Journal of Trauma and Acute Care Surgery, Publish Ahead of Print
DOI: 10.1097/TA.0000000000003742

Performance of quick sequential organ failure assessment (qSOFA) and modified age disease adjusted qadSOFA for the prediction of outcomes in emergency general surgery patients

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Disclosure / Conflict of interest statement: All authors have no conflicts of interest or financial ties to disclose. No funding was received for this study.

Authors' contributions: CTJM: data analysis, data interpretation, writing, literature review, drafting, critical revision; TH: data analysis, data interpretation, drafting, critical revision; JBD: data collection, drafting, critical revision; AO: data collection, drafting, critical revision; Winterhalder S: data collection, drafting, critical revision; DC: data interpretation, drafting, critical revision; BS: study design, data interpretation, writing, drafting, critical revision

Disclosure of Meetings: Part of the results were presented and awarded with the 1st SwissACS Prize for the best abstract at the '11th Swiss Trauma & Acute Care Surgery Days 2022', March 11th, 2022, at the Inselspital, Bern University Hospital, Bern, Switzerland

Disclosure of funding: No funding was received for this study.

Social media information: This is the first study investigating the qSOFA as a predictor for clinical outcomes in EGS. A new modified qSOFA (qadSOFA) was developed. The area under the ROC curve (AUROC) of the qSOFA and qadSOFA for mortality was 0.715 and 0.859, respectively with an optimal cut-off value identified as qadSOFA≥3.

Hashtags: #emergencygeneralsurgery, #qSOFA, #qadSOFA

Abstract

Background

Sepsis is a highly prevalent condition disease and is associated with a reported in-hospital mortality rate up to 40% in patients with abdominal sepsis requiring emergency general surgery (EGS). The quick sequential organ failure assessment score (qSOFA) has not been studied for EGS patients.

Methods

Retrospective cohort study in adult patients undergoing abdominal EGS at a university tertiary care center from 2016 to 2018. The primary outcome was mortality. The effect of clinical variables on outcomes was assessed in univariable and multivariable logistic regression analyses. Based on these results, the qSOFA score was modified. The performance of scores was assessed using receiver operating characteristics (ROC).

Results

578 patients undergoing abdominal EGS were included. In-hospital mortality was 4.8% (28/578). Independent predictors for mortality were mesenteric ischemia [OR 15.9 (95%CI 5.2-48.6), *p*-value<0.001], gastrointestinal tract perforation [OR 4.9 (95%CI 1.7-14.0), *p*-value=0.003], age≥65years [OR 4.1 (95%CI 1.5-11.4), *p*-value=0.008] and increasing qSOFA [OR 1.8 (95%CI 1.2-2.8), *p*-value=0.007]. The modified qSOFA (qadSOFA) was developed. The area under the ROC curve (AUROC) of the qSOFA and qadSOFA for mortality was 0.715 and 0.859, respectively. Optimal cut-off value was identified as qadSOFA≥3 (Youden Index 64.1%).

Conclusions

This is the first study investigating the qSOFA as a predictor for clinical outcomes in EGS. Compared to the qSOFA, the new qadSOFA revealed an excellent predictive power for clinical outcomes. Further validation of qadSOFA is warranted.

Level of Evidence: Level II, diagnostic test/criteria

Keywords: emergency general surgery (EGS); quick sequential organ failure assessment (qSOFA) score; quick age disease sequential organ failure assessment (qadSOFA) score; sepsis; mortality

BACKGROUND

Sepsis is a highly prevalent condition and is associated with a 10 to 20% in-hospital mortality rate, exceeding up to 30-40% in patients with abdominal sepsis requiring surgery[1–6]. In this group of patients, adequate preoperative prediction of outcomes is crucial for the acute decision making[7].

In 2016, the quick sequential (sepsis-related) organ failure assessment score (qSOFA) was introduced[8]. The qSOFA includes three criteria with a maximum of 3 points: altered mentation (Glasgow coma scale ≤14), hypotension (systolic blood pressure ≤100mmHg), and tachypnea (respiratory rate ≥22/min). The original SOFA grades the abnormality by organ system and takes into account respiration (PaO2/FiO2), coagulation (platelets), liver (bilirubin), cardiovascular (vasopressor dosage), altered mentation (Glasgow coma scale) and renal (creatinine or urine output). The advantage of the qSOFA is given by its simplicity – particularly in situations and conditions where not all components of the SOFA are available, such as in an Emergency Department (ED) or on the surgical ward. Several studies have investigated the predictive value of the SOFA and qSOFA in various groups of patients with conflicting results regarding prognostic value (e.g. area under the receiving operator curve for mortality in suspected infection SOFA 0.79 [95%CI 0.78-0.80) vs. qSOFA 0.81 [95%CI 0.80-0.82]) [1,2,16–20,8–15]. Currently, the 2021 surviving sepsis campaign advocated against the use of qSOFA as a single screening tool due to the poor sensitivity[21].

However, the usefulness of the qSOFA for patients requiring emergency general surgery (EGS) for acute abdominal diseases specifically has not been studied so far. Moreover, a recent international multi-society consensus guideline does not provide a clinically applicable pathway on how to early identify EGS patients at risk for sepsis[7].

The aim of this study was (1) to assess the accuracy of the qSOFA to predict in-hospital mortality and the need for higher level of care [intensive care unit (ICU) admission and the need for mechanical ventilation] and (2) to improve the score regarding the prognostic value in patients undergoing abdominal EGS. We hypothesized that the predictive power of the qSOFA is (1) of limited predictive value in an EGS population and (2) can be improved by modifying the score using the specific characteristics of the investigated patient population.

METHODS

This retrospective cohort study including adult patients undergoing abdominal EGS at a tertiary hospital looking at the performance of the qSOFA in predicting clinical outcomes and aiming to improve the discriminatory power of the score. The study has been approved by the local ethics committee (Project BASEC-ID 2019-02338).

Data Collection

Adult patients (age ≥18 years) undergoing EGS for mesenteric ischemia, GIT perforation, bowel obstruction, cholecystitis, appendicitis, or incarcerated hernia at a tertiary university hospital, between January 1, 2016, and December 31, 2018, were retrospectively included. Patients with documented objection to general consent, other surgical interventions (e.g. non-traumatic bleeding, pancreatic necrosectomy, malignancy) or incomplete data were excluded. Patient demographics, disease, treatment and outcome variables were extracted from electronic medical records. The qSOFA on admission to the ED was calculated according the Sepsis-3 guideline[8] including following criteria: systolic blood pressure ≤100mmHg (1 point), respiration rate ≥22 breaths per minutes (1 point), and altered mentation defined as decreased neurology as Glasgow coma scale (GCS) ≤14 (1 point).

Definitions

Gastrointestinal (GIT) perforation was defined as gastric or duodenal perforation, small/large bowel perforation, or anastomotic leakage. Bowel obstruction included small or large bowel obstruction. The diagnosis of mesenteric ischemia (MI) was based on intraoperative confirmation of findings. In case of bowel perforation due to an incarcerated hernia, the patient was categorized to the GIT perforation subgroup. Significant morbidity was defined as a complication requiring at least a surgical, endoscopic or radiological intervention, corresponding to a Dindo-Clavien classification of ≥3a[22,23].

Outcomes

The primary goal of this study was to assess the predictive power of the qSOFA score for clinical primary outcome consisting of in-hospital mortality and secondary outcomes including ICU admission, and necessity of mechanical ventilation. The secondary goal was to improve the discriminatory power qSOFA score based on the specific characteristics of this patient population.

Statistical Analysis

Categorical variables were reported as numbers and percentages, continuous variables as medians and interquartile ranges (IQR). Normality of data distribution of continuous variables was assessed using normal distribution plots, inspection of histograms, skewness, and the Shapiro-Wilk test.

Categorical and continuous variables were compared using Pearson chi square test and Mann-Whitney U test, respectively.

Multivariable forward logistic regression analysis was applied to identify potential independent predictors for mortality, ICU admission and the need for mechanical ventilation. Variables with p-values<0.2 in univariable analysis were entered into the equation of the forward logistic regression model. A p-value≤0.05 was considered statistically significant. Effect sizes were reported as odds ratios (OR) with 95% confidence intervals (CI). Different thresholds for age were assessed. The qSOFA score was modified according to the results of the multivariable regression analysis. Variables that were independently associated with the reported outcomes were included in the modified qSOFA and weighted based on the OR.

The performance of the qSOFA and the modified qSOFA was assessed the area under the receiver operating characteristics (AUROC) curves, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) were calculated. Optimal cut-off values were determined on the ROC curve using the maximum Youden index [sensitivity − (1 − specificity)]. Acceptable Youden index was defined as ≥50%.

Statistical analysis was performed using SPSS Statistics version 25 (IBM Corporation, Armonk, New York). Reporting of this diagnostic study is undertaken in accord with the STARD guidelines (Supplemental Digital Content, http://links.lww.com/TA/C638).[24]

RESULTS

Patient Population

A total of 991 patients underwent EGS interventions for various reasons during the entire three study years. Of these, 578 patients (58.3%) were finally enrolled for further analysis (Figure 1). Table 1 is showing the demographics, disease characteristics and vital signs on ED admission for the entire study population. Median age was 60years (IQR 44-75). The majority were male (54.3%, 314/578). Median body mass index was 26.0kg/m^2 (IQR 22.8-29.1). Indications for EGS included acute appendicitis (24.9%, 144/578), acute cholecystitis (24.6%, 142/578), GIT perforation (19.4%, 112/578), bowel obstruction (14.4%, 83/578), incarcerated hernia (9.5%, 55/578), and MI (7.3%, 42/578).

Overall, observed in-hospital mortality was 4.8% (28/578) (Table 1 and Table 2). The highest mortality rate was found in patients with MI (26.2%%, 11/42) and large bowel perforation (18.2%, 8/44). Median hospital length of stay (H-LOS) and ICU-LOS were 5days (IQR 3-10) and 3days (IQR 1-6), respectively. Severe complications (Dindo-Clavien Classification ≥3a) occurred in 15.6% (90/578) of patients.

Diagnostic ability and test performance of the qSOFA

Table 1 and 2 are showing mortality rates stratified according the qSOFA. No significantly higher mortality was found when comparing patients with a qSOFA=0 vs. qSOFA=1 [2.4% (95%CI 1.0-4.9%) vs. 3.2% (95%CI 1.4-6.1%), *p*-value=0.780] and patients with a qSOFA=1 vs. qSOFA=2 [3.2% (95%CI 1.4-6.1%) vs. 7.2% (95%CI 3.1-14.3%), *p*-value=0.199]. The mortality rate of patients with a qSOFA=3 was significantly higher than the rate of patients with a qSOFA=2 [34.6% (95%CI 18.7-53.7%) vs. 7.2% (95%CI 3.1-14.3%), *p*-value<0.001].

The AUROC of the qSOFA to predict mortality, ICU admission and the need for mechanical ventilation were 0.715 (95%CI 0.602-0.829), 0.709 (95%CI 0.655-0.763) and 0.744 (95%CI 0.684-0.804), respectively (Figures 2 and supplemental digital content Figure 1 and 2, http://links.lww.com/TA/C639). For the qSOFA score, exponential trendlines demonstrated the highest correlation R^2 with regard to the observed outcomes. According the Youden Index, the optimal cut-off value for mortality was identified as qSOFA≥2 (53.6% sensitivity, 82.9% specificity, 13.8% PPV, 97.2% NPV; Youden Index 36.5%).

Diagnostic ability and test performance of a modified qadSOFA

Multivariable logistic regression analysis identified MI, GIT perforation, and age ≥65years as independent predictors for mortality, ICU admission and the need for mechanical ventilation (Table 3). Accordingly, the qSOFA score was modified using these three variables, leading to the age- and disease-adjusted qSOFA (qadSOFA) score. Based on the OR of the multivariable regression analysis, 1 point was added to the score for age >65 years, 1 point for GIT perforation, and 3 points for MI. (Table 4). If both, GIT perforation and MI were present, MI alone was entered in the score.

Figure 2 and supplemental digital content Figure 1 & 2, http://links.lww.com/TA/C639, are summarizing the diagnostic ability and test performance of the qadSOFA for mortality, ICU admission and mechanical ventilation. The AUROC of the qadSOFA to predict mortality, ICU admission and the need for mechanical ventilation were 0.859 (95%CI 0.782-0.937), 0.834 (95%CI 0.795-0.874) and 0.875 (95%CI 0.837-0.913), respectively. Linear trendlines demonstrated the highest correlation R^2 for the qadSOFA score with regard to the observed outcomes. According the Youden Index, the optimal cut-off value for mortality was identified as qadSOFA≥3 (85.7% sensitivity, 78.4% specificity, 16.8% PPV, 99.1% NPV; Youden Index 64.1%).

DISCUSSION

This study validated for the first time the qSOFA to predict mortality and higher need of care in abdominal EGS patients specifically. In this group of patients, no acceptable cut-off value of qSOFA to predict mortality was identified (maximum Youden Index 36.5%), revealing its limited prognostic ability.

On the other hand, the newly developed qadSOFA score, including age, MI, and GIT perforation in addition to the variables of the qSOFA score, revealed an excellent discriminatory performance for the investigated clinical outcomes (Figure 2 and supplemental digital content Figure 1 and 2, http://links.lww.com/TA/C639, maximum Youden Index 64.1%). Moreover, the best trendlines through the observed outcomes turned from exponential for the qSOFA to linear for the qadSOFA. This finding may improve applicability and interpretation of the qadSOFA in the daily clinical use. The qadSOFA score thus is a promising new score for the prediction of outcomes in the investigated patient population.

The current study population comprised EGS patients with various abdominal emergencies (mean 193 patients per annum) and is comparable to other busy acute care centers[1]. The detected mortality rate of 4.3% in the current study is comparable to the literature with the highest mortality rate for patients suffering from MI (26.2%)[1–6,25–27].

In the daily clinical routine, it is of highest importance to predict outcomes at a very early stage of surgical decision-making. Especially in times of reduced hospital and ICU resources, increasing frailty of EGS patients and different patients' or relatives' treatment expectations and goals, predictive scores may facilitate decision-making in a timely manner. Of note, in a recent meta-analysis, frailty (relevant especially in patients with age≥65 years) was significantly associated with mortality patients undergoing abdominal EGS [OR 4.3, (95% CI 2.25-8.19), *p*-value<0.05][26]. Similarly to the study by Kennedy et al. age has been included as a variable into the qadSOFA to further improve prediction for mortality. However, scores to predict mortality need to be applicable at a very early stage of decision making, where only a limited number of variables are available. A previous study has shown that due to the complexity of data needed to calculate scores such as the SOFA, multiple organ dysfunction score (MODS) or the Denver score, feasibility might be as low as 5.0% in EGS patient cohorts[1]. In accordance with the findings of the mentioned study, we feel that only variables that are documented routinely in daily clinical practice are useful for any predictive score. In contrast to above-mentioned scores, this does apply for the qSOFA and the proposed qadSOFA. Both scores are easy and applicable bedside also in EGS patients.

In the current study, a significant increase of mortality in abdominal EGS patients was detected only in qSOFA 2 vs. qSOFA=3 with mortality in the latter group of 34.6% (95%CI 18.7-53.7%). This finding is in contrast to previous studies on septic patients, where a cut-off value of a qSOFA≥2 has been established[28,29]. However, these studies included patients with heterogeneous sources of sepsis with no possible extrapolation to patients requiring EGS specifically. In the current study, the qSOFA revealed limited prognostic value with an AUROC of 0.715 (95%CI 0.602-0.829) and a maximal PPV for mortality of 34.6% with the maximum Youden Index <50%.

The qadSOFA remains clinically applicable as it includes solely additional variables that are available at a very early stage of hospital care. Age is a throughout available variable. The disease or pathology of the patient is identified either preoperatively by imaging (e.g. contrast-enhanced computed tomography scan) or, at the latest, during surgery. In the current study, the qadSOFA was available for 100% of patients.

Limitations

Due to the retrospective design of the current study there is a possible selection and attribution bias. Moreover, due to the single-center design at a tertiary university hospital, the reproducibility of study results might be limited at other centers. Additionally, the current analysis is lacking a validation of the newly developed qadSOFA score to other cohorts of patients undergoing EGS. A post-hoc power calculation for mortality rates in qSOFA=3 vs. qadSOFA=7 with a type I/II error rate alpha 0.05 results in 10.6% power.

Conclusion

This is the first study investigating the qSOFA score as a predictor for clinical outcomes specifically in patients undergoing EGS. Based on the characteristics of this specific patient population, the modified age and disease adjusted qSOFA (qadSOFA) score was developed. Compared to the qSOFA score, the new qadSOFA revealed an excellent predictive power for clinical outcomes. Nevertheless, in clinical practice, a qSOFA=3 is worrisome and postoperative higher level of care needs to anticipated. Future validation of the qadSOFA on different datasets is warranted.

Acknowledgements

None.

Ethics approval and consent to participate

The 1964 Helsinki declaration and its later amendments and comparable ethical standards were obeyed. There were no animal studies performed by any of the authors for this study.

Disclosures of funding

No funding was received for this study.

Availability of data and materials

Upon request.

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FIGURE LEGENDS

Figure 1: Study outline.

Abbreviation: EGS, emergency general surgery; GIT, gastrointestinal tract,

*undergoing surgery for either of the following diseases: appendicitis, cholecystitis, GIT perforation, bowel obstruction, mesenteric ischemia or hernia.

Figure 2: Diagnostic ability and test performance of qSOFA vs. qadSOFA to predict mortality.

Description: Cut-off values are calculated comparing to patients in all subgroups with score values lower eg. qSOFA$\geq$1 vs. qSOFA=0.

Abbreviations: qSOFA, quick sequential organ failure assessment score; qadSOFA, quick age disease sequential organ failure assessment score; Sens., sensitivity; Spec., specificity

Color coding: black, qadSOFA; grey qSOFA.

SUPPLEMENT DIGITAL CONTENT LEGENDS

Supplemental digital content Figure 1: Diagnostic ability and test performance of qSOFA vs. qadSOFA to predict ICU admission.

Description: Cut-off values are calculated comparing to patients in all subgroups with score values lower eg. qSOFA≥1 vs. qSOFA=0.

Abbreviations: qSOFA, quick sequential organ failure assessment score; qadSOFA, quick age disease sequential organ failure assessment score; Sens., sensitivity; Spec., specificity

Color coding: black, qadSOFA; grey qSOFA.

Supplemental digital content Figure 2: Diagnostic ability and test performance of qSOFA vs. qadSOFA to predict mechanical ventilation.

Description: Cut-off values are calculated comparing to patients in all subgroups with score values lower eg. qSOFA≥1 vs. qSOFA=0.

Abbreviations: qSOFA, quick sequential organ failure assessment score; qadSOFA, quick age disease sequential organ failure assessment score; Sens., sensitivity; Spec., specificity

Color coding: black, qadSOFA; grey qSOFA.

Figure 1: Study outline.

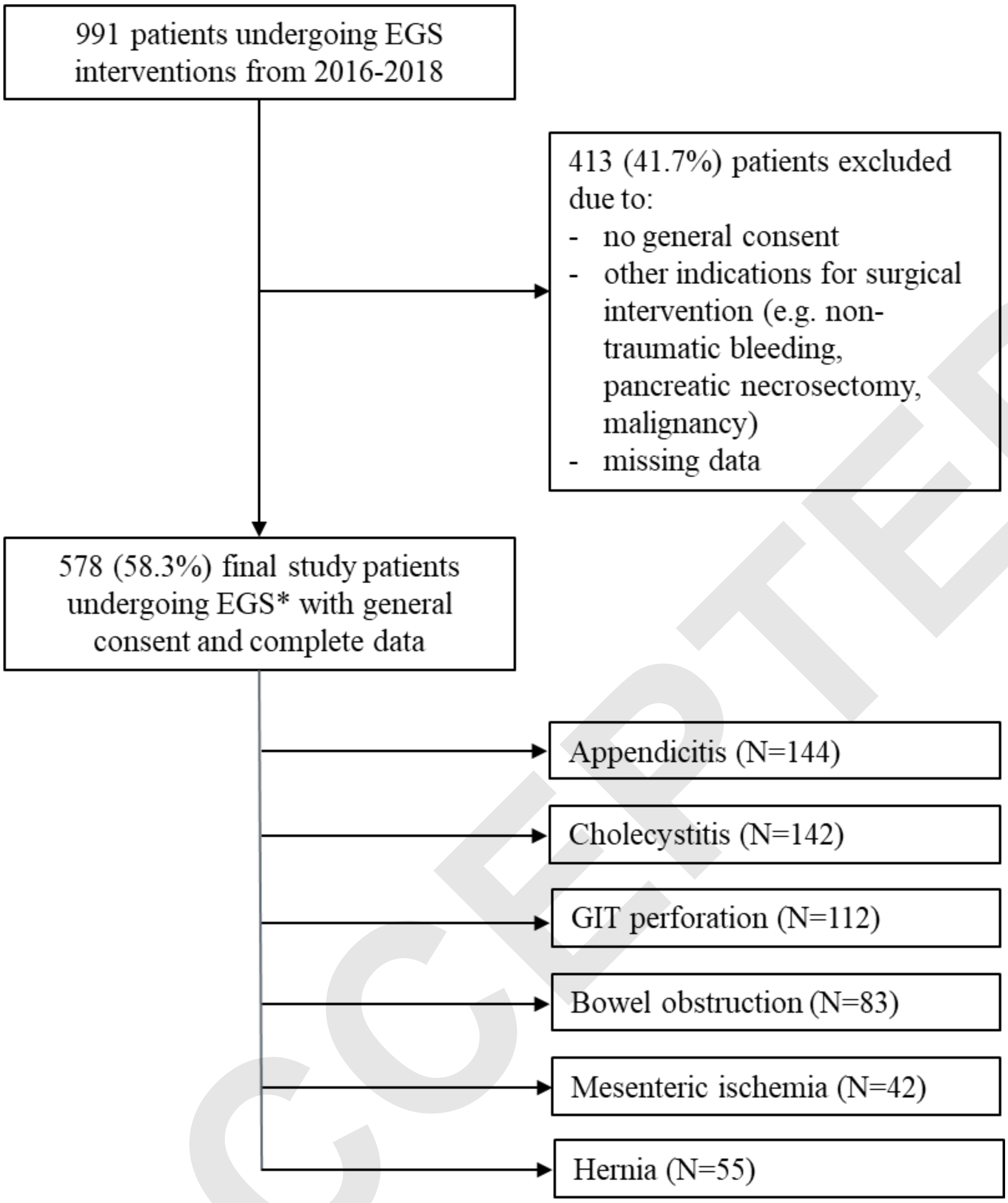
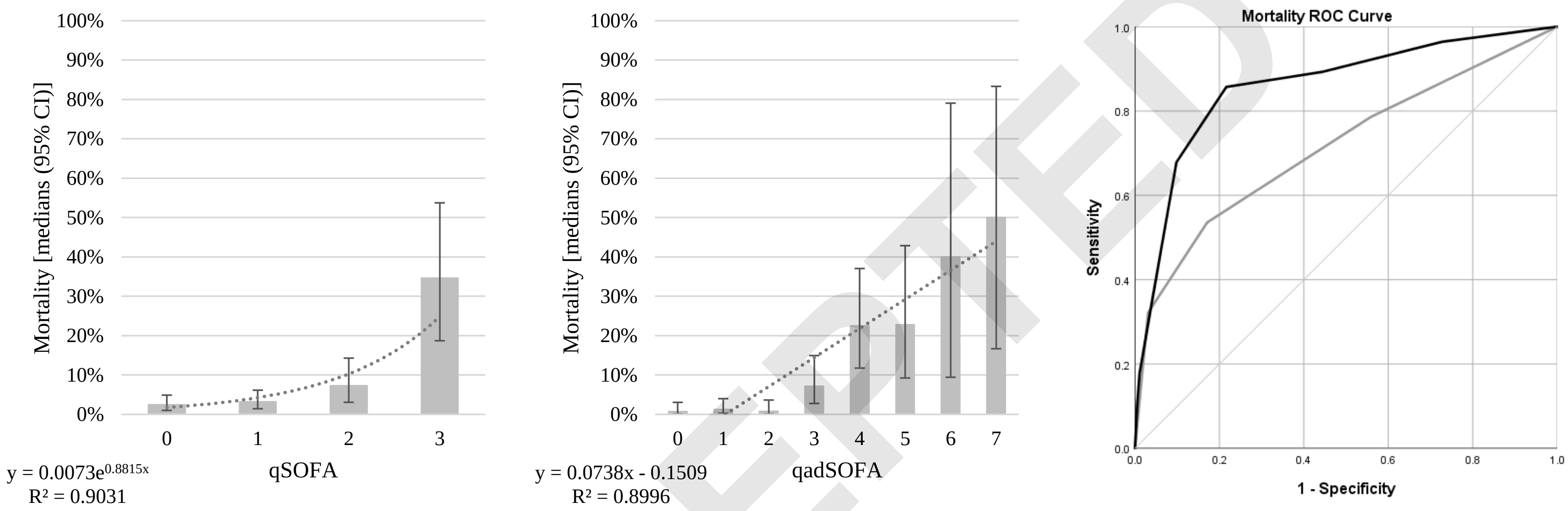


Figure 2: Diagnostic ability and test performance of qSOFA vs. qadSOFA to predict mortality.



qSOFA	Sens.	Spec.	PPV	NPV
≥1	78.6%	44.2%	6.7%	97.6%
≥2	53.6%	82.9%	13.8%	97.2%
3	32.1%	96.9%	34.6%	96.6%

qadSOFA	Sens.	Spec.	PPV	NPV
≥1	96.4%	27.3%	6.3%	99.3%
≥2	89.3%	55.6%	9.3%	99.0%
≥3	85.7%	78.4%	16.8%	99.1%
≥4	67.9%	90.2%	26.0%	98.2%
≥5	35.7%	95.8%	30.3%	96.7%
≥6	17.9%	98.9%	45.5%	95.9%
7	10.7%	99.5%	50.0%	95.6%

qSOFA Area 0.715 (95%CI 0.602 - 0.829)

qadSOFA Area 0.859 (95%CI 0.782 - 0.937)

Table 1: Effect of patient and disease characteristics on mortality.

	Total	Survivors	Non-survivors	OR (95%CI)	p-value †
n=	578	550	28		
Age ≥65 years	260 (45%)	237 (91.2%)	23 (8.8%)	6.08 (2.28 - 16.21)	<0.001
Age *	60 (44 - 75)	59 (43 - 74)	78 (69 - 84)	1.06 (1.03 - 1.09)	<0.001
Male	314 (54.3%)	298 (94.9%)	16 (5.1%)	1.13 (0.52 - 2.43)	0.759
BMI [kg/m^2] *	26.0 (22.8 - 29.1)	26.0 (22.8 - 29.1)	26.6 (22.4 - 31.0)	1.00 (0.98 - 1.03)	0.906
Mesenteric ischemia	42 (7.3%)	31 (73.8%)	11 (26.2%)	10.83 (4.67 - 25.11)	<0.001
GIT perforation	112 (19.4%)	101 (90.2%)	11 (9.8%)	2.88 (1.31 - 6.33)	0.006
Gastric duodenal perforation	28 (4.8%)	27 (96.4%)	1 (3.6%)	0.72 (0.09 - 5.48)	0.748
Small bowel perforation	18 (3.1%)	16 (88.9%)	2 (11.1%)	2.57 (0.56 - 11.76)	0.209
Colon perforation	44 (7.6%)	36 (81.8%)	8 (18.2%)	5.71 (2.35 - 13.86)	<0.001
Anastomotic leakage	22 (3.8%)	22 (100%)	0 (0%)	-	0.281
Bowel obstruction	83 (14.4%)	79 (95.2%)	4 (4.8%)	0.99 (0.34 - 2.94)	0.991
Small bowel obstruction	54 (9.3%)	52 (96.3%)	2 (3.7%)	0.74 (0.17 - 3.19)	0.682
Large bowel obstruction	29 (5%)	27 (93.1%)	2 (6.9%)	1.49 (0.34 - 6.61)	0.598
Cholecystitis	142 (24.6%)	140 (98.6%)	2 (1.4%)	0.23 (0.05 - 0.96)	0.028
Appendicitis	144 (24.9%)	144 (100%)	0 (0%)	-	0.002
Hernia	55 (9.5%)	55 (100%)	0 (0%)	-	0.079
GCS ≤14	61 (10.6%)	50 (82%)	11 (18%)	6.47 (2.87 - 14.58)	<0.001
GCS *	15 (15 - 15)	15 (15 - 15)	15 (14 - 15)	0.78 (0.69 - 0.87)	<0.001
sBP ≤100mmHg	128 (22.1%)	114 (89.1%)	14 (10.9%)	3.82 (1.77 - 8.25)	<0.001
sBP [mmHg] *	120 (103 - 138)	120 (104 - 138)	101 (81 - 138)	0.98 (0.97 - 1.00)	0.011
Respiration rate ≥22/min	275 (47.6%)	254 (92.4%)	21 (7.6%)	3.50 (1.46 - 8.36)	0.003
Respiration rate [/min] *	21 (15 - 25)	21 (15 - 25)	24 (18 - 30)	1.04 (1.00 - 1.08)	0.025
qSOFA 0 pts	249 (43.1%)	243 (97.6%)	6 (2.4%)	0.34 (0.14 - 0.86)	0.018
qSOFA 1 pts	220 (38.1%)	213 (96.8%)	7 (3.2%)	0.53 (0.22 - 1.26)	0.144
qSOFA 2 pts	83 (14.4%)	77 (92.8%)	6 (7.2%)	1.68 (0.66 - 4.26)	0.274
qSOFA 3 pts	26 (4.5%)	17 (65.4%)	9 (34.6%)	14.85 (5.87 - 37.59)	<0.001
qSOFA ≥2 pts	109 (18.9%)	94 (86.2%)	15 (13.8%)	5.60 (2.58 - 12.15)	<0.001

Abbreviations: sBP, systolic blood pressure; GIT, gastrointestinal tract; GCS, Glasgow coma score; qSOFA, quick sequential organ failure assessment score; BMI, body mass index; 95%CI, 95% confidence interval; pts, points; *,Values are medians (interquartile ranges (IQR)); †, Pearson Chi-Square or Mann-Whitney U test

Table 2: Primary and secondary outcome analysis stratified according qSOFA and qadSOFA.

		Mortality		ICU admission		Ventilation	
		n/n	median (95%CI)	n/n	median (95%CI)	n/n	median (95%CI)
qSOFA	0	6/249	2.4% (1% - 4.9%)	26/249	10.4% (7.1% - 14.7%)	15/249	6.0% (3.6% - 9.5%)
	1	7/220	3.2% (1.4% - 6.1%)	46/220	20.9% (15.9% - 26.6%)	29/220	13.2% (9.2% - 18.1%)
	2	6/83	7.2% (3.1% - 14.3%)	32/83	38.6% (28.6% - 49.3%)	25/83	30.1% (21.1% - 40.5%)
	3	9/26	34.6% (18.7% - 53.7%)	21/26	80.8% (62.9% - 92.3%)	20/26	76.9% (58.5% - 89.7%)
		Mortality		ICU admission		Ventilation	
		n/n	median (95%CI)	n/n	median (95%CI)	n/n	median (95%CI)
qadSOFA	0	1/151	0.7% (0.1% - 3.1%)	3/151	2.0% (0.6% - 5.2%)	1/151	0.7% (0.1% - 3.1%)
	1	2/158	1.3% (0.3% - 4%)	16/158	10.1% (6.1% - 15.5%)	6/158	3.8% (1.6% - 7.7%)
	2	1/126	0.8% (0.1% - 3.6%)	26/126	20.6% (14.3% - 28.3%)	15/126	11.9% (7.1% - 18.4%)
	3	5/70	7.1% (2.8% - 14.9%)	29/70	41.4% (30.4% - 53.1%)	22/70	31.4% (21.5% - 42.9%)
	4	9/40	22.5% (11.8% - 37.1%)	22/40	55.0% (39.7% - 69.6%)	17/40	42.5% (28.1% - 57.9%)
	5	5/22	22.7% (9.2% - 42.9%)	19/22	86.4% (67.9% - 96.0%)	18/22	81.8% (62.4% - 93.5%)
	6	2/5	40.0% (9.4% - 79.1%)	4/5	80.0% (37.1% - 97.7%)	4/5	80.0% (37.1% - 97.7%)
	7	3/6	50.0% (16.7% - 83.3%)	6/6	100.0% (100% - 100%)	6/6	100.0% (100% - 100%)

Abbreviations: 95%CI, 95% confidence interval; ICU, intensive care unit; n, number; qSOFA, quick sequential organ failure assessment score; qadSOFA, quick age disease sequential organ failure assessment score

Table 3: Independent predictors for mortality, ICU, and mechanical ventilation.

	Variables	OR	95%CI Lower	Upper	p-value	Nagelkerke R^2	Cox & Snell R^2
Mortality	Mesenteric ischemia	15.947	5.234	48.585	<0.001		
	GIT perforation	4.858	1.690	13.963	0.003		
	Age ≥65years	4.059	1.446	11.394	0.008		
	qSOFA	1.825	1.175	2.834	0.007	0.305	0.098
ICU	Mesenteric ischemia	8.564	3.590	20.426	<0.001		
	Age ≥65years	3.316	1.943	5.658	<0.001		
	qSOFA	2.173	1.624	2.909	<0.001		
	GIT perforation	1.847	1.002	3.404	0.049		
	Cholecysitis	0.277	0.131	0.586	0.001		
	Appendicitis	0.165	0.054	0.502	0.002	0.435	0.282
Ventilation	Mesenteric ischemia	24.664	10.413	58.424	<0.001		
	Age ≥65years	6.271	3.217	12.221	<0.001		
	GIT perforation	4.266	2.289	7.950	<0.001		
	qSOFA	2.503	1.802	3.478	<0.001	0.459	0.264

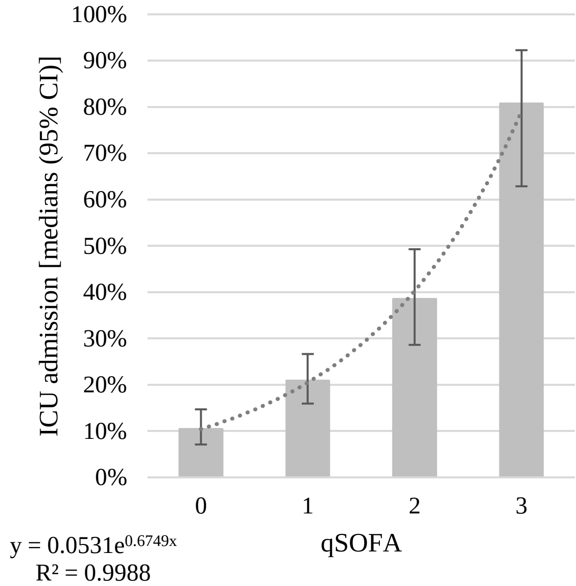
Stepwise forward logistic regression analysis with all variables with p-value <0.20 included: Age ≥ 65years, appendicitis, cholecystitis, hernia, mesenteric ischemia, GIT perforation (as composite/co-linearity of gastric duodenal perforation, small bowel perforation, colon perforation, anastomotic leakage), qSOFA (as composite/co-linearity of: sBP ≤ 100mmHg, respiration rate ≥ 22 and GCS ≤ 14)

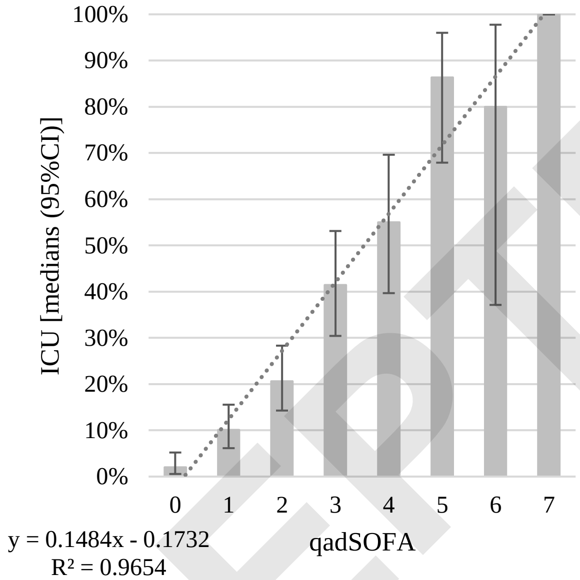
Abbreviations: 95%CI, 95% confidence interval; GCS, Glasgow Coma Scale; GIT, gastrointestinal tract; ICU, intensive care unit; OR, odds ratio; qSOFA, quick sequential organ failure assessment; sBP, systolic blood pressure

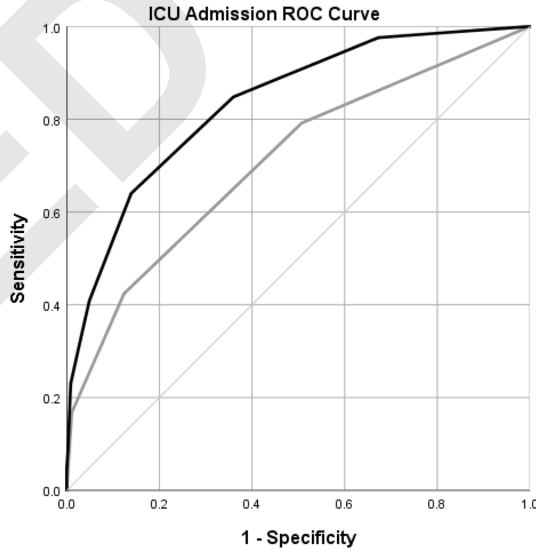
Table 4: Calculation of the qadSOFA (quick age disease sequential organ failure assessment score).

	Variable	Points
	Systolic blood pressure ≤100mmHg	+1
q	Respiration rate ≥22 breaths per minutes	+1
	Glasgow coma scale ≤14	+1
a	Age ≥65 years	+1
	Disease	
d	Gastrointestinal perforation	+1
	Mesenteric ischemia	+3
	Total	0 - 7

Supplemental digital content Figure 1: Diagnostic ability and test performance of qSOFA vs. qadSOFA to predict ICU admission.







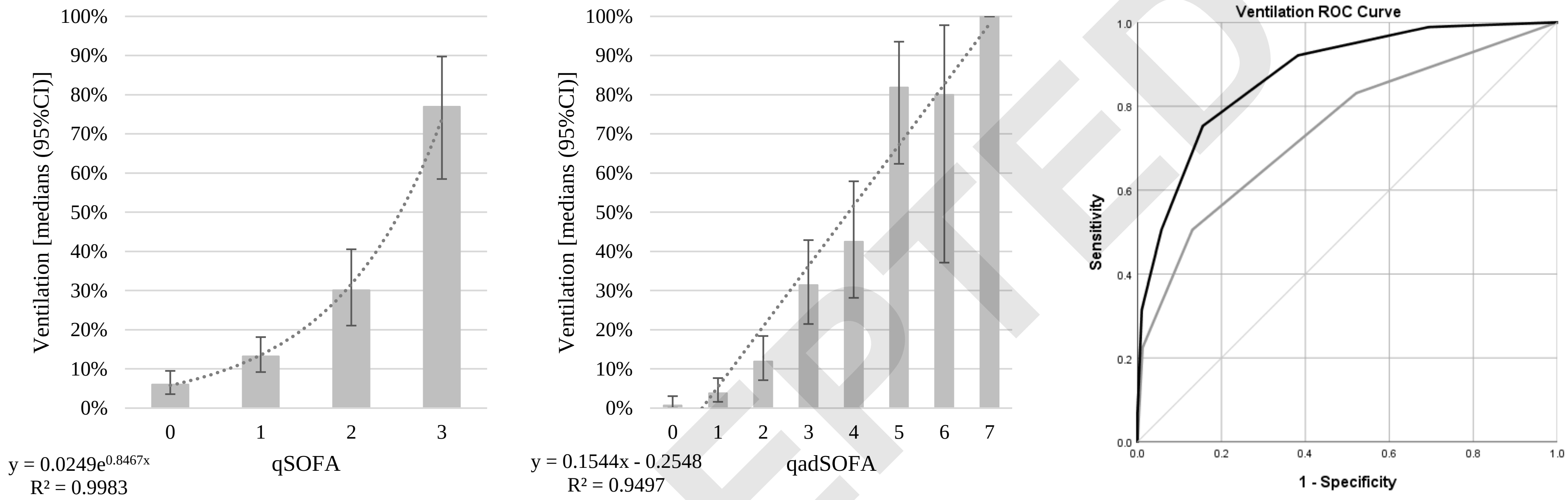
qSOFA	Sens.	Spec.	PPV	NPV
≥1	79.2%	49.2%	30.1%	89.6%
≥2	42.4%	87.6%	48.6%	84.6%
3	16.8%	98.9%	80.8%	81.2%

qadSOFA	Sens.	Spec.	PPV	NPV
≥1	97.6%	32.7%	28.6%	98.0%
≥2	84.8%	64.0%	39.4%	93.9%
≥3	64.0%	86.1%	55.9%	89.7%
≥4	40.8%	95.1%	69.9%	85.3%
≥5	23.2%	99.1%	87.9%	82.4%
≥6	8.0%	99.8%	90.9%	79.7%
7	4.8%	100.0%	100.0%	20.8%

qSOFA Area 0.709 (95%CI 0.655 - 0.763)

qadSOFA Area 0.834 (95%CI 0.795 - 0.874)

Supplemental digital content Figure 2: Diagnostic ability and test performance of qSOFA vs. qadSOFA to predict mechanical ventilation.



qSOFA	Sens.	Spec.	PPV	NPV
≥1	83.1%	47.9%	22.5%	94.0%
≥2	50.6%	86.9%	41.3%	90.6%
3	22.5%	98.8%	76.9%	87.5%

qadSOFA	Sens.	Spec.	PPV	NPV
≥1	98.9%	30.7%	20.6%	99.3%
≥2	92.1%	61.8%	30.5%	97.7%
≥3	75.3%	84.5%	46.9%	94.9%
≥4	50.6%	94.3%	61.6%	91.3%
≥5	31.5%	99.0%	84.8%	88.8%
≥6	11.2%	99.8%	90.9%	86.1%
7	6.7%	100.0%	100.0%	85.5%

qSOFA Area 0.744 (95%CI 0.684 - 0.804)

qadSOFA Area 0.875 (95%CI 0.837 - 0.913)

Section & Topic	No	Item	Reported on page #
TITLE OR ABSTRACT			
	1	Identification as a study of diagnostic accuracy using at least one measure of accuracy (such as sensitivity, specificity, predictive values, or AUC)	Abstract
ABSTRACT			
	2	Structured summary of study design, methods, results, and conclusions (for specific guidance, see STARD for Abstracts)	Abstract
INTRODUCTION			
	3	Scientific and clinical background, including the intended use and clinical role of the index test	Manuscript page 1
	4	Study objectives and hypotheses	Manuscript page 1
METHODS			
Study design	**5**	Whether data collection was planned before the index test and reference standard were performed (prospective study) or after (retrospective study)	Manuscript page 2
Participants	**6**	Eligibility criteria	Manuscript page 2
	7	On what basis potentially eligible participants were identified (such as symptoms, results from previous tests, inclusion in registry)	Manuscript page 2
	8	Where and when potentially eligible participants were identified (setting, location and dates)	Manuscript page 2
	9	Whether participants formed a consecutive, random or convenience series	Manuscript page 2
Test methods	**10a**	Index test, in sufficient detail to allow replication	Manuscript page 3, 4
	10b	Reference standard, in sufficient detail to allow replication	Manuscript page 3, 4
	11	Rationale for choosing the reference standard (if alternatives exist)	Manuscript page 3, 4
	12a	Definition of and rationale for test positivity cut-offs or result categories of the index test, distinguishing pre-specified from exploratory	Manuscript page 3, 4
	12b	Definition of and rationale for test positivity cut-offs or result categories of the reference standard, distinguishing pre-specified from exploratory	Manuscript page 3, 4
	13a	Whether clinical information and reference standard results were available to the performers/readers of the index test	Manuscript page 3, 4
	13b	Whether clinical information and index test results were available to the assessors of the reference standard	Manuscript page 3, 4
Analysis	**14**	Methods for estimating or comparing measures of diagnostic accuracy	Manuscript page 3, 4
	15	How indeterminate index test or reference standard results were handled	Manuscript page 3, 4
	16	How missing data on the index test and reference standard were handled	Manuscript page 3, 4
	17	Any analyses of variability in diagnostic accuracy, distinguishing pre-specified from exploratory	Manuscript page 3, 4
	18	Intended sample size and how it was determined	-
RESULTS			
Participants	**19**	Flow of participants, using a diagram	-
	20	Baseline demographic and clinical characteristics of participants	Manuscript page 5 & Tables
	21a	Distribution of severity of disease in those with the target condition	Manuscript page 5, 6 & Tables
	21b	Distribution of alternative diagnoses in those without the target condition	Manuscript page 5, 6 & Tables
	22	Time interval and any clinical interventions between index test and reference standard	Manuscript page 3
Test results	**23**	Cross tabulation of the index test results (or their distribution) by the results of the reference standard	Manuscript page 5, 6 & Tables
	24	Estimates of diagnostic accuracy and their precision (such as 95% confidence intervals)	Manuscript page 5, 6 & Tables & Figure
	25	Any adverse events from performing the index test or the reference standard	Not applicable

DISCUSSION			
	26	Study limitations, including sources of potential bias, statistical uncertainty, and generalisability	Manuscript Page 7-9
	27	Implications for practice, including the intended use and clinical role of the index test	Manuscript Page 7-9
OTHER INFORMATION			
	28	Registration number and name of registry	Manuscript Page 2
	29	Where the full study protocol can be accessed	-
	30	Sources of funding and other support; role of funders	Title Page 2

STARD 2015

AIM

STARD stands for "Standards for Reporting Diagnostic accuracy studies". This list of items was developed to contribute to the completeness and transparency of reporting of diagnostic accuracy studies. Authors can use the list to write informative study reports. Editors and peer-reviewers can use it to evaluate whether the information has been included in manuscripts submitted for publication.

EXPLANATION

A **diagnostic accuracy study** evaluates the ability of one or more medical tests to correctly classify study participants as having a **target condition.** This can be a disease, a disease stage, response or benefit from therapy, or an event or condition in the future. A medical test can be an imaging procedure, a laboratory test, elements from history and physical examination, a combination of these, or any other method for collecting information about the current health status of a patient.

The test whose accuracy is evaluated is called **index test.** A study can evaluate the accuracy of one or more index tests. Evaluating the ability of a medical test to correctly classify patients is typically done by comparing the distribution of the index test results with those of the **reference standard**. The reference standard is the best available method for establishing the presence or absence of the target condition. An accuracy study can rely on one or more reference standards.

If test results are categorized as either positive or negative, the cross tabulation of the index test results against those of the reference standard can be used to estimate the **sensitivity** of the index test (the proportion of participants *with* the target condition who have a positive index test), and its **specificity** (the proportion *without* the target condition who have a negative index test). From this cross tabulation (sometimes referred to as the contingency or "2x2" table), several other accuracy statistics can be estimated, such as the positive and negative **predictive values** of the test. Confidence intervals around estimates of accuracy can then be calculated to quantify the statistical **precision** of the measurements.

If the index test results can take more than two values, categorization of test results as positive or negative requires a **test positivity cut-off**. When multiple such cut-offs can be defined, authors can report a receiver operating characteristic (ROC) curve which graphically represents the combination of sensitivity and specificity for each possible test positivity cut-off. The **area under the ROC curve** informs in a single numerical value about the overall diagnostic accuracy of the index test.

The **intended use** of a medical test can be diagnosis, screening, staging, monitoring, surveillance, prediction or prognosis. The **clinical role** of a test explains its position relative to existing tests in the clinical pathway. A replacement test, for example, replaces an existing test. A triage test is used before an existing test; an add-on test is used after an existing test.

Besides diagnostic accuracy, several other outcomes and statistics may be relevant in the evaluation of medical tests. Medical tests can also be used to classify patients for purposes other than diagnosis, such as staging or prognosis. The STARD list was not explicitly developed for these other outcomes, statistics, and study types, although most STARD items would still apply.

DEVELOPMENT

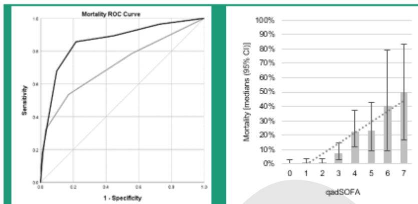
This STARD list was released in 2015. The 30 items were identified by an international expert group of methodologists, researchers, and editors. The guiding principle in the development of STARD was to select items that, when reported, would help readers to judge the potential for bias in the study, to appraise the applicability of the study findings and the validity of conclusions and recommendations. The list represents an update of the first version, which was published in 2003.

More information can be found on [http://www.equator-network.org/reporting-guidelines/stard.](http://www.equator-network.org/reporting-guidelines/stard)

Validation qSOFA in EGS & proposal of qadSOFA

Mortality in EGS with sepsis up to 30%
No data on qSOFA in EGS

Validation of score qSOFA & proposal of new score



Independent predictors for mortality: mesenteric ischemia, GIT perforation, age ≥65years and increasing qSOFA

Proposal new **qadSOFA**

Author et al *Journal of Trauma and Acute Care Surgery*
Month Year [doi]

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