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Original Article

Diagnostic Accuracy of Lactate, SOFA and qSOFA Scores as Predictors of Mortality in Sepsis and Septic Shock

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Abstract

Objective: This study aims to assess the accuracy of serum lactate levels, SOFA and qSOFA scores as prognostic indicators of mortality in sepsis patients, and to compare their accuracy in our population and setting.

Methods: This retrospective cohort study assessed all adult patients hospitalized at the Aga Khan University Hospital from October 2019 and December 2019 with the diagnosis of sepsis. Data of the included patients was collected from medical records and extracted variables included demographics, patient and hospitalization characteristics, laboratory investigations and outcome.

Results: Three hundred and sixty-six patients were admitted during the study period with the diagnosis of sepsis. There were 208 (57%) males and 158 (43%) females; mean age was 59 ± 18 years. Overall mortality in sepsis was 25% and mean length of stay was 7.5 ± 6.2 days. The AUROC of serum lactate for predicting mortality was 0.79 with 81% sensitivity and 64% specificity. Furthermore, the AUROC of SOFA for predicting mortality was 0.54 with 60% sensitivity and 43% specificity in comparison to the AUROC of qSOFA score which was 0.49 with 54% sensitivity and 48% specificity.

Conclusion: In our sepsis patients, serum lactate levels were more reliably associated with mortality; qSOFA and SOFA scores had low sensitivity and specificity as mortality predictors. Further large-scale studies are needed in our population to determine the utility and reliability of these tools.

Key Words: sepsis; lactate; SOFA; qSOFA; sensitivity and specificity.

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Introduction

Sepsis is defined as a host inflammatory response to infection that can result in organ dysfunction and failure, while septic shock is a subcategory of sepsis that has a greater risk of mortality.[1,2]

It has a mortality rate of 20-30%.[3,4] Early identification and treatment of sepsis can improve patient outcomes and reduce mortality.[5] Hence, various biomarkers are being tested for their value as prognostic indicators in sepsis and septic shock.

Serum lactate level is one such prognostic marker in patients with sepsis.[6,7] Various studies have shown serum lactate levels to be a predictor of mortality in patients with septic shock with cut-offs ranging from ≥4 mmol/L to > 10 mmol/L, and higher levels predicting higher mortality.[8-18] Thus, serum lactate levels can aid in early identification of patients with high risk of mortality, allowing early and more focused treatment.

Similarly, the SOFA score, developed in the early 1990s, giving points according to the extent of hepatic, renal, pulmonary, cardiovascular, hematological and neurological dysfunction and the shorter quick SOFA (qSOFA) score, designed by the Sepsis-3 task force, in light of the new sepsis definition centered on organ dysfunction, are prognostic markers used to predict mortality in the Intensive Care Unit (ICU) setting.[19,20] Studies have shown serum lactate to be a more accurate predictor of mortality than the SOFA score or qSOFA score.[7,21] This study aims to assess the accuracy of serum lactate levels, SOFA scores and qSOFA scores as prognostic indicators of mortality in sepsis patients, and to compare their accuracy in patients admitted with sepsis at a quaternary care center in Karachi, Pakistan.

Methods

We assessed all adult patients hospitalized at the Aga Khan University Hospital, a 740 bed quaternary care center in Karachi, between October 2019 and December 2019 with the diagnosis of sepsis. The study was approved by the Institutional Review Board and informed consent was waived because of the retrospective nature of the study and that the analysis used anonymous clinical data. Patients were identified using the ICD-9 codes for sepsis (995.91), severe sepsis (995.92) or septic shock (785.52).

Data was collected from medical records of patients using a pre-approved pro forma. The extracted variables included demographics, patient and hospitalization characteristics, laboratory investigations and outcome. The first serum lactate reading during the admission was considered for analysis. The SOFA and qSOFA scores were calculated by our research team using the relevant clinical findings and laboratory readings documented for each patient. Outcome measures included in-hospital mortality and length of stay. IBM SPSS 22 was used for data analysis. We compared clinical characteristics of the mortality and survival group using chi-square test for categorical variables, and Student t test for continuous variables. P-values ≤ 0.05 were considered significant. Serum lactate, qSOFA and SOFA scores were compared by assessing the area under the receiver operating curve (AUROC).

Results

Three hundred and sixty-six patients were admitted during the study period with the diagnosis of sepsis, severe sepsis and/or septic shock. There were 208 (57%) males and 158 (43%) females; mean age was 59±18 years. Patient demographics and hospitalization characteristics are presented in table 1. Overall mortality in sepsis was 25% and mean length of stay was 7.5 ± 6.2 days (Figure 1).

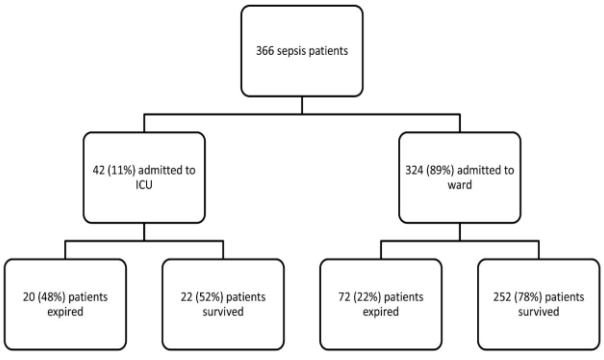

Figure 1: *Outcome of Sepsis patients (N = 366)*

Table 1: *Characteristics of Sepsis Patients (n = 366)*

Characteristics	Overall (N = 366)	Expired (N = 92)	Survived (N=274)	P value
Mean age (years)	59.2 ± 18	60.6 ± 17.1	58.8±18.5	0.398
Gender				**0.544**
Male	208 (57%)	55 (%)	153 (%)	
Female	158 (43%)	37 (%)	121 (%)	
Comorbid conditions				
Charlson score	3.9 ± 2.5	4.1 ± 2.4	3.9 ± 2.5	0.406
Diabetes	165 (45%)	34 (%)	131 (%)	0.090
Hypertension	194 (53%)	47 (%)	147 (%)	0.718
Ischemic heart disease	127 (35%)	35 (%)	92 (%)	0.450
Chronic Kidney Disease	92 (25%)	22 (%)	70 (%)	0.783
Malignancy	45 (12%)	18 (%)	27 (%)	0.018
Clinical characteristics				
GCS	13 ± 2	13.2 ± 3.4	13.8 ± 2.6	0.079
Respiratory rate	25.8 ± 7.0	27.1 ± 8.8	25.5 ± 6.3	0.091
Systolic blood pressure	120.3±27.1	116.9±26.9	121.5±27.1	0.151
PaO2	91.7±31.2	88.2±24.1	92.9±33.4	0.223
FiO2	26.9±13.7	30.3±16.8	25.9±12.3	0.007
MAP	86.1±20.1	84.2±21.0	86.8±19.9	0.297
Septic Shock	115(31%)	49 (%)	66 (%)	<0.001
ICU admission	42 (11%)	20 (%)	22 (%)	0.001
Intubation	80 (22%)	37 (%)	43 (%)	<0.001
Mean serum lactate (mmol/L)	4.1±3.8	4.9 ± 0.5	2.8 ± 2.3	<0.001
SOFA score	4.3 ± 2.7	5.0 ± 3.1	4.0 ± 2.5	0.002
qSOFA score	1.3 ± 0.9	1.4 ± 0.9	1.2 ± 0.8	0.145
Platelets	233±147	198.5±125.	244.9±152.	0.009
Creatinine	2.9 ± 3.2	3.0 ± 3.4	2.6 ± 2.2	0.246
Total Bilirubin (mg/dl)	1.9 ± 4.0	3.2 ± 5.8	1.6 ± 3.2	0.001

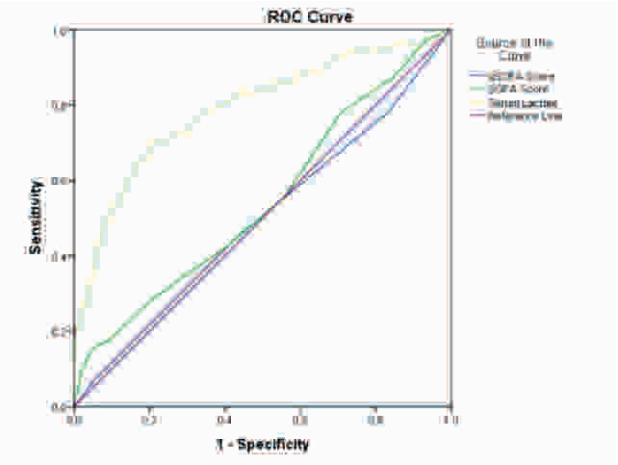

Figure 2: *AUROC for Serum Lactate, qSOFA Score and SOFA Score (N = 366)*

The AUROC of serum lactate for predicting mortality in these patients was 0.79 (95% CI; 0.72–0.86) with 81% sensitivity and 64% specificity. In comparison, the AUROC of SOFA for predicting mortality was 0.54 (95% CI; 0.47–0.62) with 60% sensitivity and 43% specificity versus the AUROC of qSOFA score which was 0.49 (95% CI; 0.42–0.58) with 54% sensitivity and 48% specificity (Figure 2).

Discussion

Lactate, SOFA and qSOFA are widely used markers across hospitals for predicting the outcomes of sepsis, a life-threatening inflammatory response for which immediate screening and intervention is needed.[2] We looked at the performance of serum lactate level, qSOFA and SOFA as predictors of mortality in septic patients with varying degrees of severity and found that serum lactate levels had the highest sensitivity and specificity in predicting sepsis-related mortality. This is an important finding in a resource constrained setting of LMIC.

Lactate remains the more reliable serum marker for sepsis, as is also shown in our studywith an AUROC of 0.79, comparable to 0.664-0.72; similar observations have been made in other studies.7, 22 Sepsis-3 has also recommended serum lactate level > 2 mmol/L as a major criterion for clinical identification of septic shock.[23]

While lactate has been a consistent marker in terms of its sensitivity and specificity, the values of AUROC for SOFA and qSOFA have been in different ranges. SOFA scores are recognized to be a useful predictor of ICU mortality and have been seen to have much higher values of 0.753- 0.829 previously. Between SOFA and qSOFA, SOFA is also known to be more reliable.[23,24] While our study reiterates what is already known about lactate levels in sepsis, the AUROC value of 0.54 for SOFA in our study is much lower than what has been seen in other studies.[25-27] AUROC value of 0.49 for qSOFA in our patients is contrary to what has been reported previously from other parts of the world. Some studies have reported lower qSOFA AUROC values of 0.607 while others have shown a much higher AUROC (0.66-0.754). This probably suggests the presence of other variables that could be influencing sepsis outcome.[23] Despite its variable performance, qSOFA remains a quick and simple method of screening patients with sepsis, especially in the ICU setting.[24,28,29] To increase qSOFA's overall reliability, it has been suggested to combine it with lactate levels.[23-29]

Presence of diabetes mellitus, tachypnea, lower mean arterial pressure and low score on Glasgow Coma Scale showed association with sepsis-related mortality but did not achieve significance on statistical analysis; higher $FiO_2$was significantly associated with mortality. Other findings in patients who died of severe sepsis included higher total bilirubin levels and lower platelet counts. Length of stay was observed to be longer in patients with septic shock and in those who required ICU admission.

Conclusion

In our sepsis patients, serum lactate levels correlated with mortality; qSOFA and SOFA scores had low sensitivity and specificity as mortality predictors. Further large-scale studies are needed in our population to determine the utility and reliability of these tools as markers of outcome in sepsis.

Conflict of Interest

None

Funding Source

None

References

1. Soong J, Soni N. Sepsis: recognition and treatment. Clin Med (Lond). 2012;12(3):276-80. doi:10.7861/clinmedicine.12-3-276
2. Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, et. al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). JAMA. 2016;315(8): 801- 10. doi: 10.1001/jama.2016.0287
3. Bengmark S. Pro- and synbiotics to prevent sepsis in major surgery and severe emergencies. Nutrients. 2012; 4(2):91-111. doi:10.3390/nu4020091
4. Stevenson EK, Rubenstein AR, Radin GT, Wiener RS, Walkey AJ. Two decades of mortality trends among patients with severe sepsis: a comparative meta-analysis*. Crit Care Med. 2014;42(3):625-31. doi: 10.1097/CCM.0000000000000026
5. Rivers E, Nguyen B, Havstad S, Ressler J, Muzzin A, Knoblich B, et. al. Early goal-directed therapy in the treatment of severe sepsis and septic shock. N Engl J Med. 2001;345(19):1368-77. doi:10.1056/ NEJMoa 010307
6. Faix JD. Established and novel biomarkers of sepsis. Biomark Med. 2011;5(2):117-30. doi: 10.2217/bmm.11.21
7. Liu Z, Meng Z, Li Y, Zhao J, Wu S, Gou S, et. al. Prognostic accuracy of the serum lactate level, the SOFA score and the qSOFA score for mortality among adults with Sepsis. Scand J Trauma Resusc Emerg Med. 2019;27(1):51.doi:10.1186/s13049-019-0609-3
8. Krishna U, Joshi SP, Modh M. An evaluation of serial blood lactate measurement as an early predictor of shock and its outcome in patients of trauma or sepsis. Indian J Crit Care Med. 2009;13(2):66-73. doi: 10.

4103/ 0972-5229.56051

9. Guo Y, Yang H, Gao W, Ma CE, Li T. Combination of Biomarkers in Predicting 28-Day Mortality for Septic Patients. J Coll Physicians Surg Pak. 2018;28(9): 672-6. doi:10.29271/jcpsp.2018.09.672
10. Alam, A., & Gupta, S. Lactate Measurements and Their Association With Mortality in Pediatric Severe Sepsis in India: Evidence That 6-Hour Level Performs Best. J Intens Care Med. 2020; https://doi.org/ 10.1177/ 0885066620903231
11. Lokhandwala S, Andersen LW, Nair S, Patel P, Cocchi MN, Donnino MW. Absolute lactate value vs relative reduction as a predictor of mortality in severe sepsis and septic shock. J Crit Care. 2017;37:179-84. doi:10.1016/j.jcrc.2016.09.023
12. Trzeciak S, Dellinger RP, Chansky ME, et al. Serum lactate as a predictor of mortality in patients with infection. Intensive Care Med. 2007;33(6):970-7. doi: 10.1007/s00134-007-0563-9
13. Haas SA, Lange T, Saugel B, et al. Severe hyperlactatemia, lactate clearance and mortality in unselected critically ill patients. Intensive Care Med. 2016; 42(2): 202-10. doi:10.1007/s00134-015-4127-0
14. Garcia-Alvarez M, Marik P, Bellomo R. Sepsis-associated hyperlactatemia. Crit Care. 2014; 18(5): 503.doi: 10.1186/s13054-014-0503-3
15. Thomas-Rueddel DO, Poidinger B, Weiss M, Dey K, Häberle H, Kaisers U, et.al. Hyperlactatemia is an independent predictor of mortality and denotes distinct subtypes of severe sepsis and septic shock. J Crit Care. 2015;30(2):439. doi:10.1016/ j.jcrc.2014. 10.027
16. Mahmoodpoor A, Shadvar K, Saghaleini SH, Koleini E, Hamishehkar H, Ostadi Z, et. al. Which one is a better predictor of ICU mortality in septic patients? Comparison between serial serum lactate concentrations and its removal rate. J Crit Care. 2018;44:51-6. doi: 10.1016/j.jcrc.2017.10.019
17. Puskarich MA, Trzeciak S, Shapiro NI, Arnold RC, Heffner AC, Kline JA, et. al. Prognostic value and agreement of achieving lactate clearance or central venous oxygen saturation goals during early sepsis resuscitation. Acad Emerg Med. 2012;19(3):252-8. doi: 10.1111/j.1553-2712.2012.01292.x
18. Nichol AD, Egi M, Pettila V, Bellomo R, French C, Hart G, et. al. Relative hyperlactatemia and hospital mortality in critically ill patients: a retrospective multi-centre study. Crit Care. 2010;14(1):R25. doi: 10.1186/cc8888
19. Lambden S, Laterre PF, Levy MM, Francois B. The SOFA score—development, utility and challenges of accurate assessment in clinical trials. Crit Care. 2019; 23(1):1-9.https://doi.org/10.1186/s13054-019-2663-7
20. Serafim R, Gomes JA, Salluh J, Póvoa P. A Comparison of the Quick-SOFA and Systemic Inflammatory Response Syndrome Criteria for the Diagnosis of Sepsis and Prediction of Mortality: A Systematic Review and Meta-Analysis. Chest. 2018; 153(3): 646-55. doi:10.1016/j.chest.2017.12.015
21. Shetty A, MacDonald SP, Williams JM, van Bockxmeer J, de Groot B, Esteve Cuevas LM, et. al. Lactate ≥2 mmol/L plus qSOFA improves utility over qSOFA alone in emergency department patients presenting with suspected sepsis. Emerg Med Australas. 2017;29(6):626-34. doi:10.1111/1742-6723. 12894
22. Shapiro NI, Fisher C, Donnino M, Cataldo L, Tang A, Trzeciak S, et. al. The feasibility and accuracy of point-of-care lactate measurement in emergency department patients with suspected infection. J Emerg Med. 2010;39(1):89-94. doi: 10.1016/ j.jemermed. 2009.07.021
23. Raith EP, Udy AA, Bailey M, McGloughlin S, MacIsaac C, Bellomo R, et. al. Prognostic Accuracy of the SOFA Score, SIRS Criteria, and qSOFA Score for In-Hospital Mortality Among Adults With Suspected Infection Admitted to the Intensive Care Unit. JAMA. 2017;317(3):290-300. doi: 10.1001/ jama. 2016. 20328
24. Schlapbach LJ, Straney L, Bellomo R, MacLaren G, Pilcher D. Prognostic accuracy of age-adapted SOFA, SIRS, PELOD-2, and qSOFA for in-hospital mortality among children with suspected infection admitted to the intensive care unit. Intensive Care Med. 2018; 44(2):179-88. doi:10.1007/s00134-017-5021-8
25. Usman OA, Usman AA, Ward MA. Comparison of SIRS, qSOFA, and NEWS for the early identification of sepsis in the Emergency Department. Am J Emerg Med. 2019;37(8):1490-7. doi:10.1016/ j.ajem. 2018. 10.058
26. Goulden R, Hoyle MC, Monis J, et al. qSOFA, SIRS and NEWS for predicting inhospital mortality and ICU admission in emergency admissions treated as sepsis. Emerg Med J. 2018;35(6):345-9. doi: 10.1136/ emermed-2017-207120
27. Shu E, Ives Tallman C, Frye W, Boyajian JG, Farshidpour L, Young M, et. al. Pre-hospital qSOFA as a predictor of sepsis and mortality. Am J Emerg Med. 2019;37(7):1273-8. doi:10.1016/j.ajem.2018.09.025
28. Ho KM, Lan NS. Combining quick Sequential Organ Failure Assessment with plasma lactate concentration is comparable to standard Sequential Organ Failure Assessment score in predicting mortality of patients with and without suspected infection. J Crit Care. 2017;38:1-5. doi:10.1016/j.jcrc.2016.10.005
29. Jung YT, Jeon J, Park JY, Kim MJ, Lee SH, Lee JG. Addition of lactic acid levels improves the accuracy of quick sequential organ failure assessment in predicting mortality in surgical patients with complicated intra-abdominal infections: a retrospective study. World J Emerg Surg. 2018;13:14. doi: 10. 1186/ s13017- 018-0173-6