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ORIGINAL ARTICLE – OPEN ACCESS

The Role of the Quick Sequential Organ Failure Assessment Score (qSOFA) in the Pre-Hospitalization Prediction of Coronavirus Disease 2019 (COVID-19) Prognosis

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ABSTRACT

Objective: Researchers have been investigating numerous biomarkers and scoring systems to predict the prognosis of coronavirus disease 2019 (COVID-19). We aimed to determine the effectiveness of the quick sequential organ failure assessment (qSOFA) scoring system in pre-hospital emergency health care for predicting COVID-19 prognosis in terms of the intensive care unit (ICU) admission and mortality.

Materials and Methods: We enrolled 9850 patients suspected to have COVID-19 who were transferred by 112 emergency medical services (EMS) between April 1, 2020 and July 1, 2020. Demographic and clinical data of the patients were obtained from the Ankara Emergency Health Services Automation System. The qSOFA score was calculated based on the data obtained from the ambulance medical records.

Results: The 28-day mortality rate was 6.2% (n=13) and the cut-off for the qSOFA score was >1 [area under the curve (AUC)=0.955, sensitivity 84.62%, specificity 90.4%, p<0.001, 95% confidence interval (CI): 0.918–0.979)]. The cut-off for ICU admission was a qSOFA score >1 (AUC=0.942; sensitivity 97.37%; specificity 84.97%; p<0.001; 95% CI, 0.901–0.969). The mortality risk was 51.8 times more in patients with a high qSOFA score (p<0.001; 95% CI, 10.682–251.340). Moreover, patients with a high qSOFA score were 47.7 times more likely to require ICU admission (p<0.001; 95% CI, 16.735–136.039).

Conclusion: Thus, the pre-hospital qSOFA score that comprises the ambulance vital signs of the patients can be used to predict ICU admissions and mortality in patients with COVID-19.

Keywords: COVID-19, quick sequential organ failure assessment, pre-hospital, mortality, emergency medical services, intensive care unit

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INTRODUCTION

Cases of pneumonia of unknown etiology were reported in Wuhan, Hubei, China, in December 2019 (1). The causative agent was the 2019 novel coronavirus (2019-nCoV), a virus that closely resembles certain beta-coronaviruses detected in bats, belonging to the sarbecovirus subgenus of the coronaviridae family (2). 2019-nCoV is believed to be transmitted from person-to-person via infected people or carriers (3). The epidemic rapidly spread across the world and was eventually declared a global pandemic by the World Health Organization (4).

Coronaviruses can cause various respiratory, enteric, neurological, and hepatic diseases (5). The prognosis of respiratory infections is more severe, especially among elderly individuals and those with existing underlying diseases (6). Early diagnosis of 2019-nCoV is crucial because the time interval between admission to the hospital and the development of acute respiratory distress syndrome is short, and the mortality rate is high (7). The rapid course of the disease and its high mortality rate requires a careful choice of hospital. As per a recent study conducted in the United States of America, 4000 patients could have been saved during 1 y if they were transferred to a more qualified hospital (8). Currently, an increasing number of patients in critical condition are in need of a transfer between medical care units. Inter-unit transfer poses significant risks to critical patients, especially those requiring multiple organ support (9).

There is a need to develop a clinical tool that can be used in emergency medical services (EMS) in a pre-hospital setting before examining any laboratory parameter to identify infected patients at increased risk of poor outcomes and complications (10). For paramedics and emergency room triage, it is primarily important to establish a clinical score to identify the most severe cases among the infected patients as early as possible (11). The quick sequential organ failure assessment (qSOFA) is a scoring system that includes basic vital signs and can be easily calculated at the bedside in pre-hospital and emergency department settings. The qSOFA score is reportedly successful in predicting poor clinical outcomes among the non-intensive care unit (ICU) patients with suspected infections (12). Calculating early warning scoring systems during hospitalization can help predict critical outcomes in patients with coronavirus

disease 2019 (COVID-19). Thus, early intervention can improve the clinical outcomes in high-risk patients with COVID-19 (13).

The increasing number of COVID-19 patients in our country and around the world requires intensive in hospital-based care and pre-hospital EMS. It is necessary to select hospitals that can provide advanced or specific examination and treatment facilities as per the patients' needs and ensure advanced life support and intensive care services along with sufficient medical equipment with the EMS. If patient prognosis in COVID-19 can be predicted by the EMS personnel using qSOFA score, more accurate hospital selection can be made without too much time spent on pre-hospital admission. Pandemic hospitals have been identified in our country; medical services and intensive care bed numbers of pandemic hospitals are monitored, and the patient is accordingly directed to the appropriate hospital. If this is not implemented, transfers between medical units would become necessary, and a second transfer between units poses a risk for critical patients and increases the workload during urgent need periods. Early diagnosis and correct hospital selection by the pre-hospital EMS personnel are predicted to shorten the patient's time to treatment and this lower the mortality and morbidity rates. In this study, we aimed to reveal the place and effectiveness of the use of qSOFA scoring systems in pre-hospital emergency health services for predicting the prognosis of patients with COVID-19.

MATERIALS and METHODS

This was a retrospective cohort study that was approved by the local ethics committee for research studies of the Dr. Abdurrahman Yurtaslan Oncology Education and Research Hospital (Date: July 22, 2020, No: 2020-07/707).

Overall, 9850 patients with suspected COVID-19 transferred by 112 EMS in the period from April 1, 2020 to July 1, 2020 were enrolled. Patients suspected to have COVID-19 were registered in the system with ICD code Z.03.8–observation for other suspected diseases and conditions were ruled out. Eligible patients were screened for the following inclusion criteria during the study period: age >18 y and a positive RT-PCR result. The exclusion criteria were as follows: no qSOFA score due to lack of data and negative RT-PCR result.

Of the screened subjects, 9639 did not meet our criteria and were excluded; 211 patients who fulfilled the inclusion criteria were enrolled. The demographic and clinical data of the patients were obtained from the Ankara Emergency Health Services Automation System. The qSOFA score was calculated based on the data obtained from the ambulance patient records. Data concerning 30-day mortality were obtained from the Turkish Death Notification System.

QSOFA score: This scale uses the following 3 criteria, assigning a score each for low blood pressure (SBP ≤100 mmHg), high respiratory rate (22 breaths per minute), or altered mentation (Glasgow coma scale <15). The score ranged from 0 to 3.

Data Analyses

Data were analyzed using IBM SPSS Statistics 25.0 (IBM Corp., Armonk, NY, USA) and MedCalc 15.8 (MedCalc Software bvba, Ostend, Belgium). Descriptive statistics, including frequency, percentages, mean values, standard deviation values, median values, and minimum–maximum values were calculated. The qualitative data were evaluated using the chi-square (Yates Chi-Square, Fish-

Table 1. Patient characteristics

	n=211	%
Sex		
Female	103	48.8
Male	108	51.2
Age (y)*	50.2±18.8	50 (16–93)
Cough		
Yes	129	61.1
Fever		
Yes	86	40.8
Dyspnea		
Yes	55	26.1
Headache		
Yes	16	7.6
Nausea		
Yes	18	8.5
Myalgia		
Yes	56	26.5
Diarrhea		
Yes	10	4.7
Low back pain		
Yes	1	0.5
Anosmia		
Yes	9	4.3
Abdominal pain		
Yes	1	0.5
Arthralgia		
Yes	10	4.7
Ageusia		
Yes	9	4.3
ICU admission		
Yes	38	18.0
Survival		
Died	13	6.2
Survived	198	93.8
qSOFA Score*	0.5±0.9	0 (0–3)
0	148	70.1
1	33	15.6
2	16	7.6
3	14	6.6
Mortality risk according to the qSOFA Score		
Low	181	85.8
High	30	14.2

*: Mean±SD/Median (minimum–maximum); qSOFA: Quick Sequential Organ Failure Assessment Score; ICU: Intensive care uni

Table 2. qSOFA Score ICU Admission and Survival ROC analysis

	AUC 95% CI	Cut-off*	Sensitivity 95% CI	Specificity 95% CI	Youden's index	p**
qSOFA Score –	0.942	≥1	97.37	84.97	0.823	**0.000**
ICU admission	0.901–0.969		86.2–99.9	78.8–89.9		
qSOFA Score –	0.955	≥2	84.62	90.4	0.750	**0.000**
Survival	0.918–0.979		54.6–98.1	85.4–94.1		

qSOFA: Quick sequential organ failure assessment score; AUC: Area under the curve; CI: Confidence interval; ICU: Intensive care unit; *: Cut-off values for the test were set according to Youden's index (Sensitivity + Specificity -1); **: ROC (Receiver operating characteristics) curve

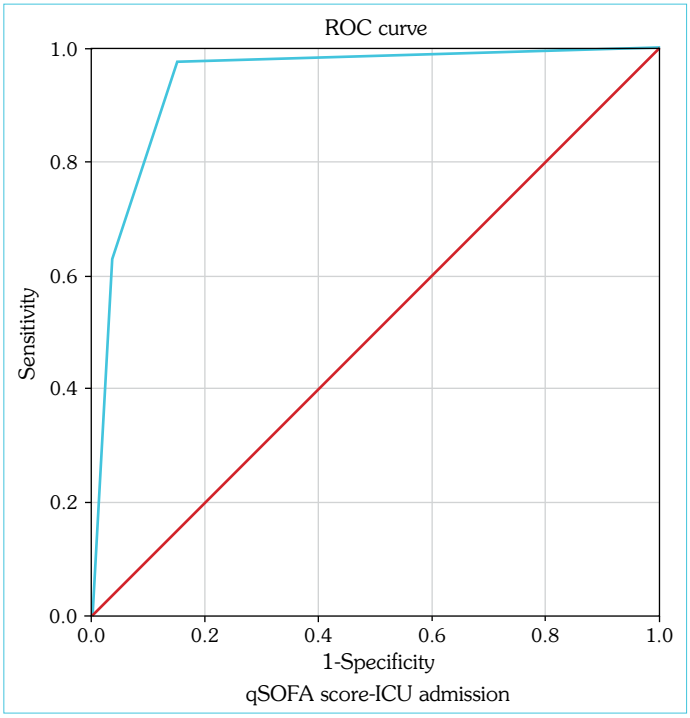

Figure 1. ROC analysis to determine the parameters contributing to ICU admission

ROC: Receiver operating characteristics; ICU: Intensive care unit; qSOFA: Quick Sequential Organ Failure Assessment Score

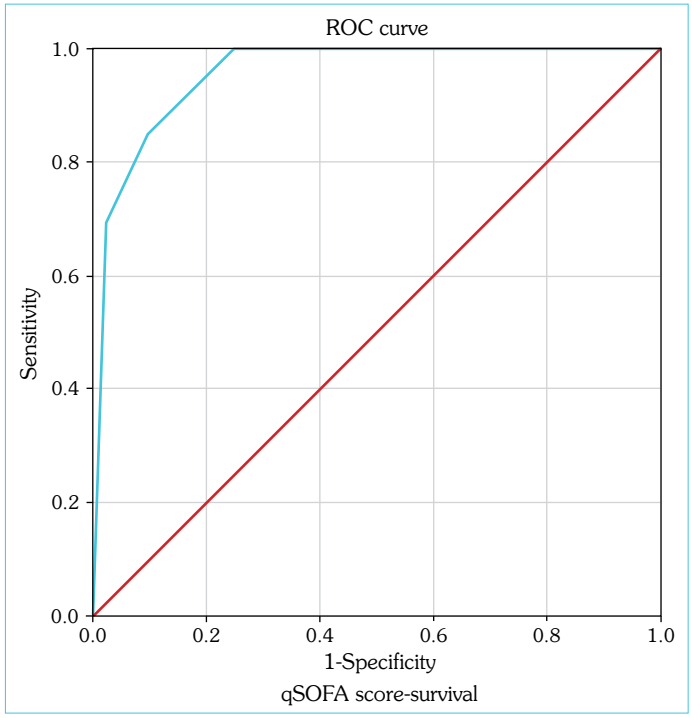

Figure 2. ROC analysis regarding the parameters for predicting 28-day mortality

ROC: Receiver operating characteristics; qSOFA: Quick Sequential Organ Failure Assessment Score

er's Exact) test. Odds ratio was calculated with risk analysis. The receiver operating characteristic (ROC) curve method was used to assess the diagnostic significance of the tested parameters. Cut-off values for the test were set as per Youden's index. Statistical significance was accepted at α=0.05.

RESULTS

Our study population included 108 men (51.2%), and the average patient age was 50.2±18.8 y. The most common reasons for seeking EMS in patients with COVID-19 were cough (61.1%, n=129), fever (40.8%, n=86), myalgia (26.5%, n=56), and dyspnea (26.1%, n=55). In addition, 18% (n=38) of the patients diagnosed with COVID-19 were admitted to the ICU. The 28-day mortality rate was 6.2% (n=13). Of these patients, 70.1% (n=148) had a qSOFA score of 0, 15.6% (n=33) had a score of 1, 7.6% (n=16) had a score of 2, and 6.5% (n=14) had a score of 3. Thus, 30 patients had an increased mortality risk (Table 1).

In terms of ICU admission, patients with a qSOFA score >1 were significantly more likely to be admitted to the ICU (p<0.05) (Table 2).

Admission

The ROC analysis revealed that for ICU admission, the cut-off was a qSOFA score >1 [area under the curve (AUC)=0.942, sensitivity 97.37%, specificity 84.97%, p<0.001, 95% confidence interval (CI): 0.901–0.969] (Fig. 1).

The 28-day mortality rate was significantly higher among patients with a qSOFA score >2 (p<0.05) (Table 2).

The ROC analysis revealed that for the 28-day mortality, the cut-off was a qSOFA score >1 (AUC=0.955; sensitivity 84.62%; specificity 90.4%; p<0.001; 95% CI, 0.918–0.979). (Fig. 2).

The qSOFA criteria could significantly help in predicting early mortality. The mortality risk was 51.8 times higher in patients with a high qSOFA score (p<0.001; 95% CI, 10.682–251.340) (Table 3).

Table 3. qSOFA Score Comparisons

	Mortality risk as per the qSOFA score				
	High (n=30)	**Low (n=181)**	**p**	**OR**	**95% CI**
ICU admission					
Yes	24 (80.0%)	14 (7.7%)	**0.000***	47.7	16.735–136.039
No	6 (20.0%)	167 (92.3%)			
Survival					
Died	11 (36.7%)	2 (1.1%)	**0.000****	51.8	10.682–251.340
Survived	19 (63.3%)	179 (98.9%)			

qSOFA: Quick Sequential Organ Failure Assessment Score; *: Yates chi-square test; **: Fisher's exact test; OR: Odds ratio; CI: Confidence interval; ICU: Intensive care unit

Moreover, the qSOFA score could significantly enable the prediction of ICU admission. Patients with a high qSOFA score were 47.7 times more likely to require ICU admission (p<0.001; 95% CI, 16.735–136.039) (Table 3).

DISCUSSION

The present findings indicate that the pre-hospital qSOFA score that comprises the ambulance vital signs of patients can be used to predict ICU admissions and mortality of patients with COVID-19.

Moreover, 51.2% (n=108) of the subjects were men, and the average patient age was 50.2±18.8 y. A large-scale study by Richardson et al. (14) reported that the mean age of their study population that comprised patients with COVID-19 was 63 y; of these, 60.3% were men. Fu et al. (15) indicated that the average age of patients with COVID-19 was 46.6±14 years; of which, 60% of these were men. These data are consistent with the findings reported in the literature in terms of the age and sex distribution of patients with COVID-19.

In this study, the most common reasons for seeking EMS in patients with COVID-19 were cough, fever, myalgia, and dyspnea. Similarly, Argenziano et al. (16) reported that the most common symptoms in these patients were cough (732/1000), fever (728/1000), and dyspnea (631/1000). Yang et al. (17) reported fever, shortness of breath, and myalgia in patients with COVID-19 who were transported by EMS. These patients indicated similar complaints in pre-hospital EMS as those on hospital admission.

In the context of the global COVID-19 pandemic, early diagnosis of patients who are at risk of severe disease and choosing the correct hospital are crucial. The qSOFA score was proposed by the Sepsis-3 study published in 2016 as a good prognostic factor for predicting the mortality and ICU hospitalization in non-ICU patients and was emphasized to have successfully predicted the in-hospital mortality (12). Despite being commonly used in clinical practice, the predictive performance of the qSOFA score has not been evaluated in patients with COVID-19. Jang et al. (13) reported an AUC value of 0.779 (95% CI, 0.600–0.957) of the admission qSOFA scores for predicting the mortality of COVID-19 patients. Myrstad et al. (18) reported that the AUC value for a qSOFA score >1 for predicting the mortality in patients with COVID-19 was 0.624 (0.446–0.810). Fan et al. (19) indicated that in patients with COVID-19 pneumonia, a qSOFA score >1 had an AUC value of 0.73 (95% CI, 0.69–0.78) with 82% sensitivity (0.75–0.89) and 57% specificity (0.53–0.61). In this study, the AUC for a qSOFA score >1 for predicting the mortality of patients with COVID-19 was calculated as 0.942 (95% CI, 0.901–0.969, sensitivity 94%, specificity 84.97%).

Jang et al. (13) reported that the AUC value for a qSOFA score >1 for predicting ICU admission was 0.776 (95% CI, 0.620–0.899). In this study, the AUC value of a qSOFA score >1 was 0.942 (95% CI, 0.901–0.969, sensitivity 94%, specificity 84.97%). The pre-hospital qSOFA score had high sensitivity and specificity in patients with COVID-19.

Based on the patient's vital signs, EMS technicians calculate the pre-hospital qSOFA score to predict the ICU admission and mortality of patients with COVID-19. A high qSOFA score was associated with a 47.7-fold increase in ICU admission and a 51.8-fold increase in the mortality. To our knowledge, this is the first study on the predictive performance of a pre-hospital scoring system in the context of COVID-19; more studies on this subject are warranted.

Limitations

We received PCR confirmation positivity in the diagnosis of COVID-19. However, we were unable to include PCR negative, clinical, and computed tomography compatible patients with COVID-19.

CONCLUSION

In conclusion, the pre-hospital qSOFA score that comprises the ambulance vital signs of patients can be used to predict ICU admissions and mortality among patients with COVID-19.

Ethics Committee Approval: This was a retrospective cohort study that was approved by the local ethics committee for research studies of the Dr. Abdurrahman Yurtaslan Oncology Training and Research Hospital (date: 22.07.2020, number: 2020-07/707).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – EU; Design – SK; Supervision – EU; Resource – EU; Materials – SK; Data Collection and/or Processing – EU; Analysis and/or Interpretation – EU; Literature Search – SK; Writing – EU; Critical Reviews – SK.

Conflict of Interest: The authors have no conflict of interest to declare.

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REFERENCES

1. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of novel Coronavirus-infected pneumonia. N Engl J Med 2020; 382(13): 1199207. [CrossRef]
2. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A Novel Coronavirus from Patients with Pneumonia in China, 2019. N Engl J Med 2020; 382(8): 727–33. [CrossRef]
3. Du Z, Wang L, Cauchemez S, Xu X, Wang X, Cowling BJ, et al. Risk for Transportation of Coronavirus Disease from Wuhan to Other Cities in China. Emerg Infect Dis 2020; 26(5): 1049–52. [CrossRef]
4. World Health Organization. Coronavirus disease (COVID-19) Situation reports 102. Available from: URL: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/5. Accessed May 2, 2020.
5. Bennett J, Dolin R, Blaser MJ. Mandell, Douglas, and Bennett's principles and practice of infectious diseases.2- Vol Set. 8th edition. Elsevier Health Sciences, Saunders; 2015.
6. Lu R, Yu X, Wang W, Duan X, Zhang L, Zhou W, et al. Characterization of human coronavirus etiology in Chinese adults with acute upper respiratory tract infection by real-time RT-PCR assays. PLoS One 2012; 7(6): e38638. [CrossRef]
7. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020; 395(10223): 497–506. [CrossRef]
8. Kahn JM, Linde-Zwirble WT, Wunsch H, Barnato AE, Iwashyna TJ, Roberts MS, et al. Potential value of regionalized intensive care for mechanically ventilated medical patients. Am J Respir Crit Care Med 2008; 177(3): 285–91. [CrossRef]
9. Droogh JM, Smit M, Absalom AR, Ligtenberg JJ, Zijlstra JG. Transferring the critically ill patient: are we there yet?. Crit Care 2015; 19(1): 62.
10. Seymour CW, Rea TD, Kahn JM, Walkey AJ, Yealy DM, Angus DC. Severe sepsis in pre-hospital emergency care: analysis of incidence, care, and outcome. Am J Respir Crit Care Med 2012; 186(12): 1264–71.
11. Tusgul S, Carron PN, Yersin B, Calandra T, Dami F. Low sensitivity of qSOFA, SIRS criteria and sepsis definition to identify infected patients at risk of complication in the prehospital setting and at the emergency department triage. Scand J Trauma Resusc Emerg Med 2017; 25(1): 108.
12. Seymour CW, Liu VX, Iwashyna TJ, Brunkhorst FM, Rea TD, Scherag A, et al. Assessment of Clinical Criteria for Sepsis: For the Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). JAMA 2016; 315(8): 762–74. Erratum in: JAMA 2016; 315(20): 2237. [CrossRef]
13. Jang JG, Hur J, Hong KS, Lee W, Ahn JH. Prognostic Accuracy of the SIRS, qSOFA, and NEWS for Early Detection of Clinical Deterioration in SARS-CoV-2 Infected Patients. J Korean Med Sci 2020; 35(25): e234. [CrossRef]
14. Richardson S, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW, et al; the Northwell COVID-19 Research Consortium. Presenting Characteristics, Comorbidities, and Outcomes Among 5700 Patients Hospitalized With COVID-19 in the New York City Area. JAMA 2020; 323(20): 2052–9. Erratum in: JAMA 2020; 323(20): 2098. [CrossRef]
15. Fu J, Kong J, Wang W, Wu M, Yao L, Wang Z, et al. The clinical implication of dynamic neutrophil to lymphocyte ratio and D-dimer in COVID-19: A retrospective study in Suzhou China. Thromb Res 2020;192: 3–8. [CrossRef]
16. Argenziano MG, Bruce SL, Slater CL, Tiao JR, Baldwin MR, Barr RG, et al. Characterization and clinical course of 1000 patients with coronavirus disease 2019 in New York: retrospective case series. BMJ 2020; 369: m1996. [CrossRef]
17. Yang BY, Barnard LM, Emert JM, Drucker C, Schwarcz L, Counts CR, et al. Clinical Characteristics of Patients With Coronavirus Disease 2019 (COVID-19) Receiving Emergency Medical Services in King County, Washington. JAMA Netw Open 2020; 3(7): e2014549. [CrossRef]
18. Myrstad M, Ihle-Hansen H, Tveita AA, Andersen EL, Nygård S, Tveit A, et al. National Early Warning Score 2 (NEWS2) on admission predicts severe disease and in-hospital mortality from Covid-19 - a prospective cohort study. Scand J Trauma Resusc Emerg Med 2020; 28(1): 66. [CrossRef]
19. Fan G, Tu C, Zhou F, Liu Z, Wang Y, Song B, et al. Comparison of severity scores for COVID-19 patients with pneumonia: a retrospective study. Eur Respir J 2020; 56(3): 2002113. [CrossRef]