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Prognostic ability of quick-SOFA across different age groups of patients with suspected infection outside the intensive care unit: A cohort study

João Gabriel Rosa Ramos, MD, PhD [a,b,*], Rogério da Hora Passos, MD [a,c,d], Mauricio Brito Teixeira, MD [c,e,f,g], Andre Luiz Nunes Gobatto, MD, PhD [a,c,h,i], Rafael Viana dos Santos Coutinho [j], Juliana Ribeiro Caldas, MD, PhD [a,f], Suzete Farias da Guarda, MD, PhD [a,c,j,k], Michel Pordeus Ribeiro, MD [a,k,l], Paulo Benigno Pena Batista, MD, PhD [a,f,k]

[a] Intensive Care Unit, Hospital Sao Rafael, Salvador, Brazil
[b] Palliative Care Team, Hospital Sao Rafael, Salvador, Brazil
[c] Internal Medicine, Hospital Sao Rafael, Salvador, Brazil
[d] Intensive Care Unit, Hospital Portugues, Salvador, Brazil
[e] Nephrology Department, Hospital Ana Nery, Salvador, Brazil
[f] Medical School, Escola Bahiana de Medicina, Salvador, Brazil
[g] Medical School, Universidade do Estado da Bahia, Salvador, Brazil
[h] Medical School, Universidade Salvador, Salvador, Brazil
[i] Intensive Care Unit, Hospital da Cidade, Salvador, Brazil
[j] Medical School, Universidade Federal da Bahia, Salvador, Brazil
[k] Medical School, Uniao Metropolitana para o Desenvolvimento da Educação e Cultura UNIME, Lauro de Freitas, Brazil
[l] Intensive Care Unit, Hospital Sagrada Familia, Salvador, Brazil

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ABSTRACT

Objectives: Sepsis identification in older patients is challenging. We evaluated the performance of qSOFA across different age groups of patients with suspected infection outside the intensive care unit (ICU).
Methods: Retrospective cohort in a tertiary hospital in Brazil, from January 2016 to December 2016. Outcomes were hospital mortality, ICU admission and bacteremia. Performance of qSOFA was compared over three age groups: (1) reference: ≤65 years, (2) old: 65 to 79 years and (3) very old: ≥80 years.
Results: There were 420 patients in the study, of which 259 (61.7%) were ≤65 years, 80 (19%) were 65 to 79 years and 81 (19.3%) were ≥80 years. Old and very old patients had higher qSOFA scores and lower SIRS scores. Overall, qSOFA ≥2 was associated to hospital mortality [OR (95% CI) = 5.8 (3.3–10.4), $p < 0.001$], ICU admission [OR (95% CI) = 2.7 (1.6–4.6), $p < 0.001$] and bacteremia [OR (95% CI) = 3.1 (1.7–5.8), $p < 0.001$]. Those associations were stronger in old and very old patients. qSOFA and SIRS demonstrated overall AUROCs for hospital mortality of 0.72 and 0.50, respectively.
Conclusion: qSOFA demonstrated good overall accuracy and was more strongly associated to outcomes in old and very old patients, when compared to younger patients.

1. Introduction

Sepsis is a common condition with high mortality and an increasing incidence in developed and developing countries [1-3]. Older patients account for a large proportion of sepsis cases [4] and sepsis-related resource utilization [5]. Moreover, sepsis in the older population is associated with higher morbidity and mortality rates [6] than sepsis in younger patients.

There are many challenges associated with the management of sepsis in older patients [7, 8], one of which is correct and timely diagnosis. Older patients may have atypical presentations because common signs and symptoms associated with severe infections, such as fever, are less frequent in the elderly population; therefore, this population may require a higher clinical index of suspicion for infection [9-12]. Furthermore, differentiating infection from other noninfectious diseases, such as congestive heart failure and urinary incontinence, can cause diagnostic uncertainty [7, 8]. Additionally, it has been suggested that systemic inflammatory response system (SIRS) criteria [13] may be less accurate as a prognostic tool in this population [9].

In 2016, a task force convened by national societies, including the Society of Critical Care Medicine (SCCM) and the European Society of Intensive Care Medicine (ESICM), proposed a new definition of sepsis,

* Corresponding author at: Av. Sao Rafael, 2152, Unidade de Terapia Intensiva, 5o. Andar, Sao Marcos, Salvador, Bahia ZIP code: 41253-190, Brazil.
E-mail addresses: joao.ramos@hsr.com.br (J.G.R. Ramos), paulo.benigno@hsr.com.br (P.B.P. Batista).

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termed Sepsis-3 [14]. The new proposal defines sepsis as life-threatening organ dysfunction caused by a dysregulated host response to infection and described a simplified method termed "quick-SOFA" (qSOFA), which is a modified version of the Sequential (Sepsis-related) Organ Failure Assessment score (SOFA) [15], to facilitate easier identification of patients potentially at risk of dying from sepsis [14]. These new definitions have been tested in the literature and have presented mixed results, with most studies demonstrating that qSOFA had higher overall accuracy but lower sensitivity than SIRS criteria and that there were different results for patients with sepsis inside or outside of the intensive care unit (ICU) [16-18]. Because older people tend to present with fewer SIRS criteria, it is possible that the new definition may perform better in the elderly population.

The objective of this study was to evaluate the accuracy of qSOFA in predicting adverse outcomes in patients with suspected infection outside of the ICU. We specifically tried to evaluate whether this accuracy changed in different age groups. As a secondary analysis, we also compared the accuracy of qSOFA and SIRS overall and in different age groups.

2. Methods

2.1. Ethics

This study was approved by the Hospital Sao Rafael (HSR) Ethics Committee, which granted a waiver for informed consent.

2.2. Study design

The study design was a retrospective, observational cohort study.

2.3. Study setting

Hospital Sao Rafael is a private, not-for-profit, tertiary hospital in Salvador, Brazil, with 350 beds, including 34 intensive care unit beds. HSR is a referral center for solid-organ and bone marrow transplantation, with 78,142 emergency room visits and 20,253 hospital admissions in 2016, including 2305 ICU admissions.

2.4. Population

We included inpatients older than 16 years with suspicion of infection (defined as patients with sepsis pathway activation) from January 1st, 2016, to December 31th, 2016. Only the first episode was analyzed for each patient. We only included patients with sepsis pathway activation in the wards or emergency department; therefore, episodes of sepsis in the ICU were excluded from this study.

2.5. Description of the sepsis pathway

The sepsis pathway is an institutional protocol to optimize care for septic patients. Briefly, physicians can activate the sepsis pathway for any patient with a clinical suspicion of severe infection. After it is activated, the sepsis pathway leads to alerts in the laboratory and pharmacy, with a goal of culture collection and initiation of antibiotics in <1 h and measurement of laboratory tests, including lactate, in <30 min. Moreover, it is recommended that any patient with a suspicion of sepsis and evidence of organ dysfunction (including elevated lactate) should be admitted to the ICU. Of note, as part of the hospital rapid response system, the nursing staff should call physicians if there is suspicion of a new infection, defined as two or more SIRS criteria or as per clinical judgment. However, the nursing staff may not activate the sepsis pathway, which can only be activated by a physician after direct patient evaluation. Even though any physician evaluating a patient may activate the sepsis pathway (including the primary attending team), most activations are in the emergency department or are activated by the rapid response team, which is composed by emergency physicians with background in internal medicine or general surgery.

2.6. Data collection

Data were retrospectively collected from electronic health records by trained medical students. We collected data on demographic and clinical variables of patients, including comorbidities and reason for acute admission. In addition, data were collected on the sepsis pathway activation episode, including vital signs and laboratory results for calculation of the qSOFA and SIRS criteria. Data on ICU admission, culture results, and hospital outcomes were also collected.

Quick-SOFA criteria [14] were defined as (1) respiratory rate ≥22/min; (2) altered mentation; and (3) systolic blood pressure ≤100 mmHg. A qSOFA ≥2 was defined as qSOFA positive. SIRS was defined as previously described [13] according to the following criteria: (1) temperature >38 °C or <36 °C; (2) heart rate >90 bpm; (3) respiratory rate >20/min or PaCO2 <32 mmHg; and (4) white blood cell count >12,000/mm^3 or <4000/mm^3. A SIRS ≥2 was defined as SIRS positive.

2.7. Missing data

For calculation of the qSOFA and SIRS scores, we defined missing values as normal values, which has been a standard approach [19, 20]. However, sensitivity analyzes were performed, assessing the differences in score performance in the population with and without missing values (Supplementary material).

2.8. Outcomes and definitions

We evaluated the performance of qSOFA in predicting the following outcomes: hospital mortality, ICU admission and positive blood cultures (bacteremia). The performance of qSOFA was compared over three age groups: (1) reference: <65 years, (2) old: 65 to 79 years and (3) very old: 80 or more years old.

As a secondary analysis, we also evaluated the performance of SIRS with the same outcomes.

2.9. Statistical analyses

Categorical variables were described as number of cases (percentage). Continuous variables were described as the mean ± standard deviation or median (interquartile range). Differences in proportions were evaluated with chi-square statistics or Fisher's exact test, where appropriate. Odds ratio (95% confidence interval) were assessed with the Mantel-Haenszel statistics. Continuous variables were evaluated via an ANOVA test or the Mann-Whitney *U* test.

The association of qSOFA and SIRS with the defined outcomes was assessed with these variables as ordinal variables for the discrimination analysis or as dichotomic variables (qSOFA ≥2 or SIRS ≥2) for calculation of odds ratios. Discrimination was assessed through analysis of the area under the receiving operator characteristic (AUROC) curve. A two-tailed p value of <0.05 was considered as statistically significant in all analyses. Statistical analyses were performed with SPSS 21.0™ (SPSS Inc., USA).

3. Results

In the study period, there were 710 sepsis pathway activations, 420 (59%) of which were included in the study. Of the excluded patients, 48 (7%) were not admitted to the hospital, 87 (12%) were duplicate episodes, 2 (0.3%) were younger than 16 years and 152 (21%) were patients in the ICU.

Most patients (383, 91.2%) were in the emergency department at the moment of sepsis pathway activation, whereas 37 (8.8%) were in the wards. Overall, 189 (45%) patients had a qSOFA of 0, whereas 161

(38.3%), 60 (14.3%) and 10 (2.4%) had a qSOFA of 1, 2 and 3, respectively. Twenty-nine (6.9%) patients had a SIRS score of 0, whereas 79 (18.8%), 126 (30%), 132 (31.4%) and 54 (12.9%) had a SIRS score of 1, 2, 3 and 4, respectively.

3.1. Details of age groups

The median age was 58 years (IQR 38–75). Of the patients analyzed, 259 (61.7%) were younger than 65 years, 80 (19%) were old (between 65 and 79 years) and 81 (19.3%) were very old (80 years or older). Characteristics of the patients are presented in the Table 1.

As described in Table 1, old or very old patients had higher Charlson comorbidity index, were less likely to be admitted from home and were more likely to have pneumonia and urinary tract infections as possible sources of infection. Additionally, old or very old patients were more likely to be admitted to the ICU and to die in the hospital.

Old or very old patients had higher qSOFA scores and lower SIRS scores (Fig. 1). Of the patients younger than 65 years, 29 (11.8%) had a qSOFA ≥2, whereas 20 (25%) patients between 65 and 79 and 21 (25.9%) patients 80 years or older had a qSOFA ≥2 ($p = 0.001$). On the other hand, 206 (79.5%) patients younger than 65 years had a SIRS ≥2, whereas 55 (68.8%) patients between 65 and 79 years and 51 (63%) patients older than 80 years had a SIRS ≥2 ($p = 0.005$).

There were differences among the age groups in the individual components of the scores (Fig. 1). Old or very old patients were more likely to demonstrate an altered level of consciousness and altered respiratory rate, as defined by the qSOFA score. However, old or very old patients were less likely to demonstrate an altered heart rate or altered temperature, as defined by the SIRS score.

3.2. Predictive ability of qSOFA and SIRS in different age groups

Overall, qSOFA ≥2 was associated with hospital mortality [OR (95% CI) = 5.8 (3.3–10.4), $p < 0.001$], ICU admission [OR (95% CI) = 2.7 (1.6–4.6), $p < 0.001$] and positive blood cultures (bacteremia) [OR (95% CI) = 3.1 (1.7–5.8), $p < 0.001$], as shown in Fig. 2.

These associations of qSOFA and outcomes were stronger in the older age groups (Fig. 2). For hospital mortality, OR (95% CI) were 2.8 (1.0–7.7), 7.9 (2.5–25.2) and 6.6 (2.2–19.9) for patients younger than 65 years, 65 to 79 years and 80 years or older, respectively. For ICU admission, OR (95% CI) were 1.1 (0.5–2.5), 4.9 (1.3–18.7) and 4.9 (1.3–18.5) for patients younger than 65 years, 65 to 79 years and 80 years or older, respectively. For bacteremia, OR (95% CI) were 2.4 (0.9–6.3), 1.6 (0.5–5.5) and 7.9 (2.2–28.1) for patients younger than 65 years, 65 to 79 years and 80 years or older, respectively.

However, overall, SIRS was not associated with hospital mortality [OR (95% CI) = 0.9 (0.5–1.8), $p = 0.921$], ICU admission [OR (95% CI) = 0.7 (0.4–1.0), $p = 0.077$] or positive blood cultures (bacteremia) [OR (95% CI) = 1.8 (0.9–3.8), $p = 0.092$].

Table 1
Characteristics and outcomes of the cohort by age group.

Characteristic	Age < 65 years	65–79 years	Age ≥ 80 years	p
	N = 259	N = 80	N = 81	
Age, median (IQR)	43 (30–55)	72 (68–76)	87 (82–89)	<0.001
Male sex, N(%)	125 (48.3)	48 (60)	36 (45)	0.116
Charlson comorbidity index, median (IQR)	0 (0–1)	2 (1–3)	2 (0–3)	<0.001
Place before hospitalization				
Home	243 (94.6)	70 (87.5)	71 (87.7)	0.022
Assisted living facility	3 (1.2)	3 (3.8)	6 (7.4)	
Other hospital	11 (4.3)	7 (8.8)	4 (4.9)	
Reason for hospital admission				0.125
Elective surgery	3 (1.2)	3 (3.8)	0 (0)	
Urgent surgery	9 (3.5)	0 (0)	2 (2.5)	
Medical admission	246 (95.3)	76 (96.2)	79 (97.5)	
Days between hospital admission and sepsis pathway activation episode, median (IQR)	0 (0–0)	0 (0–0)	0 (0–0)	0.148
Setting at sepsis pathway activation episode				
Emergency department	237 (91.5)	71 (88.8)	75 (92.6)	0.663
Wards	22 (8.5)	9 (11.3)	6 (7.4)	
Probable infection source				0.004
Pneumonia	40 (15.7)	21 (26.3)	26 (32.5)	
Urinary tract	49 (19.2)	18 (22.5)	20 (25)	
Abdominal	41 (16.1)	5 (6.3)	5 (6.3)	
Skin or soft tissue	11 (4.3)	5 (6.3)	3 (3.8)	
Central nervous system	3 (1.2)	0 (0)	0 (0)	
Bloodstream infection	1 (0.4)	0 (0)	0 (0)	
Other	35 (13.7)	3 (3.8)	3 (3.8)	
No specific source suspected	75 (29.4)	28 (35)	23 (28.8)	
Heart rate at sepsis pathway activation episode, mean ± SD	111 ± 19	100 ± 19	98 ± 21	<0.001
Systolic blood pressure at sepsis pathway activation episode, mean ± SD	126 ± 28	125 ± 32	136 ± 29	0.026
Respiratory rate at sepsis pathway activation episode, mean ± SD	20 ± 3.9	21 ± 6	22 ± 5.4	0.033
Temperature at sepsis pathway activation episode, mean ± SD	37.6 ± 1.2	37.1 ± 1.4	36.9 ± 1.2	<0.001
Vasoactive drugs at sepsis pathway activation episode, N(%)	7 (2.9)	6 (7.7)	7 (9.6)	0.035
Mechanical ventilation at sepsis pathway activation episode, N(%)	7 (2.7)	6 (7.7)	5 (6.4)	0.107
Lactate (mmol/L) at sepsis pathway activation episode, median (IQR)	1.2 (1.0–1.9)	1.7 (1.0–2.4)	1.5 (1.1–2.2)	0.084
qSOFA, mean ± SD	0.59 ± 0.7	0.96 ± 0.86	1.0 ± 0.85	<0.001
SIRS, mean ± SD	2.4 ± 1.1	2.1 ± 1.1	1.9 ± 1.2	<0.001
ICU admission, N(%)	91 (35.1)	49 (61.3)	51 (63)	<0.001
Vasoactive drugs in the ICU, N(%)	23 (26.7)	23 (46.9)	13 (25.5)	0.028
Mechanical ventilation in the ICU, N(%)	20 (23)	21 (42.9)	14 (26.4)	0.044
Renal replacement therapy in the ICU, N(%)	12 (14.5)	8 (16.3)	4 (7.8)	0.403
Days between sepsis pathway activation episode and ICU admission, median (IQR)	0 (0–1)	0 (0–1)	0 (0–1)	0.734
Length of stay in the ICU (days), median (IQR)	4 (2–9)	3 (2–7)	3 (2−10)	0.793
Positive blood cultures, N(%)	32 (13)	15 (19)	14 (17.7)	0.334
Length of hospital stay (days), median (IQR)	5 (2−13)	10 (5–23)	10 (4–20)	0.001
Hospital deaths, N(%)	25 (9.9)	19 (23.8)	26 (32.9)	<0.001

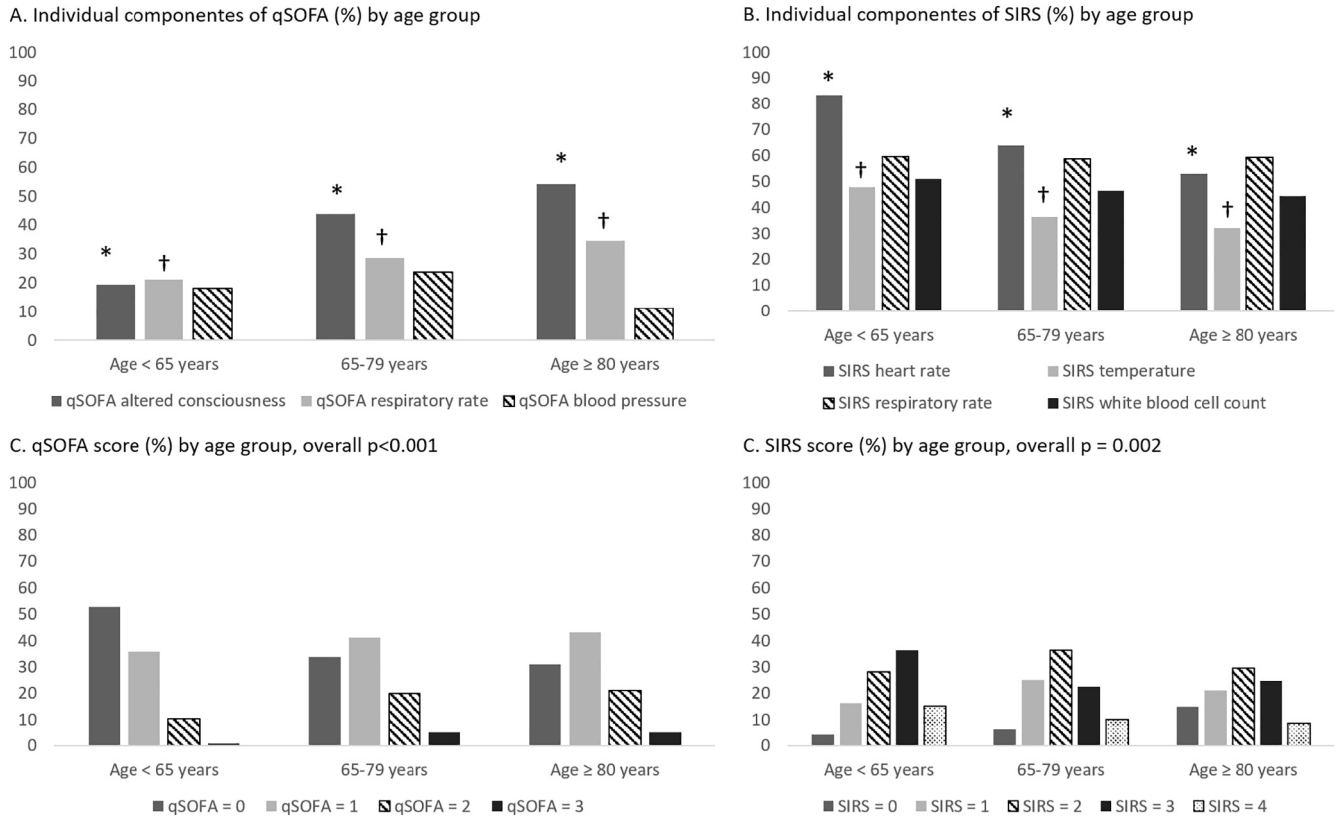

Fig. 1. Distribution of individual components of qSOFA (1A), SIRS (1B), overall qSOFA score (1C) and SIRS score (1D) by age group. *, $p < 0.001$; †, $p < 0.05$.

Associations of SIRS and outcomes were not modified in the different age groups. For hospital mortality, OR (95% CI) were 0.9 (0.3–2.7), 0.7 (0.2–2.2) and 0.9 (0.5–1.7) for patients younger than 65 years, 65 to 79 years and 80 years or older, respectively. For ICU admission, OR (95% CI) were 0.9 (0.5–1.6), 0.8 (0.3–2.2) and 0.6 (0.2–1.6) for patients younger than 65 years, 65 to 79 years and 80 years or older, respectively. For bacteremia, OR (95% CI) were 1.3 (0.5–3.5), 8.4 (1.0–67) and 1.7 (0.5–5.9) for patients younger than 65 years, 65 to 79 years and 80 years or older, respectively (Fig. 2).

3.3. Discrimination of qSOFA and SIRS in different age groups

As shown by the area under the ROC curve for hospital mortality, ICU admission and bacteremia, qSOFA was more accurate than SIRS for the defined outcomes, both overall and in most different age groups (Table 2). However, the accuracy of qSOFA was similar among the different age groups for the defined outcomes.

3.4. Missing data sensitivity analysis

We performed sensitivity analyses comparing patients with missing data and patients with complete dataset. There were 19 (4.5%) patients with missing data for calculation of the qSOFA consciousness parameter, 18 (4.3%) with missing data for calculation of the qSOFA hypotension parameter and 107 (25.5%) with missing data for calculation of the qSOFA respiratory parameter (Supplementary Fig. 1). When compared to patients without missing data, patients with missing data were less likely to be admitted to the ICU, but there were no other significant differences between the two groups (Supplementary Table 1). Rates of hospital mortality, ICU admission and bacteremia of patients with missing data were similar to those of patients with a qSOFA of 0 (Supplementary Fig. 2). Analyses of the strength of association of qSOFA with hospital mortality and of the accuracy of qSOFA for hospital mortality in patients without missing values yielded similar results to those from the overall cohort (Supplementary Table 3).

An analysis of missing data for SIRS is also presented in the Supplementary material (Supplementary Table 2, Supplementary Fig. 3 and Supplementary Fig. 4).

4. Discussion

In this study, which evaluated the accuracy of qSOFA across different age groups of patients with suspected infection outside of the ICU, we have shown that qSOFA was associated with adverse outcomes and that these associations were stronger in the older age groups, even though the overall accuracy of qSOFA did not change across the different age groups. SIRS was not associated with outcomes in this population.

The overall accuracy of qSOFA for hospital mortality, as measured by the AUC ROC, was 0.72, which was similar to what has been reported in the literature. For example, in a meta-analysis of studies evaluating the performance of qSOFA outside of the ICU, the pooled AUC for hospital mortality was 0.74 [16]. On the other hand, in this study, SIRS was not associated with hospital mortality with an overall AUC of 0.5. This finding is in contrast to what has been reported in other studies [16], although some studies have presented similar results [21-24]. Possibly, differences in case-mix, inclusion criteria and data collection methods may account for some of the observed differences [25]. Of note, we defined patients with suspected infection as patients who had sepsis pathway activation after physician assessment, which differs from other studies that have included patients based on antibiotic utilization and collection of cultures [19, 21, 23].

In our study, qSOFA demonstrated greater predictive ability in old (65–80 years) or very old (>80 years) patients. In these older patients, qSOFA was more strongly associated with hospital mortality, ICU admission and bacteremia. Overall, qSOFA was more strongly associated with outcomes than SIRS in every age group. The frequencies of tachycardia and altered temperature were significantly lower among older

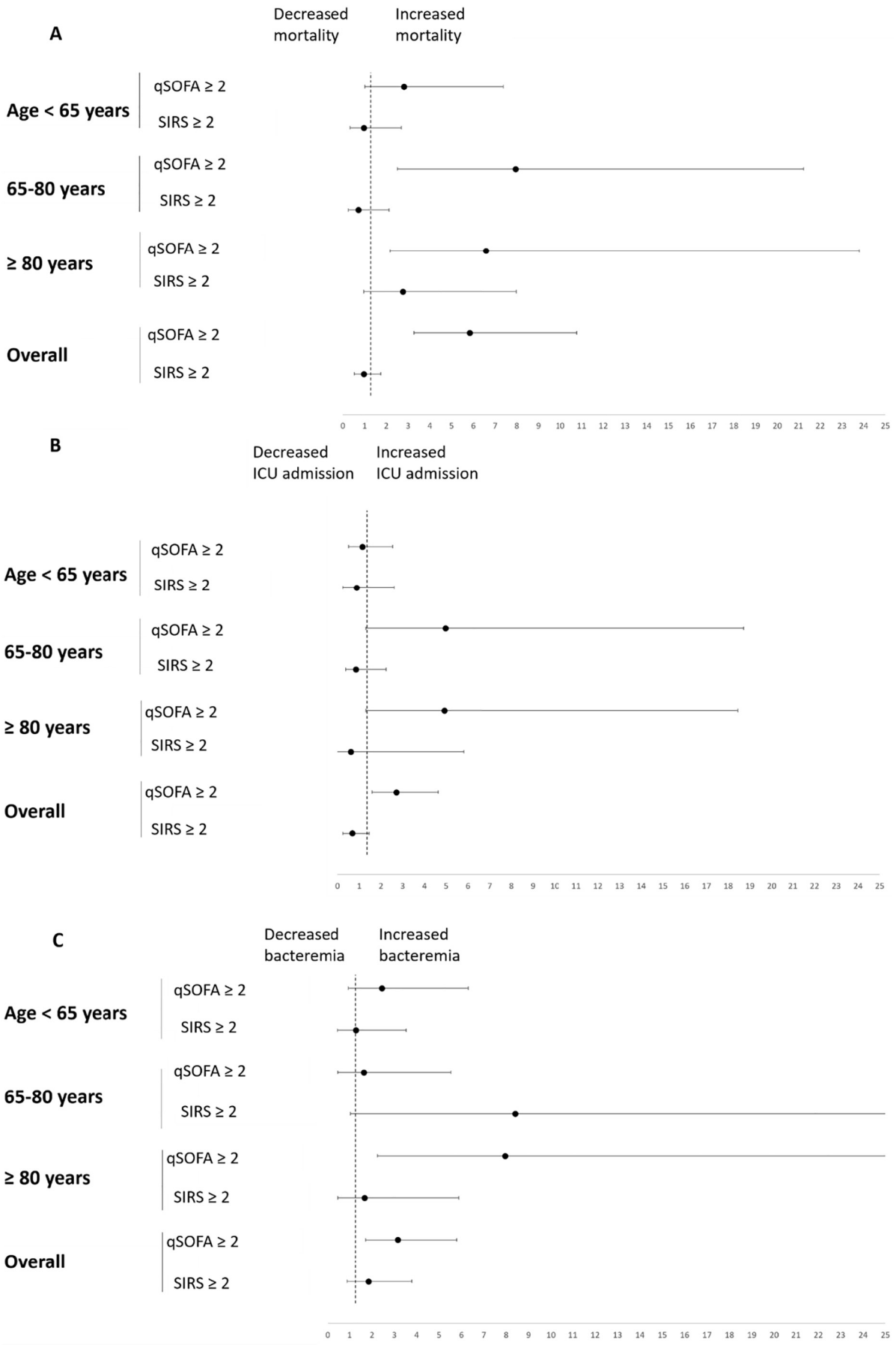

Fig. 2. Association of qSOFA and SIRS with outcomes by age group.

Table 2
Area under ROC curve for SIRS and qSOFA for hospital mortality (A), ICU admission (B) and bacteremia (C) by age group.

A. AUROC for hospital mortality					B. AUROC for ICU admission					C. AUROC for bacteremia				
Characteristic	AUC	95% CI		p	Characteristic	AUC	95% CI		p	Characteristic	AUC	95% CI		p
		Lower	Upper				Lower	Upper				Lower	Upper	
Age < 65 years					Age < 65 years					Age < 65 years				
qSOFA	0.679	0.569	0.789	0.003	qSOFA	0.641	0.571	0.711	<0.001	qSOFA	0.594	0.484	0.705	0.057
SIRS	0.495	0.385	0.605	0.935	SIRS	0.499	0.425	0.574	0.986	SIRS	0.584	0.478	0.69	0.054
65–79 years					65–79 years					65–79 years				
qSOFA	0.738	0.599	0.877	0.071	qSOFA	0.69	0.571	0.808	0.004	qSOFA	0.562	0.398	0.726	0.457
SIRS	0.466	0.311	0.622	0.079	SIRS	0.452	0.323	0.582	0.474	SIRS	0.697	0.555	0.838	0.018
Age ≥ 80 years					Age ≥ 80 years					Age ≥ 80 years				
qSOFA	0.714	0.589	0.84	0.002	qSOFA	0.665	0.546	0.783	0.014	qSOFA	0.787	0.674	0.899	0.001
SIRS	0.649	0.518	0.78	0.032	SIRS	0.442	0.312	0.573	0.389	SIRS	0.599	0.456	0.742	0.248
Total					Total					Total				
qSOFA	0.724	0.656	0.792	<0.001	qSOFA	0.671	0.619	0.723	<0.001	qSOFA	0.64	0.561	0.718	0.001
SIRS	0.5	0.426	0.573	0.993	SIRS	0.45	0.395	0.506	0.079	SIRS	0.595	0.522	0.669	0.018

patients, even though tachypnea and altered mental status were more common among older patients in our population. The results have been mixed in other studies. In a retrospective, unicentric study evaluating patients with positive blood cultures [9], older patients presented more frequently with atypical symptoms, and SIRS criteria had poor prognostic accuracy. In another retrospective, unicentric study evaluating patients with suspected infection at the emergency department [26], similar to our data, elderly patients were less likely to present with altered temperature, tachycardia or abnormal white blood cell count, but they were more likely to present with tachypnea. Nevertheless, SIRS was marginally more likely to predict bacteremia in older patients than in younger patients but was not associated with mortality after multivariable analysis [26]. In the only other study specifically evaluating the performance of qSOFA in older patients, 1071 elderly patients (>75 years) were prospectively evaluated in a multicenter cohort [27]. In that study, qSOFA was the most specific score to predict mortality, with a specificity of 94%, a sensitivity of 28% and an AUC of 0.69. On the other hand, SIRS was marginally less accurate with an AUC of 0.65, but it had a greater sensitivity of 65% and a lower specificity of 49%. That study, however, did not compare older patients with younger patients, and it included a less severe population with a 30-day mortality of 6.5%, whereas the mortality of older patients in our study ranged from 24 to 33%.

We have shown that older age was associated with worse outcomes in a cohort of patients with suspected infection. This association has been widely reported in the literature [9, 26]. For instance, in the original derivation and validation cohort for qSOFA, age was part of the baseline risk for hospital mortality [19]. Older age is also associated with greater mortality in a wide range of other critical illnesses, but mortality may decrease with time [28, 29]. Nevertheless, indiscriminate admission of very elderly patients to the ICU may be not-beneficial – it may even be harmful [30]. As life expectancy increases and rates of ICU admission of elderly patients also increase in parallel, there has been special interest in the management of critical illness in this population, including tools for prognosis assessment and decision-making [31]. Quick-SOFA appears to be a promising tool for rapid evaluation of elderly patients with suspected sepsis. However, other information will need to be integrated in the decision-making process of how to treat a specific patient, such as functional status, co-morbidities and patient's and relatives' wishes [31-33].

This study has several strengths. To the best of our knowledge, it is one of the few studies to evaluate the performance of sepsis criteria in older patients and the first to specifically compare the performance of qSOFA in different age groups. Moreover, qSOFA was proposed as clinical criteria to help differentiate patients with an increased risk of mortality and not as a diagnostic tool for sepsis [14, 34, 35]. In our study, we have included selected patients who were judged as severe enough to lead to the activation of the sepsis pathway after physician assessment, which may increase the pretest probability of adverse outcomes in those patients. In that way, this study probably does not suffer from an oversampling of less severe patients, which may falsely inflate the accuracy of prognostic scores [36]. This approach may also help explain the findings on SIRS accuracy in our data.

The study, however, also has several limitations. It is a retrospective study. As such, we may have missed some patients in our cohort. Moreover, the retrospective nature of the study led to some missing data. Although missing data were minimal for most variables, the percentage of missing data was up to 25% for respiratory rate. Missing data on vital signs is a common problem and it has been reported that, in general wards, the frequency of incomplete vital signs assessment is high, e.g., up to 77% for the absence of registration of respiratory rate in the 48 h before an adverse event [37]. Missing data was also a problem in studies evaluating qSOFA, with up to 35% of missingness for respiratory rate in a recently published study evaluating qSOFA in low and middle income countries [20] and was also common in the original validation cohort for qSOFA [19]. It is expected that any choice for handling missing data may incur an additional bias [38]. We have chosen to input normal values for missing data because it is common guidance for prognostic scores [39] and because it was the approach in the original validation cohort for qSOFA and subsequent studies [19, 20, 40]. Additionally, sensitivity analyses demonstrated that patients with missing data performed similarly to patients with normal values. Nevertheless, we also presented in the study sensitivity analyses comparing patients with complete datasets to patients with missing variables for further interpretation and clarification of the findings. Moreover, pragmatically, it has been hypothesized that some of this missingness may reflect the likely condition in clinical practice [20, 40]. Another limitation is that we were unable to retrieve information on functional status and frailty of the patients studied. However, most of our patients came from home and had low comorbidity scores, implying that these patients were probably fit, even though the frequency of patients coming from home decreased and the Charlson comorbidity index increased with older age.

This study raises important questions about the performance of qSOFA in different age groups and the performance of SIRS in older patients. It is possible that different clinical criteria may perform better in different sepsis phenotypes. The investigation of different subgroups may help personalize and reduce imprecision in patient care, especially in the older population [41].

5. Conclusion

In this cohort of patients with suspected infection outside of the ICU, qSOFA was associated with adverse outcomes and these associations were stronger in the older age groups, whereas SIRS was not associated with outcomes in this population.

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Conflicts of interest

The authors declare no conflict of interest.

Authors' contribution

JGRR and RHP contributed to the designing, acquisition, analysis and interpretation of data, drafting and revising the manuscript. MT and AG contributed to the designing, acquisition of data, drafting and revising the manuscript. RC contributed to the acquisition of data, drafting and revising the manuscript. JC, SFG, MPR and PBP contributed to the designing, drafting and revising the manuscript.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jcrc.2018.07.008.

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