropenia. *Support Care Cancer*. 2017;25(5):1557–1562. doi:10.1007/s00520-016-3567-6
16. Williams BAG, Ball C, Bell D, Binks R, Durham L. National Early Warning Score (NEWS): standardising the assessment of acute illness severity in the NHS. London. The Royal College of Physicians; 2012.
17. Sutherasan Y, Theerawit P, Suporn A, Nongnuch A, Phanachet P, Kositchaiwat C. The impact of introducing the early warning scoring system and protocol on clinical outcomes in tertiary referral university hospital. *Ther Clin Risk Manag*. 2018;14:2089–2095. doi:10.2147/TCRM.S175092

18. Lee SJ, Kim JH, Han SB, Paik JH, Durey A. Prognostic factors predicting poor outcome in cancer patients with febrile neutropenia in the emergency department: usefulness of qSOFA. *J Oncol*. 2018;2018:7. doi:10.1155/2018/2183179
19. Lynn JJ, Chen KF, Weng YM, Chiu TF. Risk factors associated with complications in patients with chemotherapy-induced febrile neutropenia in emergency department. *Hematol Oncol*. 2013;31(4):189–196. doi:10.1002/hon.2040
20. Lee JS, Kwon OY, Choi HS, Hong HP, Ko YG. Application of the Sequential Organ Failure Assessment (SOFA) score in patients with advanced cancer who present to the ED. *Am J Emerg Med*. 2012;30(2):362–366. doi:10.1016/j.ajem.2010.12.017
21. Klastersky J, Paesmans M, Rubenstein EB. The multinational association for supportive care in cancer risk index: a multinational scoring system for identifying low-risk febrile neutropenic cancer patients. *Am J Clin Oncol*. 2000;18:3038–3051. doi:10.1200/JCO.2000.18.16.3038
22. Marín M, Gudiol C, Ardanuy C, et al. Factors influencing mortality in neutropenic patients with haematologic malignancies or solid tumours with bloodstream infection. *Clin Microbiol Infect*. 2015;21(6):583–590. doi:10.1016/j.cmi.2015.01.029
23. Jiang J, Yang J, Mei J, Jin Y, Lu Y. Head-to-head comparison of qSOFA and SIRS criteria in predicting the mortality of infected patients in the emergency department: a meta-analysis. *Scand J Trauma Resusc Emerg Med*. 2018;26(1):56. doi:10.1186/s13049-018-0527-9
24. Usman OA, Usman AA, Ward MA. Comparison of SIRS, qSOFA, and NEWS for the early identification of sepsis in the Emergency Department. *Am J Emerg Med*. 2019;37(8):1490–1497. doi:10.1016/j.ajem.2018.10.058
25. Atzpodien J, Kirchner H. Cancer, cytokines, and cytotoxic cells: interleukin-2 in the immunotherapy of human neoplasms. *Klin Wochenschr*. 1990;68(1):1–11. doi:10.1007/BF01648882
26. Demandt AMP, Geerse DA, Janssen BJP, Winkens B, Schouten HC, van Mook WNKA. The prognostic value of a trend in modified SOFA score for patients with hematological malignancies in the intensive care unit. *Eur J Haematol*. 2017;99(4):315–322. doi:10.1111/ejh.12919