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The role of point of care ultrasound in diagnosis of patients with sepsis in comparison with sequential organ failure assessment score in emergency medicine department of Suez Canal University hospital

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Abstract---Background: The term "sepsis" refers to the life-threatening organ dysfunction that may result from an infection that has been amplified and then dysregulated by the body's immune system. Objective: To assess the role of Point of Care Ultrasound biomarker in evaluation of patient with sepsis in comparison with the Sequential Organ Failure Assessment (SOFA) score at emergency department in Suez Canal university hospital. Patients and Methods: A total of 42 patient were recruited to our study regarding inclusion

criteria using Q-SOFA score for assessing patients who were complaining of sepsis. While, regarding the diagnosis of sepsis SOFA score was calculated for each patient in the study to confirm their state, and POCUS algorithm was performed on each of them. We followed up them for 48 hours to assess the survived and non-survived patients. Results: The mean age of the patients was 63.45 ± 10.87 years. Females formed about 57% of the sample. The POCUS showed positive findings that helped in diagnosis among 57.14% of the patients and that there was a statistically significant higher total SOFA scores among patients with conclusive findings in POCUS (9.27 ± 2.19) in comparison to patients with a non-conclusive POCUS finding (6.34 ± 2.63). The dead patients had significantly higher total SOFA scores (10.36 ± 2.56) compared to survived patients (5.18 ± 2.72) ($p < 0.001$). Conclusions: POCUS is a crucial tool in the diagnosis and treatment of septic patients and potentially help to speed up the diagnosis and management process.

Keywords---sepsis, sequential organ failure assessment (SOFA), point of care ultrasound.

Introduction

Sepsis is a prevalent disease that affects emergency and intensive care units all around the world and is linked to significant morbidity and mortality. There is currently no specific treatment for sepsis, despite decades of intensive research. Early detection is crucial for sepsis treatment since it can dramatically enhance patient outcomes when the infection is eradicated promptly. ⁽¹⁾ The greatest ways to stop sepsis from progressing into septic shock are early diagnosis and treatment. Because clinical signs and symptoms of systemic inflammation are difficult to distinguish from those of noninfectious inflammation, it may be challenging to make a sepsis diagnosis. So clinical and laboratory parameters should be combined to diagnose sepsis⁽²⁾. The European Society of Intensive Care Medicine uses the Sequential Organ Failure Assessment (SOFA) score to measure organ dysfunction in sepsis-3 patients. This score is made up of clinical and laboratory parameters related to breathing, blood clotting, liver function, heart function, nervous system function, and kidney function. A SOFA score of 2 or more shows that an organ isn't working right. While septic shock is defined by the need for a vasopressor to keep mean arterial blood pressure at or above 65 mmHg or by serum lactate levels of more than 2 mmol/L in the absence of hypovolemia, septic shock can also be caused by a bacterial infection ⁽³⁾.

The SOFA score, on the other hand, is a straightforward but efficient way to describe organ dysfunction or failure in critically ill patients. Patient state and disease development can be tracked and better assessed with frequent, repeated scoring. Compared to Q-SOFA and SIRS criteria, the SOFA score is a more accurate predictor of organ failure and death among sepsis patients admitted to the ICU ⁽⁴⁾. In a variety of emergency department presentations, point-of-care ultrasound (POCUS) has established itself as a routine tool for the emergency physician. Extended focused assessment with sonography in trauma (eFAST) and

Rapid Ultrasound in Shock (RUSH) are two protocols that are currently established for management of trauma and shock respectively. ⁽⁵⁾.

It is clear that bedside ultrasound is an extremely valuable adjuvant for the diagnosis of many urgent and life-threatening illnesses. Emergency room doctors have started using this technology. Emergency physicians should employ limited bedside ultrasonography more frequently because it will boost patient care quality and diagnostic precision. On the other hand, one of the American College of Surgeons' five recommendations that choosed precisely in 2014 was to avoid routine whole body CT. ⁽⁶⁾. This study aimed to evaluate the role of Point of Care Ultrasound biomarker in assessment of patient with sepsis in comparison with Sequential Organ Failure Assessment (SOFA) score at emergency department in Suez Canal university hospital.

Patients and Methods

A cohort study that assessed the role of Point of care ultrasound (POCUS) levels in assessment of patient with sepsis in comparison to SOFA score in Suez Canal University Hospital during the period from November 2020 to April 2021. Included 42 patients who attended the Emergency Department (ED) at Suez Canal University Hospital and having Q-SOFA score ≥ 2 . Ethics approval came from the Faculty of Medicine Research Ethics Committee at Suez Canal University, in accordance with the Declaration of Helsinki. All patients were notified about the trial and provided signed consent, explaining the purpose, effects, technique, and complications. Data was collected in pre-organized data sheet by the researcher from 42 patients who fulfilled inclusion criteria all ages, both sexes were involved in the study. We selected the patients regarding Q-SOFA criteria, patient had at least two of Systolic arterial blood pressure (SBP) ≤ 100 mmHg, Respiratory rate (RR) > 21 breaths/min and Altered mental status (Glasgow Coma Scale (GCS) < 15). Exclusion criteria were; Post Cardiac arrest patients and traumatic patients.

Medical records were used to acquire demographic and clinical information. At baseline, available laboratory data such as hemograms, electrolytes, and renal function were obtained. The algorithmic approach of sepsis using POCUS was done for each patient and his result was compared with (his /her) SOFA score to evaluate the role of POCUS in sepsis diagnosis as follow:

- Exams were performed using a Siemens ACUSON NX2 Series Ultrasound system Envisor C Version C1.5 (Siemens, Henkestr, Germany), equipped with adult sectorial (L10`5v) and convex (Cs5`2) transducers.
- The result of POCUS examination was concluded as positive or negative examination, and if it was positive, a detailed comment of the affected system and it`s radiological finding was written in the patient`s data sheet.
- The result of patient`s POCUS examination was then compared with (his /her) SOFA score to evaluate the role of POCUS in sepsis managment.

Statistical analysis

The statistical program for social sciences (SPSS) for Windows 22.0 was used for all analyses (SPSS, Chicago, IL, USA). Continuous data were provided in the form

of mean standard deviation, whilst categorical data were presented in the form of frequencies and percentages. To examine data homogeneity, all variables exhibited skewed distributions, which the Kolmogorov-Smirnov (KS) test proved. The Mann-Whitney U test was used to evaluate continuous variables since the data were not regularly distributed. Spearman's correlation analysis was used to assess the correlations between continuous variables. Fisher's exact test and the chi-square test were used to assess categorical data statistically. The binary logistic regression analysis was used to explore the role of the variables studied (SOFA and Presepsin) in mortality prediction. P values of 0.05 or below were considered statistically significant.

Results

Table 1
Baseline characteristics of the studied patients

Variable	n= 42
Age (years), mean \pm SD	63.45 \pm 10.87
Gender, n (%)	
Male	18 (42.9)
Female	24 (57.1)
Residency, n (%)	
Urban	12 (28.6)
Rural	30 (71.4)
Complaint, n (%)	
Disturbed level of consciousness	37 (88.1)
Shock	33 (78.6)
Fever	29 (69)
Dyspnea	24 (57.1)
Turbid urine + dysuria	5 (11.9)
Comorbidities, n (%)	
Diabetes mellitus	39 (92.9)
Hypertension	29 (70)
Ischemic heart disease	12 (28.6)
Chronic liver disease	5 (11.9)
Chronic kidney disease	5 (11.9)
History of previous infection, n (%)	
Absent	12 (28.6)
Present	30 (71.4)
Antibiotic therapy, n (%)	
Administered	17 (40.5)
Not administered	25 (59.5)

Table1; showed summarizes the baseline characteristics of the studied patients. The mean age of the patients was 63.45 \pm 10.87 years. Females formed about 57% of the sample. The most frequent presentations of the patients were confusion (88.1%), shock (78.6%) and fever (69%). Meanwhile, the most prevalent comorbidities were DM (92.9%) and hypertension (70%).

Table 2
Outcome measures among the studied patients

Variable	n= 42
Total Q-SOFA score	
mean \pm SD	2.31 \pm 0.47
median (range)	2 (2 – 3)
Total SOFA score	
mean \pm SD	8.26 \pm 3.66
median (range)	8.5 (2 – 15)

Table 2: shows that the mean total Q-SOFA score was 2.31 \pm 0.47 points, while the mean total SOFA score was 8.26 \pm 3.66 points.

Table 3
Diagnostic tools used among our study patients

Variable	n= 42
Final diagnosis (Based on POCUS, CT scan and culture)	
Infected bed sores	13 (31)
Septic shock (of unidentified origin)	8 (19)
Urinary tract infection	6 (14.3)
Diabetic foot infection	4 (9.5)
Necrotizing fasciitis	3 (7.1)
Lower respiratory tract infection	3 (7.1)
Perforated viscus + peritonitis	2 (4.8)
Acute cholecystitis	1 (2.4)
Iliopsoas abscess	1 (2.4)
Osteomyelitis	1 (2.4)
Role of POCUS in aid the diagnosis, n (%)	
Conclusive	24 (57.14)
Non-conclusive	18 (42.85)

Table 3: shows that the most frequent source of sepsis was infected bed sores (31%), followed by septic shock of unidentified origin (19%) then Urinary tract infection (UTI). Both necrotizing fasciitis and pneumonia formed about 7%. The POCUS showed positive findings that help in diagnosis among 57.14% of the patients.

Table 4
Comparison between role of POCUS in aid diagnosis with patient's Q-SOFA and total SOFA scores

Variables	Role of POCUS in aid the diagnosis		
	Conclusive (n=24)	Non- Conclusive (n=18)	p-value
Q-SOFA	2.21 \pm 0.42	2.37 \pm 0.39	0.22 ^a
total SOFA	9.27 \pm 2.19	6.34 \pm 2.63	0.04 ^a

^a P values are based on Mann-Whitney U test. Statistical significance at P < .05

Table 4: shows that there was a statistically significant higher total SOFA scores among patients with conclusive findings in POCUS (9.27 ± 2.19) in comparison to patients with a non-conclusive POCUS finding (6.34 ± 2.63), while there was no statistically significant association between POCUS findings and Q-SOFA score.

Table 5
Comparison between survived and died patients in regard to their SOFA score and POCUS diagnosis

Variables	Survived (n=17)	Died (n=25)	p-value
Quick SOFA			
mean ± SD	2.18 ± 0.39	2.4 ± 0.5	0.129 ^a
median (range)	2 (2 – 3)	2 (2 – 3)	
Total SOFA			
mean ± SD	5.18 ± 2.72	10.36 ± 2.56	<0.001 ^a
median (range)	5 (2 – 12)	10 (6 – 15)	
Role of POCUS in aid the diagnosis, n (%)			
Conclusive (n=24)	13 (76.4)	11 (44)	0.7 ^b
Non-conclusive (n=18)	4 (23.5)	14 (56)	
^a P values are based on Mann-Whitney U test. Statistical significance at P < .05			
^b P values are based on Chi-square U test. Statistical significance at P < .05			

Table 5: shows that died patients had significantly higher total SOFA score (10.36 ± 2.56) compared to survived patients (5.18 ± 2.72) (p<0.001). However, there was no significant difference between the two groups in regard to their quick SOFA score (p=0.129) and their POCUS final diagnosis (p=0.7).

Discussion

The mean age of the patients was 63.45 ± 10.87 years, and this is owing to that the risk of sepsis is bimodal distribution which increased in infants (particularly those preterm) and is reduced in the rest of childhood and is increased again beyond 50–60 years of age⁽⁷⁾. (Table 1). The present study denoted that sepsis was prevalent in females more than males (57% vs 42.9%) respectively. (Table 1). We also denoted that sepsis was prevalent among patients from rural area more than those from urban area (71.4% vs 28.6%) respectively. (Table 1). Possible explanations include late access to healthcare, and lack of immunizations among rural areas, also poverty level and hospital standard effect are important risk factor for sepsis⁽⁸⁾.

The current study showed that the most frequent presentations of the patients were confusion (88.1%), shock (78.6%) and fever (69%). Meanwhile, the most prevalent comorbidities were DM (92.9%) and hypertension (70%). (Table 1). Which is agreed with Czempik and Pluta, s their study demonstrated that the most prevalent form of encephalopathy in critically ill individuals is sepsis-

associated brain dysfunction (SABD). The most common organ deficiency related to sepsis is SABD, which can occur in up to 70% of septic patients. (9). Concerning to the frequency of sepsis sources among the studied patients, our study had clarified that the most frequent source of sepsis was infected bed sores (31%), followed by septic shock of unidentified origin (19%) then Urinary tract infection. Both necrotizing fasciitis and pneumonia formed about 7%. (Table 3). According to a nine-year research conducted by D. Chou and S. Mann, the two infections with the sharpest yearly increases among sepsis patients were skin and skin structure infections (annual increase: 23.0 percent) and musculoskeletal infections (annual increase: 34.2%) (10).

On the other hand, an eleven-year study period was conducted by Chen, et al, had stressed that the most frequent cause of sepsis in patients, as well as the one with the greatest fatality rate, is a lower respiratory tract infection. The rate of advancement for genitourinary tract infection incidence is the quickest(11). This difference may be subjected to neglected care of bed ridden patients as our hospital is deficient of geriatric care department, and also due to insufficient places in Suez Canal university stroke unite. On spot of the role of POCUS in diagnosis the source of patient sepsis using POCUS algorithmic approach, the study had concluded that POCUS had achieved the accurate source of infection in 57% of the study population, while only 18 patients were not diagnosed using POCUS. This was very helpful in rapid diagnosis and in the definitive management of septic patients (Table 3)

This is agreed upon by Cortellaro et al., whose study's objective was to ascertain how precisely point-of-care ultrasonography could identify the infection site in septic patients. Their research revealed that POCUS-implemented diagnosis had a sensitivity of 73 percent (95 percent CI 66-79 percent), a specificity of 95 percent (95 percent CI 77-99 percent), and an accuracy of 75 percent, making it useful for locating the infection's source and cutting down on the amount of time it takes to diagnose.. (12). This was also affirmed by Pontet et al, as their analysis revealed that in critically ill patients during their first week of ICU admission, systematic application of POCUS facilitates early diagnosis and may reduce consumption of conventional diagnostic imaging resources and time spent on mechanical ventilation. (13).

Moreover, the study also highlighted that there was a statistically significant higher total SOFA scores among patients with conclusive findings in POCUS (9.27 ± 2.19) in comparison to patients a non-conclusive POCUS finding (6.34 ± 2.63). On other hands there was no statistically significant association between POCUS findings and qSOFA score. (Table 4). This is supported by research by Xie et al., who examined the relationship between point-of-care ultrasound and its assessment of severity and prognosis in ARDS patients. Their findings revealed that at each time point (0 h, 24 h, 48 h, and 72 h), the lung ultrasonography in the death group was higher than in the survival group (all $P < 0.05$). Noting that although the LUS of the survivors showed a significant decline over time, that of the death group showed a significant rise over time (all $P < 0.05$) (14).

The current study shows that died patients had highly significant higher SOFA score (10.36 ± 2.56) compared to survived patients (5.18 ± 2.72) ($p < 0.001$).

However, there was no significant difference between the two groups regarding quick SOFA score ($p=0.129$). (Table 5). This finding is conceded with Li et al, as their study granted that SOFA score have higher accuracy than q-SOFA score in predicting the prognosis of mortality in septic patients as follow respectively, AUC was 0.630 (0.621, 0.640) for SOFA, 0.551 (0.541, 0.560) for qSOFA, AUC-SOFA vs. AUC-qSOFA was 0.079 (0.065, 0.094) ($P<0.001$)⁽¹⁵⁾.

As SOFA core is based on the new definition of sepsis-3 and involved vital signs and laboratory tests that early deteriorates in septic shock and also it reflects accurately the clinical course of the disease⁽¹⁶⁾. The current study also justified that among patients who had conclusive POCUS exam survival rates are higher than mortality rates (54% vs 46%) respectively. (Table 5). This is conceded with Chen et al, as their study attempted to examine whether the routine incorporation of POCUS during morning rounds improved the clinical outcomes in critically ill- patients. Their findings showed that this practise was associated with a lower risk of prolonged (>7 days) ICU stays (OR: 0.39, 95 percent CI: 0.29-0.88; $p = 0.029$).⁽¹⁷⁾.

Conclusion

POCUS is a crucial tool for the diagnosis and treatment of septic patients, and it has the potential to speed up the diagnosis process and direct treatment decisions.

We recommended

- Integration of POCUS in emergency room is crucial as it has come to perform a major role in the practice of emergency medicine. With a broad scope of application: Resuscitative, Diagnostic, Procedural, Therapeutic and Monitoring of management plane
- Managing the following as potential key obstacles for POCUS incroporation in management plane : a lack of necessary tools, training, money, assurance of product quality, and the inability to keep up with necessary skill maintenance.
- Developing telesonography training for rural physicians as a viable solution, extending financing for POCUS instruction to practicing ER physicians, expanding residency education in ultrasound capabilities, and transferring POCUS education courses to remote locales.

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