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The Quick Sequential Organ Failure Assessment (qSOFA) Score is a Poor Mortality Predictor in Patients with Complicated Intra-abdominal Infections

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Abstract

BACKGROUND: Despite the evolution in surgical treatment and antimicrobial therapy in the last years the complicated intra-abdominal infections (cIAIs) are still associated with high morbidity and mortality. Different scoring systems are already available for early prognostic evaluation and yet none has been widely accepted.

AIM: Our aim was to evaluate the prognostic accuracy of quick sequential organ failure assessment (qSOFA), one of the most recent scores, in patients with cIAIs.

MATERIALS AND METHODS: We studied retrospectively 110 patients with cIAIs admitted to the Department of Surgical Diseases (DSD) at University Hospital "Prof. Dr. Stoyan Kirkovich" Stara Zagora from January 2017 to July 2019. Area under receiver operating characteristics (AUROC) curves of systemic inflammatory response syndrome (SIRS), qSOFA, and Mannheim Peritonitis Index (MPI) were analyzed and a comparison of ROC curves was performed to explore their prognostic performance.

RESULTS: Twenty-five (22.7%) patients died during hospitalization. qSOFA score showed poor prognostic accuracy (AUROC = 0.698, 95% CI = 0.566–0.829), worse than MPI score (AUROC = 0.698 vs. 0.844), but better than SIRS (AUROC = 0.698 vs. 0.583). The qSOFA score ≥2 points was observed with lack of sensitivity (32.0%) as outcome predictor. ROC curve analysis showed prognostic inferiority of qSOFA compared to MPI (difference between areas = 0.146, p = 0.0232).

CONCLUSION: In patients with cIAIs, quick-SOFA score was observed with poor prognostic performance.

Introduction

At the beginning of 21st century complicated intra-abdominal infections (cIAIs) are still associated with unacceptably high mortality rates. In intensive care units (ICUs) they hold the second place after pneumonia as infectious cause of death [1]. Nowadays, more than 20% of sepsis in ICUs is a result of cIAIs [1].

cIAIs spread beyond the affected organ into the peritoneal cavity, which results in localized or diffuse peritonitis [2] and usually they are accompanied with sepsis. Sepsis is defined as a life-threatening organ dysfunction based on dysregulated host response to infection [3].

Early prognostic evaluation and appropriate treatment of patients with cIAIs are crucial for the final outcome. Various scoring systems have been applied over the years; so far however no score has shown enough prognostic accuracy in everyday practice. Most of the scoring systems are complex and difficult to calculate, require many clinical and laboratory measurements, and are used rarely outside of ICUs. One of the most recent and least investigated prognostic scores is quick sequential organ failure assessment score (qSOFA). It is very easy to calculate based on only three clinical parameters at admission. qSOFA score was introduced by Sepsis-3 definitions task force [3] as prognostic tool that can promptly identify at the bedside patients with suspected infection who are likely to have a prolonged ICU stay or high risk for unfavorable outcome. qSOFA score was found superior to previous sepsis criteria for outcome prediction – in the emergency department (ED) [4], [5] and in patients with suspected infection outside ICU [6].

However, qSOFA showed lack of sensitivity as outcome predictor in several studies. Low sensitivity was observed in septic patients from Medical Admission Unit [7], in patients with acute infectious diseases [8], and in patients with infection presented to ED [9].

The insufficient data about the predictive value of qSOFA in patients with cIAIs and the increasing alert of its poor performance as mortality predictor in different clinical settings led us to the decision to evaluate the prognostic accuracy of qSOFA in surgical patients with cIAIs.

Materials and Methods

Design and participants

This retrospective study was performed in the Department of Surgical Diseases at University Hospital "Prof. Dr. Stoyan Kirkovich" Stara Zagora. The medical records of 110 adult patients admitted to DSD from the ED who required emergency surgery for cIAIs from January 2017 to July 2019 were reviewed. None of the patients were suitable for percutaneous drainage or any other method of non-operative treatment. For this time interval, the admitted patients with diagnosis cIAIs were 131. Missing data about some clinical parameters were found in 18 patients, two patients died preoperatively, and one was under 18 years old. Finally, 110 patients were included in the study.

Data collection

We collected laboratory measurements, clinical information, clinical outcomes, and demographic data from hospital medical records of the studied patients.

Scoring systems

The quick-SOFA score includes three criteria – a systolic blood pressure (SBP) ≤100 mm Hg, a respiratory rate (RR) ≥22 breaths/min, and a Glasgow Coma Scale (GCS) <15. A positive qSOFA score is ≥2 out of 3 points [3]. Systemic inflammatory response syndrome (SIRS) includes four criteria – a heart rate >90/min, a tachypnea >20/min, a temperature <36°C or >38°C, and leukocytes count <4000/mm^3 or >12,000/mm^3. Positive SIRS is defined as ≥2 out of four signs [10]. SIRS and qSOFA were calculated based on patients' clinical data at admission. Mannheim Peritonitis Index (MPI) was calculated based on eight clinical parameters postoperatively [11] (Table 1).

Table 1: MPI (0–47 score)

Risk factor	Points
Age >50 years	5
Female	5
Organ failure	7
Malignancy	4
Preoperatively duration of peritonitis >24 h	4
Origin of sepsis non-colonic	4
Diffuse peritonitis	6
Exudate	
Clear	0
Purulent	6
Fecal	12

Statistical analysis

Sensitivity and specificity analysis and area under receiver operating characteristics (AUROC) for outcome prediction were evaluated for each score. De Long's method was used for comparison of the ROC curves. We evaluated the association between scoring systems and clinical outcome using bivariate correlation analysis and Spearman correlation coefficient. Continuous variables were expressed as mean (SD) or median (range) and categorical variables were expressed as frequency (%). Comparisons were made by Mann–Whitney U-test or Student's t-test for continuous variables and by Chi-square test or Fisher exact test for categorical variables. $p < 0.05$ was considered statistically significant. Statistical analysis was performed using SPSS Statistics 19.0 (IBM, Chicago, Illinois, USA) and MedCalc 14.8.1 (MedCalc Software, Ostend, Belgium).

Results

Patients characteristics

Of the total of 110 patients, 25 (22.7%) died in hospital. Their average age was higher than survivors (74.80 ± 12.64 vs. 56.84 ± 18.89, $p < 0.0001$). Significant differences between non-survivors and survivors were found according to the spread ($p = 0.016$) and site of infection ($p = 0.041$), exudate ($p = 0.007$), presence of chronic renal failure ($p = 0.004$), and malignancy ($p = 0.002$). We observed no significance according to gender ($p = 0.693$), presence of arterial hypertension ($p = 0.353$), and diabetes ($p = 1.00$) (Table 2).

Clinical parameters and scoring systems

Eleven patients (10.0%) had GCS <15 at admission, only one survived ($p < 0.0001$). Tachypnea ≥22/min was found in 19 patients (17.3%), nine died ($p = 0.013$). Twenty-one patients (19.1%) had SBP ≤ 100 mmHg, nine died ($p = 0.021$). Thirty-four patients had heart rate >90/min, and 12 of them were non-survivors ($p = 0.035$). A positive SIRS showed no significant prognostic value ($p = 0.172$). The qSOFA score in survivors and non-survivors differs significantly ($p < 0.0001$). Eleven patients (10.0%) had qSOFA ≥2 and only three of them survived ($p < 0.0001$). Non-survivors had higher MPI score than survivors (30[26–35.5] vs. 21[16-25]). Eighty percent of non-survivors had MPI >25 points ($p < 0.0001$) (Table 3).

Sensitivity, Specificity, and AUROCs

Among the surveyed scores, we found SIRS as the worst mortality predictor (AUROC = 0.583, 95% CI = 0.447–0.720), qSOFA showed better predictive performance (AUROC = 0.698, 95% CI = 0.566–0.829), and MPI score was observed with the best prognostic value (AUROC = 0.844, 95% CI = 0.763–0.924) (Figure 1). The identified sensitivity and specificity for MPI threshold >25 points were 80.0% and 77.6%, for qSOFA higher or equal to 2 points – 32.0% and 96.5%, and for SIRS higher or equal to 2 points – 40.0% and 70.6%, respectively (Table 4).

Table 2: Patients characteristics

Variable	Total population	Survivors (n=85)	Non-survivors (n=25)	p-value
Age, years±SD	60.92±19.17	56.84±18.89	74.80±12.64	<0.0001
Sex, n (%) male/female	61 (55.5)/49 (45.5)	48 (78.7)/37 (75.5)	13 (21.3)/12 (24.5)	0.693
Site, n (%)				
Appendix	27 (24.5)	25 (29.4)	2 (8.0)	0.041
Gallbladder	26 (23.6)	20 (23.5)	6 (24.0)	
Stomach/duodenum	24 (21.8)	18 (21.2)	6 (24.0)	
Large bowel	18 (16.4)	10 (11.8)	8 (32.0)	
Small bowel	2 (18.0)	1 (1.2)	1 (4.0)	
Gynecological	7 (6.4)	7 (8.2)	0 (0)	
Other	6 (5.5)	4 (4.7)	2 (8.0)	
Spread, n (%)				
Local peritonitis	40 (36.4)	36 (42.4)	4 (16.0)	0.016
Diffuse peritonitis	70 (63.6)	49 (57.6)	21 (84.0)	
Exudate, n (%)				
Clear	21 (19.1)	19 (22.4)	2 (8.0)	0.007
Purulent	84 (76.4)	65 (76.5)	19 (76.0)	
Fecal	5 (4.5)	1 (1.2)	4 (16.0)	
Comorbidity, n (%)				
Diabetes	13 (11.8)	10 (11.8)	3 (12.0)	1.000
Hypertension	44 (40.0)	32 (37.6)	12 (48.0)	0.353
Malignancy	16 (14.5)	7 (8.2)	9 (36.0)	0.002
Chronic renal failure	9 (8.2)	3 (3.5)	6 (24.0)	0.004

Table 3: Clinical parameters and scoring systems

Variable	Total population	Survivors (n=85)	Non-survivors (n=25)	p-value
SBP ≤100 mmHg, n (%)	21 (19.1)	12 (14.1)	9 (36.0)	0.021
Heart rate >90/min, n (%)	34 (30.9)	22 (25.9)	12 (48.0)	0.035
RR ≥22/min, n (%)	19 (17.3)	10 (11.8)	9 (36.0)	0.013
GCS <15, n (%)	11 (10.0)	1 (1.2)	10 (40.0)	<0.0001
SIRS, n (%)	36 (32.7)	25 (29.4)	11 (44.0)	0.172
qSOFA ≥2, n (%)	11 (10.0)	3 (3.5)	8 (32.0)	<0.0001
qSOFA, n (%)				
0	77 (70.0)	66 (77.6)	11 (44.0)	<0.0001
1	22 (20.0)	16 (18.8)	6 (24.0)	
2	6 (5.5)	3 (3.5)	3 (12.0)	
3	5 (4.5)	0 (0)	5 (20.0)	
MPI, points (IQR)	21 (18.8–30)	21 (16–25)	30 (26–35.5)	<0.0001
MPI >25, n (%)	39 (35.5)	19 (22.4)	20 (80.0)	<0.0001

MPI: Mannheim Peritonitis Index, qSOFA: Quick sequential organ failure assessment, SIRS: Systemic inflammatory response syndrome, SBP: Systolic blood pressure, RR: Respiratory rate, GCS: Glasgow Coma Scale.

Using pairwise comparison analysis of ROC curves, we found significant differences between scores. The MPI showed prognostic superiority than SIRS (difference between areas = 0.260, 95% CI = 0.109–0.412, p = 0.0008) and qSOFA (difference between areas = 0.146, 95% CI = 0.0199–0.272, p = 0.0232). qSOFA was better outcome predictor than SIRS (difference between areas = 0.114, 95% CI = 0.0249–0.226, p = 0.0451) (Table 5).

Table 4: Sensitivity, specificity, and AUROCs

Variable	Sensitivity, %	Specificity, %	AUROC
SIRS ≥2	40.0	70.6	0.583 (0.447–0.720)
qSOFA ≥2	32.0	96.5	0.698 (0.566–0.829)
MPI >25	80.0	77.6	0.844 (0.763–0.924)

AUROC: Area under receiver operating characteristic, MPI: Mannheim Peritonitis Index, qSOFA: Quick sequential organ failure assessment, SIRS: Systemic inflammatory response syndrome.

Correlations

We found weak correlation between qSOFA and outcome (r = 0.356, p < 0.0001), moderate correlation between MPI and outcome (r = 0.500, p < 0.0001), and very weak correlation with no significance between SIRS and outcome (r = 0.128, p = 0.181) (Table 6).

Discussion

The enormous diversity of patient groups affected by cIAIs makes the recommendation of a general treatment algorithm not an easy task. By predicting the outcome of each patient with cIAI, there has to be considered a wide range of unfavorable factors such as poor nutrition, immunosuppression, nosocomial pathogens, pre-existing diseases, advanced age, diffuse peritonitis, delayed treatment, septic shock, organ failures, and poor source control [12].

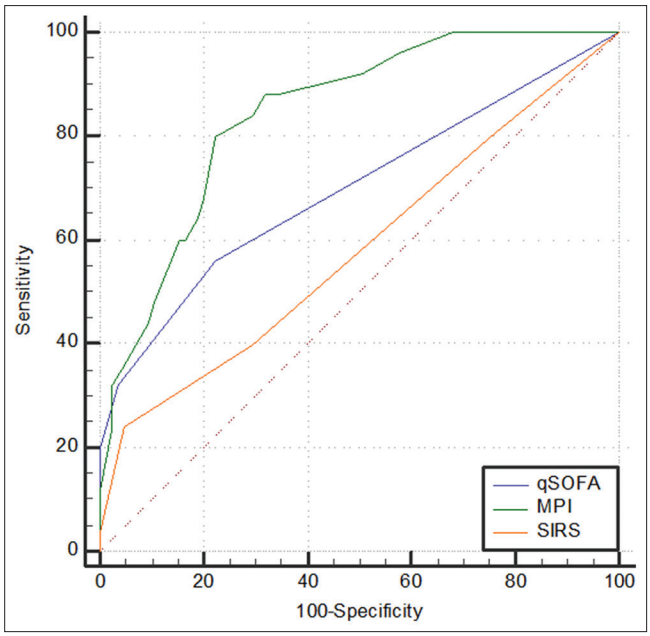

Figure 1: Comparison of ROC curves

Table 5: Pairwise comparison of ROC curves

Comparison criteria	MPI ~ qSOFA	qSOFA ~ SIRS	MPI ~ SIRS
Difference between areas	0.146	0.114	0.260
Standard Error[c]	0.0643	0.0571	0.0772
95% CI	0.0199-0.272	0.0249-0.226	0.109-0.412
Significance	p=0.0232	p=0.0451	p=0.0008

MPI: Mannheim Peritonitis Index, qSOFA: Quick sequential organ failure assessment, SIRS: Systemic inflammatory response syndrome.

Despite the identical conservative and surgical management some patients' populations distinguish with a high mortality rates. Nevertheless, early prognosis and timely therapy in these patients enhance the chances of favorable outcome [13]. All these facts indicate the necessity of significant methods that could contribute for early prognostic assessment and determine the aggressiveness of treatment regimens. A

large number of researchers are still trying to deal with these problems focusing on the predictive reliability of different prognostic scoring systems.

Table 6: Correlations

Outcome	qSOFA	SIRS	MPI
Correlation coefficient	r=0.356	r=0.128	r=0.500
Significance	p<0.0001	p=0.181	p<0.0001

MPI: Mannheim Peritonitis Index, qSOFA: Quick sequential organ failure assessment, SIRS: Systemic inflammatory response syndrome.

One of these scoring systems, the full SOFA (fSOFA) score showed reliable characteristics over the years and nowadays it is a part of the new SEPSIS 3 DEFINITIONS [3]. This score showed better prognostic accuracy than SIRS or qSOFA in adult patients with suspected infection admitted to ICU [14].

However, fSOFA is not a simple score – it needs numerous clinical and laboratory measurements for calculation; moreover, outside ICUs in everyday practice this score is hardly used. As simplified version of fSOFA, Sepsis-3 Group introduced qSOFA score – for easier identification of ED patients with infection and higher risk of death.

However, in cIAIs qSOFA showed low sensitivity as prognostic score. Only two authors (to the best of our knowledge) explored prognostic value of qSOFA score in surgical patients exclusively. Jung *et al*. [15] investigated qSOFA score in 457 surgical patients with cIAIs. Authors observed sensitivity of 46% for qSOFA ≥2 as outcome predictor. The second study with surgical patients of Raimondo *et al*. [16] reported even worse sensitivity – only 14.3%. We also observed low sensitivity of qSOFA as mortality predictor – 32%.

Jiang *et al*. [17] in their meta-analysis identified lack of sensitivity (42%) of this score in ED patients with infection.

Various studies with non-surgical patients presented to ED showed higher sensitivity of qSOFA. The highest sensitivity of qSOFA ≥2–90% was found in the study of Finkelsztein *et al*. [6] with non-critically ill patients. A sensitivity of 70% for qSOFA ≥2 was reported by Freund *et al*. [4] in ED patients with suspected infection. Osatnik *et al*. [5] observed in their study sensitivity of 63.6%.

Although its limitations, qSOFA score has one serious advantage – a perfect ability to recognize the patients who will survive – the observed specificity for qSOFA ≥2 in our study was 96.5%; the other two studies with surgical patients with cIAIs showed also very high specificity – 86% Jung *et al*. [15] and 98.3% Raimondo *et al*. [16]. A meta-analysis [17] from 2018 with infected patients from ED reported also very high specificity of 88% for outcome prediction.

We made an interesting observation in the present study – a change in patient mental status is strongly associated with fatal outcome. Of the total of eleven patients with GCS <15, ten died (p < 0.0001) and they represented 40% of non-survivors. Perhaps the altered mental status may represent an important factor for early prognosis in patients with cIAIs. Unlike our study, Jung *et al*. [15] observed that only 4 out of 15 patients with GCS < 15 were non-survivors. The observations of Freund *et al*. [4] were similar to our results – 56% of ED patients with altered mental status died.

In our study, qSOFA showed poor prognostic value (AUROC = 0.698). The other two studies with surgical patients reported also not good prognostic accuracy of qSOFA – Jung *et al*. [15] (AUROC = 0.717) and Raimondo *et al*. [16] (AUROC = 0.722). Osatnik *et al*. [5] in patients admitted to the ED with suspected infection observed similar prognostic performance of qSOFA (AUROC = 0.71).

Good prognostic performance was established by Freund *et al*. [4] in other study with ED patients – AUROC = 0.80.

All of the performed statistical analyses in the present study showed prognostic inferiority of qSOFA compared to MPI, one of the oldest scores for mortality prediction in patients with acute peritonitis. ROC curve analysis revealed better prognostic value of MPI (AUROC = 0.844) compared to qSOFA (AUROC = 0.698). The pairwise comparison of ROC curves of MPI and qSOFA scores revealed prognostic superiority of MPI (difference between areas = 0.146, p = 0.0232). The bivariate correlation analysis pointed weak correlation between qSOFA and outcome (r = 0.356) and stronger correlation between MPI and outcome (r = 0.500). No other study (to the best of our knowledge) investigated correlations between qSOFA, MPI and outcome and compared prognostic values of both scores in patients with cIAI.

Limitations

The present study has several limitations. First of all, it was a retrospective study. The investigated sample size was small. Other important limitation is that this was a single-center trial.

Conclusion

In patients with cIAIs qSOFA score showed poor prognostic performance. Although its simplicity, easy calculation and high specificity this score could not recognize nearly two-third of the patients with higher risk of death. Maybe it is time to announce the uselessness of qSOFA as prognostic score in patients with cIAIs and to pay attention to other scoring systems.

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