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Predicting sepsis in the emergency department of a Middle Eastern tertiary hospital using qSOFA vs. NEWS2

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Abstract

Background: Sepsis syndrome is one of the major emergency department (ED) presentations, which if not recognized and managed in a timely manner carries high mortality. The ED at King Faisal Specialist Hospital & Research Centre (KFSF&RC) receives a large cohort of immunocompromised patients, which makes them highly vulnerable to sepsis. There are two validated criteria that can be used in predicting sepsis: quick Sequential Organ Failure Assessment (qSOFA) and National Early Warning Scoring System (NEWS2). In our ED, no specific criteria is used to alert ED physicians, hence diagnosis of sepsis is based on clinical judgement. We wanted to know, if the above two predictive criteria can be applied to all those patients treated as sepsis within ED. We also wanted to know the disposition of these patients.

Objectives:

- How many patients diagnosed as sepsis by the ED physician could have been predicted by qSOFA & NEWS2.

- How many of these patients needed ICU admissions.

Methods: Retrospective review of medical records of all ED patients over a 6 month period (Dec 2020 till June 2021), who had a minimum of blood culture, urinary culture and chest X-ray requested from ED for a new emergency attendance. A data collection sheet was used to record patients' demographics, temperature, heart rate (HR), respiratory rate (RR), blood pressure (BP), oxygen saturations (O2 sats), clinical symptoms, Canadian Triage & Acuity Scale (CTAS) category, Glasgow Coma Scale (GCS), blood culture, urine culture, COVID-19 PCR result (where applicable), lactate, C-reactive protein (CRP), pro-calcitonin, White Blood Cell (WBC) count, platelets count, creatinine level and Chest X-ray (CXR) status.

Results: A total of 3897 patients were eligible for our study. Age ranged from 17-101 years. 1476 (37.9%) were males. On the qSOFA scale, 3675 (94.3%) were assessed to be "not high risk" and 176 (4.5%) were assessed to be at "high risk" of sepsis. On the NEWS2 scale, 3287 (84.3%) were assessed to be at "low risk" of sepsis, 549 (14.1%) were assessed to be at "high risk" of sepsis. qSOFA's sensitivity in detecting sepsis was 43.47%, while the specificity was 95.91%. NEWS2 sensitivity for detecting sepsis was 82.61%, while the specificity was observed to be 86.6%. 16 (0.4%) patients needed ICU admission and 99.5% were admitted to a standard bed.

Conclusion: NEWS2 is relatively a more sensitive tool than qSOFA for detecting sepsis within our ED. It could be due to inclusion of additional clinical parameters, which makes it more sensitive in identifying patients with sepsis. The tertiary care patients have complex clinical presentations, needing a wide-ranging set of parameters to suspect sepsis.

Introduction

Sepsis syndrome encompasses a wide array of presentations, ranging from early sepsis to septic shock, which can lead to multiple organ dysfunction and death. It is a significant cause of mortality and morbidity in patients admitted to the ED. The number of worldwide sepsis incidents reported in 2017 was estimated to be 48.9 million, and there were 11 million sepsis-related deaths [1].

In total, 30% of patients admitted in the ICU worldwide in 2011 had sepsis. Such patients had a mortality rate between 11.9% and 39.5%, across different regions. More than $20.3 billion is spent annually on sepsis-related care in the United States in 2011 [2,3]. Systemic inflammatory response syndrome (SIRS) encompasses a group of physiological and immune-mediated reactions that are caused by an infectious or non-infectious insult [4]. SIRS is diagnosed when a patient is found to have two or more of the following four criteria: tachycardia (HR >90/m), tachypnea (>20/m), hyperthermia/hypothermia (> 38C or <36C), and/or leukocytosis/leukopenia (>12000/mm^3 or < 4000mm^3) [5]. When SIRS is confirmed to be caused by an infectious process, it is termed as sepsis [6].

Early detection and management of sepsis is crucial for preventing the progression of sepsis to septic shock and improving survival rates [7]. Unfortunately, early recognition of sepsis is complex due to its vague symptomatology and lack of standardized criteria for diagnosis and management.

Sepsis prediction criteria can allow timely interventions and help reduce associated morbidity and mortality. Numerous scoring systems have been deployed to aid early detection of sepsis. NEWS2 and qSOFA are the two main scoring systems that are widely used within the ED to predict sepsis and many studies have been published comparing the two criteria [8,9]. The NEWS2 tool includes RR, O2 saturation, systolic blood pressure (SBP), pulse rate, temperature and Glasgow

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coma scale (GCS). It classifies patients as low risk (0-4), medium risk (5-6) and high risk (7 or more) [Reference Table 1,2]. qSOFA criteria allocates one point each for SBP ≤100 mm Hg, RR of ≥ 22/minute and GCS score <15. It classifies patients as "Not high risk" (0-1) and "High risk" (2-3) [10] [Reference Table 3]. A study that assessed the validity of qSOFA found it to be a poor screening tool for identifying sepsis in the ED. It also found that the time needed to meet qSOFA criteria was significantly longer than for SIRS criteria [11].

In contrast, a study comparing qSOFA, NEWS2, and SIRS concluded that both qSOFA and NEWS2 were superior to SIRS in diagnosing sepsis and predicting mortality [12]. The variability in the research regarding the accuracy and effectiveness of these scoring systems further denotes the importance of establishing a standardized way to identify sepsis.

In 2004, the surviving sepsis campaign (SSC) established its first guideline for managing sepsis to reduce mortality. Updated guidelines have later been published in 2023. Adherence to these guidelines has led to better patient outcomes and lower healthcare costs [13]. The SSC also released guidelines for managing sepsis caused by COVID-19 during the pandemic [14].

A retrospective study conducted in Australia assessed the impact of implementing evidence-based sepsis guidelines. The new guidelines led to a 230-minute decrease in the time to administer antibiotics. Overall, it enhanced the early assessment, recognition, and management of sepsis patients [3].

The lack of reliable tools to diagnose sepsis can harm patients by unnecessary administration of fluids and medications. A study was conducted to assess the number of patients initially diagnosed with sepsis on presentation to the ED and compared them to those still diagnosed with sepsis upon discharge. It was found that most patients meeting sepsis criteria in the ED were not diagnosed with sepsis at discharge [15].

A study assessed the clinical application of artificial intelligence (AI) in sepsis. Targeted Real Time Early Warning System (TRESS), a bedside tool was designed to create a sepsis alert for the clinician, by combining patients medical records with symptoms and laboratory results. It claimed a reduction in sepsis related mortality from 21.3% to 8.96%. These findings can provide significant aid to ED physicians in future [16].

It is evident that there is a need for more research to establish a standardized approach for properly detecting sepsis within the ED, as very few studies address such a pervasive topic. Furthermore, establishing a unified prediction tool for identifying sepsis patients will optimize treatment and minimize harm. We wanted to know the sensitivity and specificity of qSOFA and NEWS2 criteria treated as sepsis within our ED.

Materials and methods

Study design and setting

Retrospective review of the medical records of ED patients over a 6-month period (from Dec 2020 to June 2021) in the ED of KFSH&RC, Riyadh, Saudi Arabia.

Inclusion criteria

All patients with suspected sepsis within the ED (patients who had blood culture and/or urine culture and chest x-ray requested by the ED physician).

Exclusion criteria

Boarded patients in the ED (already admitted patients under a specialty, waiting an inpatient bed).

Data collection tool

The patients' data was collected from the electronic medical records of KFSH&RC.

Reference Table 1. NEWS is a sum total scoring system derived from six physiologic parameters

Physiological parameter	3	2	1	0	1	2	3
Respiratory rate (per minute)	≤ 8		9-11	12-20		21-24	≥25
SpO2 scale 1 (%)	≤ 91	92-93	94-95	≥96			
SpO2 scale 2 (%)	≤ 83	84-85	86-87	≥ 88-92 ≥ 93 on air	93-94 on oxygen	95-96 on oxygen	≥97 on oxygen
Air or oxygen		Oxygen		Air			
Systolic blood pressure (mmHg)	≤ 90	91-100	101-110	111-219			≥ 220
Pulse (per minute)	≤ 40		41-50	51-90	93-110	111-130	≥131
Consciousness				Alert			CVPU

Reference Table 2.

NEW score	Clinical risk	Response
Aggregate score 0-4	Low	Ward-based response
Red score Score of 3 in any individual parameter	Low-Medium	Urgent ward-based response
Aggregate score 5-6	Medium	Key threshold for urgent response
Aggregate score 7 or more	High	Urgent or emergency responses

Reference Table 3. qSOFA is the modified version of the Sequential Organ Assessment Score (SOFA)

qSOFA criteria	qSOFA value point
Respiratory rate >22 breaths per minute	1 point
Altered Mentation ≤14	1 point
Systolic blood pressure <100 mmHg	1 point
Score >2 is associated with poor outcome due to sepsis	

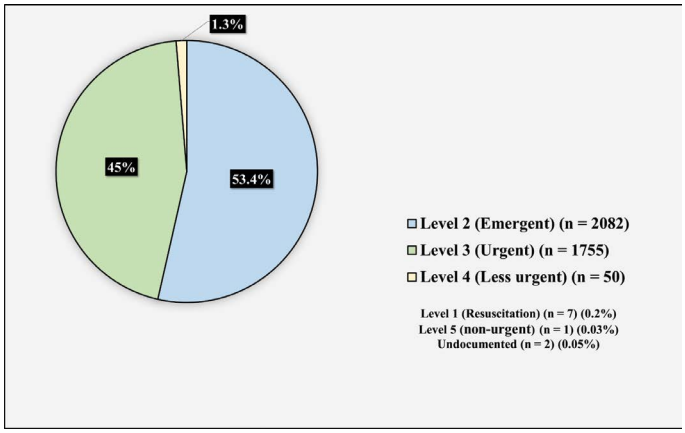

Figure 1. Patients' triage levels

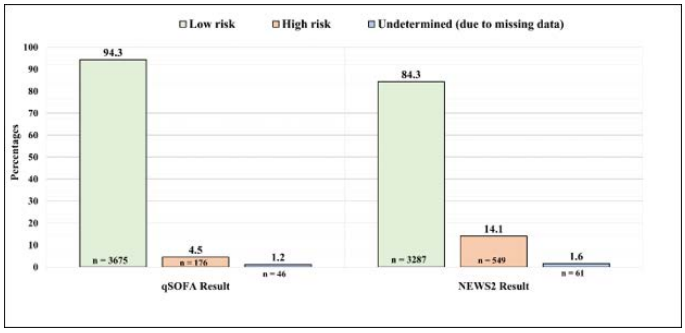

Figure 2. Patients' risk assessment of sepsis

Statistical analysis

Data analysis was performed using "Statistical Package for the Social Sciences," SPSS 23rd version. Frequency and percentages were used to display categorical variables. Mean and standard deviation were used to present numerical variables. Sensitivity and specificity were used for qSOFA and NEWS2 scales for sepsis risk assessment.

Ethical considerations

The study was approved by the Research advisory council (RAC: 2211111) of KFSH&RC. There was no funding or cost associated with this study.

Results

A total of 3897 patients were included in the study. The age range was 17-101years with a mean of 45.7 (SD 17.68). 2421(62.1%) patients were females (Table 1). Seven (0.2%) patients were triaged as CTAS 1 (immediate), 2082 (53.4%) CTAS 2 (emergent), 1755 (45%) CTAS 3 (urgent), 50 (1.3%) CTAS 4 (less urgent), 1 (0.03%) was triaged as CTAS 5 (non-urgent), while 2 (0.05%) did not have a documented triage level (Figure 1). The most common reported symptom was "fever", documented in 2062 (42.9%) patients, followed by "shortness of breath" in 1280 (32.8%), "vomiting" in 781 (20%), and "malaise" in 754 (19.3%). The least reported symptom was "flank pain" in 11 (0.3%) patients. 3607 (92.6%) patients had a normal GCS score, 205 (5.3%) ranged between 13-14, 74 (1.9%) between 9 – 12, eight (0.2%) between 3 – 8, while 3 (0.1%) did not have a documented GCS score (Table 2).

The mean temperature was 37.86 °C (SD.92), HR 88.88 (18.14), RR 20.55 (2.96), SBP 120.79 (18.18), diastolic (DBP) 73.96 (10.58), and O2 saturation 97.53 (3.54) (Table 3). The mean WBC count was 12.57 (10.06), RBC count 9.59 (9.41), platelets count 165.52 (121.35), CRP 23.99 (49.04), creatinine 78.76 (40.02), lactate 2.64 (2.15), and pro-calcitonin 3.2 (7.36). CXR was done for 3864 (99.2%) (Table 4). In accordance to qSOFA scale, 3675 (94.3%) were assessed to be "not high risk" of sepsis, 176 (4.5%) were assessed to be "high risk", while 46 (1.2%) were not assessed due to missing data. According to NEWS2 scale, 3287 (84.3%) were assessed to be at low risk of sepsis, 549 (14.1%) were assessed to be at high risk, while 61 (1.6%) were not assessed (Figure 2).

Among the participants, 2026 (52%) fulfilled the SIRS criteria, 1849 (47.4%) did not meet the criteria, while the status of 22 (0.6%) stayed undetermined due to missing data. 46 (1.2%) of these patients were categorised as sepsis (due to positive cultures) and remaining 3824 (98.1%) as not having sepsis, while the sepsis status of 27 (0.7%) patients was undetermined, due to missing data (Figure 3). As for the qSOFA sensitivity and specificity scale in detecting SIRS, the sensitivity was observed to be 7.06%, while the specificity was 98.14%. Moreover, in detecting sepsis, qSOFA sensitivity was observed to be 43.47%, while the specificity was 95.91%. As for NEWS2, the sensitivity for detecting SIRS was 24.33%, while the specificity was 96.71%. NEWS2 sensitivity for detecting sepsis was 82.61%, while the specificity was recorded to be 86.6% (Table 5).

Discussion

Sepsis is a time-sensitive condition that requires prompt diagnosis and management. For every hour of delay in commencing treatment, there is a 3-7% increase in the chance of a poor outcome [17]. The CTAS category allocated by the ED triage nurse plays a vital role in expediting management of sepsis [18]. Tertiary center nurses are accustomed to triaging a complex cohort of patients, which helps allocate appropriate triage categories [18,19]. This is comparable to the findings in a cohort study of 60 patients, where 63% of the sepsis patients were allocated CTAS category 2 [19].

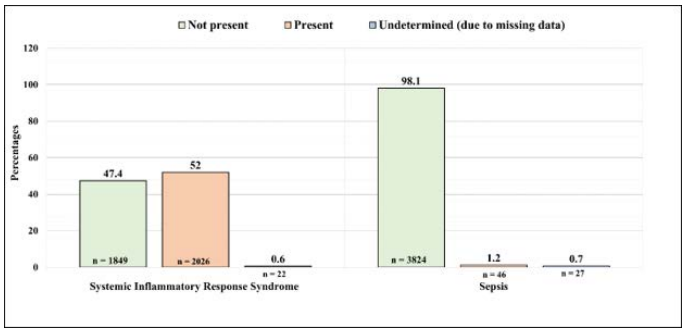

Figure 3. Prevalence of systemic inflammatory response syndrome and sepsis

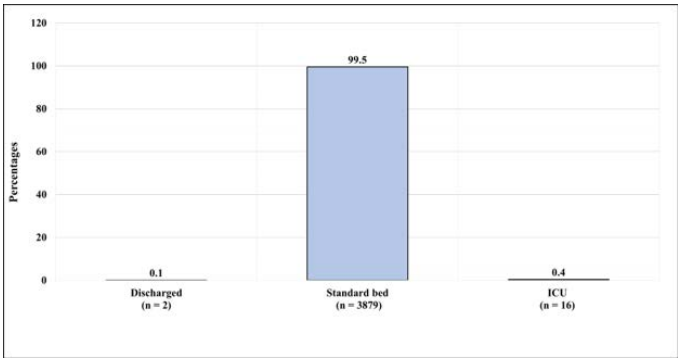

Figure 4. Patients' disposition

It is recommended that sepsis patients receive antibiotics within one hour of arriving at the ED [20]. In our study, ED physicians seen time (door to doctor time) for 2,564 (66%) patients was between 1-2 hours, resulting in a relative delay in starting treatment for patients. A similar observational study conducted in Norway found only 44.9% were seen by a physician in line with the triage priority [21]. The delay in door to doctor time has been attributed to multiplicity of factors, including overcrowding within the ED [22].

A significant number of our study patients presented with undifferentiated symptoms. The heterogeneity in clinical presentation makes it difficult for physicians to diagnose sepsis, as was seen in a cohort study, where 56% of the patients had undifferentiated clinical presentations [21]. Another prospective cohort study of 551 ED ambulance patients with sepsis, had abnormal temperature (64.1.%), pain (38.4%), acute altered mental status (38.2%), weakness of the legs (35.1%), breathing difficulties (30.4%), loss of energy (26.2%) and gastrointestinal symptoms (24.0%) [23]. This further highlights the variability in the presentation of suspected sepsis patients.

Table 1. Socio-Demographic profile of the patients (n = 3897)

Demographical charactaristics	**n**	**%**
Age		
Minimum	17	
Maximum	101	
Mean	45.7	
Standard deviation	17.68	
Gender		
Male	1476	37.9
Female	2421	62.1

Table 2. Clinical presentation profile (n = 3897)

Question	**n**	**%**
Presenting Symptoms		
Fever	2062	52.9
Shortness of breath	1280	32.8
Vomiting	781	20
Malaise	754	19.3
Nausea	753	19.3
Cough	576	14.8
Diarrhea	378	9.7
Altered mental status	287	7.4
Abdominal pain	282	7.2
Headache	146	3.7
Flank pain	11	0.3
Others	1377	35.3
Mental status Level Based on Glasgow Coma Scale		
Normal (score of 15)	3607	92.6
Mild altered mental status (score between 13 - 14)	205	5.3
Moderate altered mental status (score between 9 - 12)	74	1.9
Severe altered mental status (score between 3 - 8)	8	0.2
Undocumented	3	0.1

Table 3. Vitals profile (n = 3897)

Item	**Mean**	**Standard deviation**
Vitals sign		
Temperature (°C)	37.86	0.92
Heart rate	88.88	18.14
Respiratory rate	20.55	2.96
Systolic blood pressure	120.79	18.18
Diastolic blood pressure	73.96	10.58
Oxygen saturation	97.53	3.54

Table 4. Laboratory investigation, imaging profile, and evidence of infection (n = 3897)

Item	**Median**	**Interquartile range**
Laboratory investigation		
WBC count	10.82	12.13
RBC count	5.62	9.06
Platelets	125	50
C-reactive protein	11.3	12.85
Creatinine	75	15
Lactate	2	1.6
Procalcitonin	1.8	1.89
Imaging	**n**	**%**
Chest x-ray		
Done	3864	99.2
Not done	33	0.8
Evidence of Infection	**n**	**%**
Blood culture		
Negative	3870	99.3
Positive	27	0.7
Urine culture		
Negative	3880	99.6
Positive	17	0.4
COVID-19		
Negative	3873	99.4
Positive	17	0.4
Undocumented	7	0.2

Table 5. Sensitivity and specificity of qSOFA and NEWS2 in detecting systemic inflammatory response syndrome and sepsis

qSOFA (n = 3845)	
qSOFA parameters for systemic inflammatory response syndrome	
True positive	142
False positive	34
True negative	1799
False negative	1870
qSOFA sensitivity and specificity in detecting systemic inflammatory response syndrome	
Sensitivity	7.06%
Specificity	98.14%
qSOFA parameters for sepsis	
True positive	20
False positive	155
True negative	3639
False negative	26
qSOFA sensitivity and specificity in detecting sepsis	
Sensitivity	43.47%
Specificity	95.91%
NEWS2 (n = 3835)	
NEWS2 parameters for systemic inflammatory response syndrome	
True positive	489
False positive	60
True negative	1765
False negative	1521
NEWS2 sensitivity and specificity in detecting systemic inflammatory response syndrome	
Sensitivity	24.33%
Specificity	96.71%
NEWS2 parameters for sepsis	
True positive	38
False positive	507
True negative	3277
False negative	8
NEWS2 sensitivity and specificity in detecting sepsis	
Sensitivity	82.61%
Specificity	86.60%

Table 6. Factors associated with sepsis risk assessment based on qSOFA

Factor	Sepsis Risk Assessment based on qSOFA		P-Value
	Low risk of sepsis	High risk of sepsis	
Clinical presentation			
Headache (n, %)			
Present	140 (96.6%)	5 (3.4%)	0.51
Not present	3535 (95.4%)	171 (4.6%)	
Abdominal pain (n, %)			
Present	265 (95.7%)	12 (4.3%)	0.844
Not present	3410 (95.4%)	164 (4.6%)	
Flank pain (n, %)			
Present	8 (72.7%)	3 (27.3%)	< 0.001*
Not present	3667 (95.5%)	173 (4.5%)	
Shortness of breath (n, %)			
Present	1205 (95.6%)	56 (4.4%)	0.789
Not present	2470 (95.4%)	120 (4.6%)	
Cough (n, %)			
Present	546 (96.3%)	21 (3.7%)	0.285
Not present	3129 (95.3%	155 (4.7%)	
Fever (n, %)			
Present	1970 (96.5%)	72 (3.5%)	0.001*
Not present	1705 (94.3%)	104 (5.7%)	
Diarrhea (n, %)			
Present	360 (95.5%)	17 (4.5%)	0.952
Not present	3315 (95.4%)	159 (4.6%)	
Nausea (n, %)			
Present	722 (96.8%)	24 (3.2%)	0.049*
Not present	2953 (95.1%)	152 (4.9%)	
Vomiting (n, %)			
Present	746 (96.3%)	29 (3.7%)	0.217
Not present	2929 (95.2%)	147 (4.8%)	
Malaise (n, %)			
Present	720 (96.5%)	26 (3.5%)	0.114
Not present	2955 (95.2%)	150 (4.8%)	
Vital Signs			
Temperature (°C) (mean, standard deviation)	37.87 + 0.911	37.66 + 1.03	0.003*
Heart rate (mean, standard deviation)	88.54 + 17.82	95.52 + 21.96	< 0.001*
Diastolic blood pressure (mean, standard deviation)	74.43 + 10.28	64.53 + 12.21	< 0.001*
Oxygen saturation (mean, standard deviation)	97.64 + 2.88	95.30 + 9.96	< 0.001*
Laboratory investigation			
Lactate (median, interquartile range)	2 + 1.6	2.3 + 1.8	0.021
Procalcitonin	1.8 + 1.8	1.7 + 2.88	0.464
WBC count	10.82 + 12.12	10.45 + 12.35	0.145
RBC count	5.65 + 9.06	4.39 + 5.18	< 0.001*
Platelets	124 + 46	133 + 129	0.027*
C-reactive protein	11.3 + 12.17	14 + 28.56	< 0.001*
Creatinine	75 + 15	77 + 20	0.146
Source of Infection and Imaging			
COVID-19 status (n, %)			
Negative	3658 (95.6%)	169 (4.4%)	< 0.001*
Positive	12 (70.6%)	5 (29.4%)	
Blood culture (n, %)			
Negative	3660 (95.7%)	164 (4.3%)	< 0.001*
Positive	15 (55.6%)	12 (44.4%)	

Urine culture (n, %)			
Negative	3664 (95.6%)	170 (4.4%)	< 0.001*
Positive	11 (64.7%)	6 (35.3%)	
Chest x-ray (n, %)			
Done	3650 (95.6%)	168 (4.4%)	< 0.001*
Not done	25 (75.8%)	8 (24.2%)	
NEWS2 risk assessment of sepsis (n, %)			
Low risk of sepsis	3271 (99.5%)	16 (0.5%)	< 0.001*
High risk of sepsis	389 (70.9%)	160 (29.1%)	
*Significant at level 0.05			

Table 7. Factors associated with sepsis risk assessment based on NEWS2

Factor	Sepsis Risk Assessment based on NEWS2		P-Value
	Low risk of sepsis	High risk of sepsis	
Vital Signs			
Diastolic blood pressure (mean, standard deviation)	74.73 + 10.15	69.49 + 11.86	< 0.001*
Laboratory investigation			
Lactate (median, interquartile range)	2 + 1.6	2 + 1.6	0.383
Procalcitonin (median, interquartile range)	1.8 + 1.8	1.7 + 2.3	0.243
WBC count (median, interquartile range)	10.82 + 12.12	10.82 + 12.38	0.955
RBC count (median, interquartile range)	5.67 + 9.44	4.86 + 7.22	0.001*
Platelets (median, interquartile range)	123 + 43	133 + 119	< 0.001*
C-reactive protein (median, interquartile range)	11.3 + 12.18	12.33 + 17.19	0.001*
Creatinine (median, interquartile range)	75 +14	75 + 18	0.386
Source of Infection and Imaging			
COVID-19 status (n, %)			
Negative	3283 (86.1%)	529 (13.9%)	< 0.001*
Positive	3 (17.6%)	14 (82.4%)	
Blood culture (n, %)			
Negative	3279 (86.1%)	530 (13.9%)	< 0.001*
Positive	8 (29.6%)	19 (70.4%)	
Urine culture (n, %)			
Negative	3282 (85.9%_)	537 (14.1%)	< 0.001*
Positive	5 (29.4%)	12 (70.6%)	
Chest x-ray (n, %)			
Done	3280 (86.2%)	523 (13.8%)	< 0.001*
Not done	7 (21.2%)	26 (78.8%)	
*Significant at level 0.05			

Vital signs (HR, BP, RR, O2 sats, Temp, GCS) are primary components of qSOFA and NEWS2 criteria. In a cohort study conducted within the ambulance setting mentioned above, three components of the vital signs showed most significant association with sepsis; systolic blood pressure (BP) ≤ 100 mmHg, GCS < 15, and temperature > 38.5 °C [23]. In contrast, within our patient population, 52.9% were afebrile and 92.6% had a GCS score of 15. In addition, their mean systolic and diastolic BPs were 120.79 mmHg and 73.96 mmHg respectively. This emphasises the importance of clinical judgment to go hand in hand with predictive criteria. In addition, this also highlights the lack of sensitivity of qSOFA in certain patient populations (as in our tertiary care center), where patients with multiple comorbidities can have camouflaged presentations.

Our patients had a mean HR of 88.88/minute, which is similar to the findings of a retrospective cohort study that included 11,300 patients, who had a mean HR of 80.02 (14.33) [24]. One of the known clinical presentations of sepsis is altered mental status or sepsis-associated encephalopathy (SAE). In one study, >50% of patients showed features of SAE at initial presentation [25]. Another cohort study reported 67% of the patients with sepsis had altered mental status [26]. In contrast, 92.6% of our study population was alert on arrival to the ED. This discrepancy can be attributed to the fact that 52% of our patients were in SIRS, before progressing to sepsis.

A small group (0.4%) of our patients tested positive for COVID-19. A study comparing clinical characteristics and outcomes in critically ill septic patients found higher mortality (59%) in COVID-19, when compared to the non-COVID-19 group (29%) [27]. In our study, NEWS2 was more sensitive in identifying sepsis patients, when compared to qSOFA. Overall, NEWS2 identified 14.1% of the patients as high risk compared to 4.5% identified by qSOFA (Figure 2). This concurs with the findings of the systematic review that showed qSOFA to have a poor positive predictive value and low sensitivity in identifying septic patients [20].

NEWS2 sensitivity for detecting sepsis was 82.61% compared to qSOFA, which was 43.47%. The specificity of NEWS2 and qSOFA was observed to be 86.6% and 95.91% respectively. Our findings are similar to the study carried out in an urban tertiary-care center, where NEWS2 was found to be the most accurate scoring system for the detection of sepsis. qSOFA was found to be the least sensitive and less useful in the ED setting for sepsis screening [28].

Biomarkers like pro-calcitonin serial levels have been advocated for risk stratification, prognostication and shorter treatment duration of sepsis [29]. However in our patient group, we found no statistically significant association between increased procalcitonin levels and the risk of sepsis. The unreliability of pro-calcitonin as a prognostic indicator has been observed in various other studies, indicating its limited significance as an independent variable. Additionally, preexisting conditions like chronic kidney disease may affect pro-calcitonin levels, leading to higher values at the baseline. It is probable that underlying comorbidities in our patient group may have influenced procalcitonin levels [30].

The definition of septic shock includes lactate concentrations > 2 mmol/L (> 18 mg/dL) making it an early blood test for suspecting sepsis [31]. Patients with higher lactate levels had a higher risk of dying during their hospital stay [32]. In contrast, our study revealed, no significant correlation with lactate levels in patients suspected of sepsis. This could be attributed to a very immunocompromised patient cohort with poor physiological reserves.

C-reactive protein (CRP) has high sensitivity in detecting sepsis especially in neonates [33]. Moreover, higher CRP levels were shown to be directly correlated with poor prognosis and higher risk of death [34]. We found a statistically significant proportion of our patients with elevated CRP levels (median level 11.2). However, in a study investigating the discriminative ability to predict bloodstream bacterial infection in adult ED patients, procalcitonin and lactate levels were shown to have better discriminative power in detecting sepsis than CRP at a cutoff of ≥0.8 mg/dL [35].

Blood culture positivity in sepsis patients has mixed results. Some studies show no difference and others report lower mortality in culture-negative sepsis. One study found no significant difference between the culture negative and the culture positive groups in relation to clinical severity [36]. Another study found 64.5% of sepsis patients were culture positive, with most pathogens isolated in the blood (36.4%), and lesser in the urine (20.4%) [37]. Our patients' cohort had a statistically significant correlation with blood culture positivity. Positive blood cultures help commence targeted antibiotic therapy, reducing the risk of developing microbial resistance and healthcare costs [29].

The role of platelets in the development and progression of sepsis has been the focus of some *in-vivo* studies. It was found that the severity and the duration of persistent thrombocytopenia is associated with worse outcomes. A study found 20%–58% of septic patients develop thrombocytopenia, denoting the importance of monitoring platelet levels in all septic patients. Thrombocytopenia has also been identified as a risk factor for mortality in sepsis; however, it is unknown whether low platelet count is the cause or consequence of sepsis severity [37,38]. Our study found a statistically significant proportion of sepsis suspected patients with reduced platelets levels.

The incidence of acute kidney injury in patients with septic shock is reported to be 40%–50% and is associated with an increase in mortality [39]. However, our study found a median creatinine levels of 75 mg/dL, which had no statistical significance.

Coagulopathy is a commonly reported complication of sepsis and plays a key role in multiple organ dysfunction. Studies also identified prothrombin time (PT) as a risk factor for 28-day sepsis mortality [40]. Our study did not reveal any significant correlation with PT or partial thromboplastin (PTT) time. We found that 0.4% of our study population was admitted to ICU and 0.1% of the patients were discharged. The remaining 99.5% of our patients were admitted to a standard hospital bed. In contrast, one study found that 13% of the admitted septic patients clinically deteriorated, necessitating ICU admission [41].

A study conducted in several hospitals in China found significant variability in different hospitals' ICU admission rates among septic patients, ranging from 4.1% to 61.2% [42]. Another study found 16.1% of patients with clinical sepsis were discharged from the ED. These patients were deemed to be low risk.

Limitations of the study

Our study has been conducted in a single tertiary care hospital with a specific patient group, hence the results cannot be generalised. A multicentre study will allow for a more representative sample. Furthermore, the study relied mainly on retrospective data, which can be of limited value. The inclusion criteria used in our study could have overestimated the number of sepsis patients.

Future directions

The results of our study can be used as a foundation for other centers in Saudi Arabia and worldwide to establish standardized criteria for predicting sepsis syndrome within an ED setting. We recommend AI should be incorporated in the early detection of sepsis. Prediction criteria can be electronically embedded, to generate an automated alert for patients with a constellation of symptoms and vital signs. This automation can result in the reduction of human delays/errors and potentially speed up the process of early detection and treatment of sepsis.

Conclusion

NEWS2 criteria was more sensitive but less specific in detecting sepsis compared to qSOFA in our ED. This could be due to the larger number of parameters employed by NEWS2, namely O2 saturation, pulse rate, and temperature. Our study found a significant portion of sepsis patients presented with decreased O2 saturation levels, increased pulse rate and increased temperature. These parameters allowed NEWS2 to more accurately predict the risk of sepsis. Patients with several comorbidities and immunocompromised systems can manifest sepsis atypically, hence the importance of clinical judgment to be used alongside any predictive criteria.

Conflicts of interest

The authors declare no conflicts of interest.

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