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# Accuracy of ESI Triage, qSOFA Score and Their Combinations as a Predictor of Sepsis Prognosis

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A B S T R A C T

This study is to identify the combination of ESI, qSOFA and their combination as a predictor of sepsis prognosis. The research method was retrospective study design. Out of a total 2394 MRs of patients during that period, there were only 112 MRs met the inclusion criteria and then included in this study, consisted of 42 survival and 70 un-survival outcomes respectively. Among the un-survival group, there were 41 (58,6%) have ESI 1-2, and 29 (41.4%) ESI 3-5; also 21 (30%) qSOFA≥2, and 49 (70%) qSOFA<2. The sensitivity of ESI to predict the unsurvive outcome was 71.4% and its specificity was 28.6%. Meanwhile, the sensitivity of qSOFA to predict the unsurvive outcome was 30% and its specificity was 85.7%. The use of combination of both to predict the prognosis was not significantly increase (p>0.05). The sensitivity of combination of ESI and qSOFA to predict the unsurvive outcome was 61.9% and its specificity was 52.9%. So, low ESI-score seemed to be more relevant to predict the risk of unsurvival outcome than high qSOFA, but the low qSOFA is more relevant to predict the risk of survival outcome than high ESI-score. The combination of both is not significantly increase the accuracy of prognosis-predictor.



*Kata kunci:*

Emergency Severity Index (ESI)
Quick Sequential Organ Failure Assessment (qSOFA)
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A B S T R A K

Penelitian ini bertujuan untuk mengidentifikasi kombinasi ESI, qSOFA dan kombinasinya sebagai prediktor prognosis sepsis. Metode penelitian yang digunakan adalah desain penelitian retrospektif untuk membandingkan akurasi ESI dengan qSOFA. Data yang digunakan adalah seluruh rekam medis pasien di RS Sumberglagah Mojokerto, Jawa Timur, Indonesia. Kriteria inklusi adalah rekam medis pasien berusia > 18 tahun, data lengkap meliputi tekanan darah, HR, RR, SaO2 dan kadar ESI pasien. Dari total 2394 MR pasien selama periode tersebut, hanya 112 MR yang memenuhi kriteria inklusi dan kemudian dimasukkan dalam penelitian ini, terdiri dari 42 hasil survival dan 70 unsurvival. Diantara kelompok unsurvival, ada 41 (58,6%) memiliki ESI 1-2, dan 29 (41,4%) ESI 3-5; juga 21 (30%) qSOFA 2, dan 49 (70%) qSOFA<2. Sensitivitas ESI adalah 71,4% dan spesifisitasnya adalah 28,6% untuk memprediksi unsurvive outcome, sedangkan sensitivitas qSOFA adalah 30% dan spesifisitasnya 85,7%. Kombinasi keduanya untuk memprediksi prognosis tidak meningkat secara signifikan (p>0,05). Sensitivitas kombinasi ESI dan qSOFA adalah 61,9% dan spesifisitasnya adalah 52,9%. Skor ESI rendah tampaknya lebih relevan untuk memprediksi risiko hasil yang tidak bertahan hidup daripada skor qSOFA tinggi, tetapi skor qSOFA rendah lebih relevan untuk memprediksi risiko hasil kelangsungan hidup daripada skor ESI tinggi. Kombinasi keduanya tidak secara signifikan meningkatkan akurasi prediktor prognosis.

## INTRODUCTION

Sepsis is a *life-threatening* organ dysfunction caused by dysregulation of the body's response to infection (Seymour *et al.*, 2016; Singer *et al.*, 2016). Sepsis is one of the most common causes of death in the intensive care unit (ICU), and the incidence has more than doubled over the past 10 years (Kumar *et al.*, 2011). In 2017 there were 48.9 million cases and 11 million sepsis-related deaths worldwide accounting for about 20% of all global incident deaths (Rudd *et al.*, 2020). Approximately 85% of sepsis cases and sepsis-related deaths worldwide occur in low- and middle-income countries (Rudd *et al.*, 2020). Sepsis can progress to septic shock when the circulatory system, body cells and the amount of energy are inadequate (Cecconi *et al.*, 2018). A severe sepsis can disturb a blood flow to vital organs, such as the brain, heart and kidneys, is disrupted, leading to blood clots in the organs and extremities leading to varying degrees of organ failure and tissue death (gangrene) (Sagy *et al.*, 2013). Increased mortality rates for sepsis occur in the elderly population with many comorbidities or predispositions, use of immunosuppression, invasive procedures, use of medical devices and resistance to antibiotics (Girard *et al.*, 2005). Therefore, early recognition and treatment of the condition of septic patients increases the prognostic value of hope and reduces patient mortality (Ortega *et al.*, 2019).

*The European Society of Intensive Care Medicine* issued a consensus called the *Sequential Organ Failure Assessment* (SOFA) to quantitatively and subjectively describe the level of organ dysfunction in the ICU (Levy *et al.*, 2018; Singer *et al.*, 2016). Organ dysfunction conditions diagnosed in septic patients were assessed if the SOFA score increased 2 (Singer *et al.*, 2016). Although SOFA scores are sensitive in predicting mortality, SOFA scores require laboratory tests that may not be available in the ED which can delay the identification and treatment of sepsis (Garbero *et al.*, 2019). A screening tool is needed that can solve the problem of diagnosing sepsis quickly, namely the *Quick sequential organ failure assessment* (qSOFA) (Shahsavarinia *et al.*, 2020). *Quick sequential organ failure assessment* (qSOFA) is a screening tool to identify sepsis outside the ICU such as emergency departments, hospital wards and community health care (Sinha & Ray, 2018). The qSOFA score is used to quickly and easily determine patients at high risk of sepsis (Singer *et al.*, 2016). Measurement of the qSOFA score using 3 (three) criteria, namely GCS < 15, low blood pressure (SBP≤100 mmHg), high RR (≥22 x/min) (Gilboy *et al.*, 2012). However, the qSOFA score has low sensitivity in identifying patients at high risk of death (Machado *et al.*, 2016). So it is necessary to have a combination of instruments with qSOFA scores as a more accurate screening tool. *Emergency Severity Index* (ESI) is one of the international *triage* that can be used in emergencies with a five-level *triage* system that categorizing patients based on conditions and resources (Gilboy *et al.*, 2012). In addition, there are 3 (three) reasons for using ESI as *triage* in the ER. First, the *triage* nurse is guided by a predetermined algorithm to see the condition and severity without waiting for a doctor's intervention. Secondly, consideration of resource usage allows the ED to estimate bed utilization. Thirdly, the ESI *triage* system uses a pain scale of 1-10 and vital sign measurements which are generally used (Gilboy *et al.*, 2012).

This study focused on identifying predictor tools that have a high level of accuracy that can improve the prognosis in septic patients. The use of ESI in combination with qSOFA is expected to help in screening for sepsis conditions and can immediately start a therapeutic regimen that can be applied in developing countries. The authors are interested in identifying the comparison of the accuracy of ESI, qSOFA and their combination as a predictor of sepsis prognosis.

## METHODS

### *Participant characteristics and research design*

The research method used is a *retrospective study design* with a comparative approach to compare the accuracy of *Emergency Severity Index* (ESI) triage, *Quick Sequential Organ Failure Assessment* (qSOFA) and their combination as a predictor of the prognosis of sepsis. The inclusion criteria were medical records of patients aged > 18 years and complete data. Exclusion criteria were trauma patients and the patient's medical record with no known patient *outcome* (survivor or no survivor).

### *Sampling procedures*

The sample selection using *purposive sampling* is based on the characteristics or characteristics of the population that have been known previously. All data are presented as number and percent. (Figure 1)

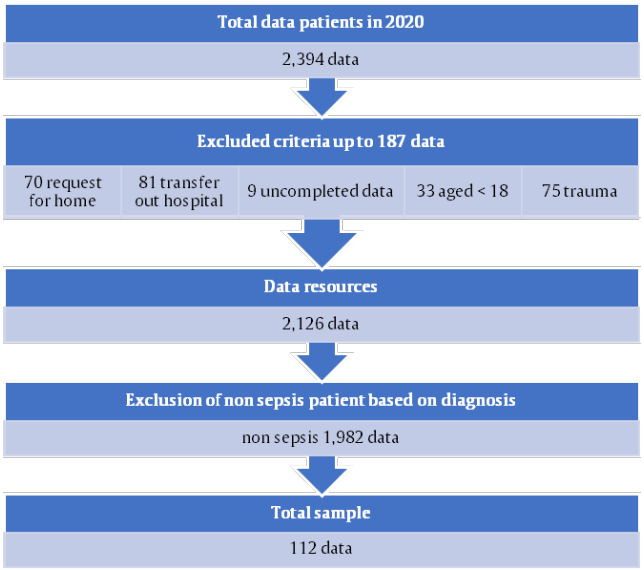


**Figure 1. Flow chart of patient selection**

### *Sample size, power, and precision*

The data were all medical records of patients of Sumberglagah Hospital in Mojokerto, East Java, Indonesia. That was recorded about 2,394 ER's patients in 2020. The data collected were age, gender. Clinical examination data in the form are GCS, pulse, RR, blood pressure, oxygen saturation (SaO2), patient outcome (survivor or no survivor) and ESI level.


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### *Measures and covariates*

Data were analyzed using STATA Statistics ver. 15. The statistical significance among groups was assessed with Chi square analysis of variance. *p* value <0.05 was considered statistically significant. Prognosis accuracy of Sepsis patients (based on sensitivity, specificity, positive predictive value, negative predictive value, and AUROC curve).

### *Data analysis*

The statistical tests used in this bivariate analysis used sensitivity tests, specificity tests and positive and negative predictive values using AUROC values to assess the level of accuracy of ESI, qSOFA and the combination of ESI and qSOFA on the prognosis of sepsis. In this bivariate analysis, what is seen are:

a. The value of ESI category such as resources, airway disorders, breathing and circulation, pain scale, disorientation, gcs, $SaO_2$, pulse, respiratory rate.
b. qSOFA scores such as respiratory rate, blood pressure and level of consciousness.
c. The patient's diagnosis was either septic or non-septic based on each instrument.
d. Outcome value of the patient, namely no survivor and survivor.
e. ESI accuracy as a predictor of sepsis prognosis.
f. Accuracy of qSOFA score as a predictor of sepsis prognosis using ROC Curve
g. The value of the effectiveness of ESI combined with qSOFA as a predictor of sepsis prognosis using comparation of the AUROC value.

*Receiver Operating Characteristics* (ROC) and AUROC curves were calculated in the ESI, qSOFA and combination groups for prediction of primary outcome (diagnosis of sepsis patients) and secondary outcome (prognosis of septic patients using length of stay). Logistics Regression Analysis Model was used to examine the relationship between ESI, qSOFA and the combination of ESI and qSOFA on primary or secondary outcomes and determine the most influential instrument in determining the prognosis of septic patients.

## RESULT AND DISCUSSION

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Overall, 112 patients admitted to ED within 24 hours of sepsis who met the inclusion criteria were included in the study. The demographic characteristics of these patients are presented in (Table 1). Based on the characteristics of the type of comorbidity, that respondents who have a history of diabetes mellitus and kidney failure have a greater tendency to experience sepsis with a poor prognosis compared to respondents who do not have this comorbid. Respondents who have a history of hypertension, stroke, heart failure, have a greater tendency to experience sepsis with a good prognosis compared to respondents who do not have this history. The results of the chi square analysis test on the subparameter of ESI are resources p = 1.00, OR = 1.140; inadequate Airway, Breathing, and Circulation resources p = 0.013, OR = 0.336; GCS = 0.506, OR = 0.593; pain scale p = 0.458, OR = 0.632; HR p = 0.920, OR = 0.885; RR = 1,000, OR = 1.022; $SaO_2$ p = 0.126, OR = 0.355; ESI triage p = 0.658, OR = 1.875. And the results of the ESI accuracy test as a predictor of sepsis prognosis (Sensitivity = 74.3%, Specificity = 28.6%, PPV = 63.4%, NPV = 40%, ROC = 0.514). ESI showed a high sensitivity value but low specificity value. Therefore, ESI triage can be recognized as an adequate screening instrument for sepsis (Table 2). The results of the chi square analysis test on the subparameter of qSOFA are SBP p = 0, OR = 0.475; GCS p = 0.723, OR = 0.796; RR p = 0.7024, OR = 0.169. qSOFA p = 0.092, OR = 0.885. And the accuracy of qSOFA as a predictor of sepsis prognosis (Sensitivity = 30%, Specificity = 85.7%, PPV = 77.8%, NPV = 42.4%, ROC = 0.579) (Table 3).

**Table 1.**
**Patient's Characteristic subdevided into Patient's Outcome**

| Variables | No Survivor | | Survivor | | p *Value* |
|---|---|---|---|---|---|
| | n | % | n | % | |
| **Gender** | | | | | |
| Female | 45 | 64.3 | 25 | 36.7 | 0.762 |
| Male | 25 | 59.5 | 17 | 40.5 | |
| **Age** | | | | | |
| 17 - 25 years old | 0 | 0 | 1 | 100 | |
| 26 - 35 years old | 7 | 77.8 | 2 | 22.2 | |
| 36 - 45 years old | 12 | 63.2 | 7 | 36.8 | 0.447 |
| 46 - 55 years old | 16 | 18.1 | 13 | 44.8 | |
| 56 - 65 years old | 21 | 72.4 | 8 | 27.6 | |
| > 65 years old | 14 | 56 | 11 | 44 | |
| **Room** | | | | | |
| Non ICU | 41 | 52.6 | 37 | 29.3 | 0.002 |
| ICU | 29 | 85.3 | 5 | 14.7 | |
| **Length of Stay (LoS)** | | | | | |
| ICU ≤ 3 days | 35 | 57.4 | 26 | 42.6 | |
| ICU > 3 days | 6 | 35.3 | 11 | 64.7 | 0.003 |
| Non ICU ≤ 7 days | 15 | 88.2 | 2 | 11.8 | |
| Non ICU > 7 days | 14 | 82.4 | 3 | 17.6 | |
| **Type of Comorbid** | | | | | |
| ***Diabetes Mellitus*** | | | | | |
| No | 55 | 61.1 | 35 | 38.9 | 0.713 |
| Yes | 15 | 68.1 | 7 | 31.8 | |
| ***Hypertention*** | | | | | |
| No | 68 | 66 | 35 | 34 | 0.013 |
| Yes | 2 | 22.3 | 7 | 77.8 | |

| | | | | | |
|---|---|---|---|---|---|
| ***Cerebrovascular disease*** | | | | | |
| No | 66 | 64.1 | 37 | 35.9 | 0.208 |
| Yes | 4 | 44.4 | 5 | 55.6 | |
| ***Heart Disease*** | | | | | |
| No | 68 | 64.8 | 37 | 35.2 | 0.068 |
| Yes | 2 | 28.6 | 5 | 71.4 | |
| ***Renal Disease*** | | | | | |
| No | 56 | 62.2 | 34 | 37.8 | 1 |
| Yes | 14 | 63.6 | 8 | 36.4 | |
| ***HIV/AIDS*** | | | | | |
| No | 68 | 61.8 | 42 | 38.2 | 0.389 |
| Yes | 2 | 100 | 0 | 0 | |
| ***Heparbilateral disease*** | | | | | |
| No | 70 | 66 | 36 | 34 | 0.002 |
| Yes | 6 | 100 | 0 | 0 | |

*Values are presented as number (n) and percent (%).*

Based on the result, qSOFA score shows a low sensitivity value but a high specificity value. So, the qSOFA score cannot be recognized as an adequate screening instrument to assess the prognosis of septic patients.

**Table 2.**
**Emergency Severity Index (ESI) subdevided into Outcome of Sepsis patient**

| Variable | No Survivor | | Survivor | | p-*value* | Odd Rasio |
|---|---|---|---|---|---|---|
| | n | % | n | % | | |
| **Resources** | | | | | 1 | 1.14 |
| ≤ 1 Resources | 13 | 65 | 7 | 35 | | |
| > 1 Resources | 57 | 62 | 35 | 38 | | |
| **Inadequate ABC** | | | | | 0.013 | 0.336 |
| No | 30 | 50.8 | 29 | 49.2 | | |
| Yes | 40 | 75.5 | 13 | 24.5 | | |
| **GCS** | | | | | 0.506 | 0.593 |
| GCS 13 -15 | 57 | 60.6 | 37 | 39.4 | | |
| GCS < 13 | 13 | 72.2 | 5 | 27.8 | | |
| **Pain Level** | | | | | 0.458 | 0.632 |
| Score 1 - 5 | 51 | 60 | 34 | 40 | | |
| Score 6 - 10 | 19 | 70.4 | 8 | 29.6 | | |
| **HR** | | | | | 0.92 | 0.885 |
| ≤ 100 x/min | 43 | 61.4 | 27 | 38.6 | | |
| > 100 x/min | 27 | 64.3 | 15 | 35.7 | | |
| **RR** | | | | | 1 | 1.022 |
| ≤ 20 x/min | 47 | 62.7 | 28 | 37.3 | | |
| > 20 x/min | 23 | 62.2 | 14 | 37.8 | | |
| **$SaO_2$** | | | | | 0.126 | 0.355 |
| 92 – 100 % | 54 | 58.7 | 38 | 41.3 | | |
| < 92 % | 16 | 80 | 4 | 20 | | |
| **ESI *Triage*** | | | | | 0.658 | 1.875 |
| No Sepsis | 6 | 59.2 | 2 | 40.8 | | |
| Sepsis | 64 | 65.1 | 40 | 34.9 | | |

**Table 3**
**Quick Sequential Organ Failure Assessment (qSOFA) subdevided into Outcome of Sepsis patient**

| Variable | No Survivor | | Survivor | | p-*value* | Odd Rasio |
|---|---|---|---|---|---|---|
| | n | % | n | % | | |
| **SBP** | | | | | 0,103 | 0,475 |
| ≤ 100 mmHg | 34 | 55,4 | 13 | 44,6 | | |
| > 100 mmHg | 36 | 72,3 | 29 | 27,7 | | |
| **GCS** | | | | | 0,723 | 0,796 |
| GCS 15 | 43 | 60,6 | 28 | 39,4 | | |
| GCS < 15 | 27 | 65,9 | 14 | 34,1 | | |
| **RR** | | | | | 0,024 | 0,169 |
| ≤ 22 x/min | 54 | 57,4 | 40 | 42,6 | | |
| > 22 x/min | 16 | 88,9 | 2 | 11,1 | | |
| **qSOFA score** | | | | | 0,098 | 0,513 |
| No Sepsis | 48 | 57,6 | 36 | 42,4 | | |
| Sepsis | 22 | 77,8 | 8 | 22,2 | | |

The combination of ESI and qSOFA as a sepsis prognosis (Sensitivity = 31.4%, Specificity = 85.7%, PPV = 78.6%, NPV = 42.9%, ROC = 0.586). The combination of ESI and qSOFA scores showed low sensitivity and high specificity values. So, the combination of ESI and qSOFA scores cannot be recognized as an adequate screening instrument to predict the prognosis of septic patients (Table 4).

***Table 4. The Accuracy of ESI, qSOFA and their combination of Prognosis Sepsis***

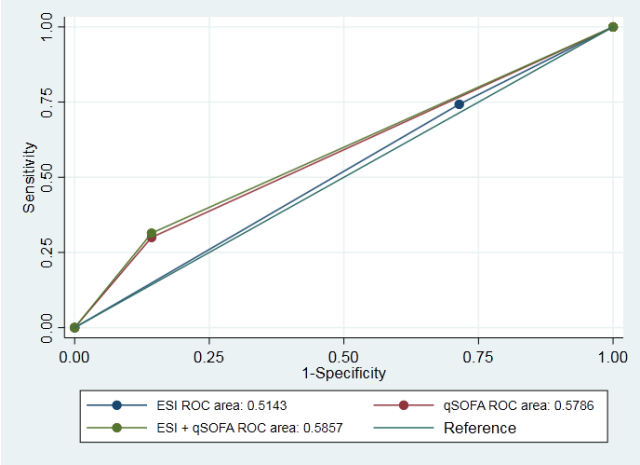
| | ESI | qSOFA | ESI + qSOFA |
|---|---|---|---|
| Sensitivity | 74,3 % | 30,0 % | 31,4 % |
| Spesificity | 28,6 % | 85,7 % | 85,7 % |
| ROC *Area* | 0,51 | 0,58 | 0,59 |
| Likelihood Ratio Positive | 1,04 | 2,10 | 2,20 |
| Likelihood Ratio Negative | 0,90 | 0,82 | 0,80 |
| Odd Ratio | 1,16 | 2,57 | 2,75 |
| Positive Predictive Value | 63,4 % | 77,8 % | 78,6 % |
| Negative Predictive Value | 40,0 % | 42,4 % | 42,9 % |

Comparison of the accuracy of *emergency severity index* (ESI) and *quick sequential organ failure assessment* (qSOFA) and their combination as a predictor of sepsis prognosis in the emergency department did not have a significant difference (Table 5).

**Table 5**
**Area Under the Curve (AUC) of ESI, qSOFA and their combination as a predictor of prognosis in sepsis patients**

| | AUROC | Std. Error | Asymptotic Sig.[b] | 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | Min | Max |
| ESI | 0.514 | 0.057 | 0.044 | 0.428 | 0.600 |
| qSOFA | 0.579 | 0.055 | 0.038 | 0.502 | 0.654 |
| ESI + qSOFA | 0.586 | 0.054 | 0.039 | 0.509 | 0.662 |

The difference of AUC between ESI, qSOFA and their combination can be shown in Figure 2.




**Figures 2. Differences of area under the curve (AUC) in ESI, qSOFA and their combination as predictors of prognosis in sepsis patients**

In the emergency department, ESI is a suitable tool to identify severe cases and enabling rapid intervention (Wang *et al.*, 2011). ESI was evaluated to be accurate and sensitive to predict hospital mortality and ICU admission for patients with suspected sepsis in the emergency room. This confirms that ESI is useful for ED triage and predicts outcomes in sepsis patients (Phungoen *et al.*, 2020). The accuracy of prognosis sepsis is related to the value of specificity, not sensitivity (Bessière *et al.*, 2013). In addition, ESI level 1 represents patients in need of life-saving intervention, and triage ESI 3 has been shown to show more false-positive results rather than specifically indicating sepsis (Nieves Ortega *et al.*, 2019).

In the study of Phungoen *et al* (2020) it was found that ESI is a tool that can predict the outcome of patients with suspected sepsis in the ER. The results showed that ESI levels 1 and 2 had the highest sensitivity to predict hospital mortality and the need for treatment of septic patients in the ICU compared to qSOFA, SIRS and NEWS. Another study from Hinson *et al.* (2018) patients who were triaged as moderate by ESI (level 3) at the time of their arrival to the ER but were found to be more suitable to be categorized into ESI level 1 or 2, commonly referred to as *under-triage,* had a prevalence of admission and outcome. Critically increased significantly compared to patients who were triaged with the appropriate category. Similarly, patients categorized as *under-triage* at ESI level 4 or 5 had a significantly increased prevalence of admission and critical outcome compared to patients appropriately prioritized to the same ESI level (Hinson *et al.*, 2018).

Several things may occur during measurement and triage determination. A larger proportion of scenarios is *under-triage* than *over-triage* (27.6% versus 13.2%) which can affect the accuracy in assessing the patient's condition (Mistry et al., 2018). Recent advances in electronic medical record systems and the development and use of information technology-based ESI to improve accuracy in triage (Aronsky *et al.*, 2008; Mistry *et al.*, 2018) or provide a data-driven approach that can be easily adopted by local ED systems (Dugas *et al.*, 2016; Ghafarypour-Jahrom *et al.*, 2018; Levin *et al.*, 2018).

In the other hand, the measuring of vital signs on *under-triage* using ESI was influenced by the condition of severe bradycardia, tachycardia, and hypoxia in patients with *high-acuity* but categorized at the ESI triage level with *moderate-acuity* (Hinson *et al.*, 2018). Measurement of oxygen saturation is also strongly associated with *under-triage* in *moderate-acuicy* ESI (Hinson *et al.*, 2018). Mild

abnormalities in vital signs are more likely to be associated with *under-triage* at the level of ESI to *low-acuity,* including mild tachycardia and mild hypotension (Hinson *et al*., 2018). The exception is temperature, at which patients with borderline hyperthermia and hyperthermia are more likely to be prioritized for *low-acuity* ESI. But there was no abnormality of vital signs that increased *over-triage* for each level of ESI (Hinson *et al*., 2018).

The new definition of Sepsis-3 in 2016, a concept of qSOFA has been introduced and used for the early detection and early treatment of sepsis (Seymour *et al*., 2016). The qSOFA score was calculated using only 3 parameters: systolic blood pressure, respiratory rate, and GCS (Osatnik *et al*., 2018). In fact, there is no need to wait for laboratory results to calculate qSOFA scores, so it is possible to score quickly, and to identify and treat patients with suspected sepsis outside the initial ICU (Kwak *et al*., 2018). qSOFA tool was introduced as a rapid model for the SOFA score in assessing sepsis prognostication. The advantage of qSOFA is that it can be done repeatedly from time to time without laboratory tests, so it doesn't take a long time to make decisions (Kim *et al*., 2017). So that it can be scored quickly, and can identify and treat patients with suspected sepsis outside the ICU early.

In our study, identification of diagnostic tool for screening of sepsis patient using ESI with qSOFA seems to be suitable with higher sensitivity and ease to use, which could be quickly done by the bedside in the ED to predict the prognosis of sepsis. In research of Kwak et al (2018) conducted research on the well-known ESI triage method, combined with qSOFA. There was a significant difference in prognostic value between ESI alone and ESI combined with qSOFA. Although the difference was not large enough, these results support our hypothesis that qSOFA may add better prognostication compared to ESI alone. In addition, we found higher in-hospital mortality rates in all qSOFA-positive ESI groups compared with qSOFA-negative patients. These results suggest that with the same level of ESI, patients with positive qSOFA had a relatively higher disease severity compared to those with negative qSOFA (Kwak *et al*., 2018).

The function of a screening tool to identify high-risk patients requires at least a high sensitivity value (Goetzinger *et al*., 2011). In the study of Kwak et al (2018) on assessing the prognosis between ESI, qSOFA and ESI combined with qSOFA, it turned out that there was a statistically significant difference. Although the difference was not large enough in Kwak et al (2018) study, these results support the hypothesis that qSOFA adds better prognostic power to ESI. In addition, the investigators found that in-hospital mortality was higher in all ESI groups with positive qSOFA compared to qSOFA negative. These results indicate that with the same level of ESI, patients with positive qSOFA had a relatively higher disease severity compared to those with negative qSOFA Kwak et al (2018).

The ROC Area values for ESI, qSOFA and their combinations are 0.514, 0.579 and 0.586 (Table 5), respectively. Based on the ROC Area, the highest value was found in the combination of ESI and qSOFA, which means that the combination of ESI and qSOFA had a higher level of accuracy than ESI or qSOFA alone in assessing the prognosis of septic patients. However, based on the results of the analysis of the ROC area comparison test, it was found that the significance of the ROC area on the prognostic variables in the sepsis group was 0.3421. Using the limit of significance ($\alpha$) 0.05, it can be concluded that the ability between ESI, qSOFA and their combination to predict the prognosis of the three septic patients did not have a significant difference.

*Receiver-operating characteristic* (ROC) curve is an effective method to compare the accuracy of a variable (Gonçalves *et al*., 2014). The ROC curve provides an index of accuracy by showing the limits of the test's ability to distinguish between variables for a health status condition (Zweig & Campbell, 1993). ROC analysis is useful for: (i) evaluating the discriminatory ability of a diagnostic tool to assign correctly to the classification of two groups; (ii) finding the appropriate cut-off point or optimal cut-off point in classifying the two groups of subjects; (iii) compare the accuracy of two (or more) diagnostic tests or tools; and (iv) studying the variability between two or more observers measuring to be measured based on the same variable continuously (Gonçalves *et al*., 2014; Janssens & Martens, 2020).

In addition, the importance of the concept of accuracy testing with sensitivity and specificity values to provide an overview of the level of aura of a diagnostic tool (Zweig & Campbell, 1993). An ideal screening tool to assess the prognosis of sepsis should have a high sensitivity to identify patients with sepsis before the patient progresses to septic shock which can potentially lead to death (Wawrose *et al*., 2016). In addition, the ideal screening tool should have a high negative predictive value (NPV) so that doctors can be confident in doing negative screening (Wawrose *et al*., 2016). However, to date no gold standard exists and there is a lack of reliable or measurable value for the diagnosis of sepsis (Loritz *et al*., 2020).

We found that the combination of ESI and qSOFA scores showed low sensitivity and specificity values. Therefore, the combination of ESI and qSOFA scores cannot be recognized as an adequate screening instrument to assess the prognosis of septic patients in the ED. We suggest that to determine the diagnostic value derived from the use of a single clinical score or criterion or a single biomarker as well as from the combination of clinical parameters and laboratory biomarker such as procalcitonin and MR-proADM. It can be increased the accuracy of a diagnostic and prognostic evaluation in 99.9% of patients with a turnaround time of approximately 45 minutes, whereas the combination of PCT, SOFA and MR-proADM scores achieved comparable accuracy (99.9%) requiring time. completion of approximately 90 minutes (Spoto *et al*., 2018, 2020). However, an accurate assessment of the prognosis of sepsis patients still includes biomarkers in the form of laboratory results of procalcitonin or MR-proADM as the gold standard for the diagnosis of sepsis which can be combined with the qSOFA instrument for assessing the prognosis of sepsis in the ED.

## LIMITATION OF THE STUDY

The study using ESI and qSOFA could not validate the actual condition of the patient because it used secondary data with a retrospective study design, which has the disadvantage of high bias. However, the researcher iteratively checked the data obtained to minimize data errors in this study. So, in future research, it can be changed using a prospective research design that can be validated for data validity or using self-assessment standards to reduce bias in the way of collecting data such as vital signs. In addition, the shortcoming in this study was to compare the ESI, qSOFA and their combination without a gold standard for assessing sensitivity and specificity. Thus, for further research, the

standard procalcitonin standard in sepsis patients can be used as a standard comparison of the instruments tested.

## CONCLUSION AND SUGGESSION

The conclusion from the results of the study and supported by several previous studies, it was found that the combination of ESI and qSOFA scores showed low sensitivity and specificity values. So the combination of ESI and qSOFA scores only cannot be recognized as an adequate screening instrument to predict the prognosis of septic patients in the ED. Adding a procalcitonin MR-proADM. biomarker as a gold standard can increased the prediction of a diagnostic and prognostic sepsis.

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## ETHICAL CONSIDERATIONS

This study was conducted in accordance with research ethical standards and all research protocols have received ethical approval from the research ethics committee of the Faculty of Medicine, Brawijaya University with No. 107/EC/KEPK-S2/04/2021 and received ethical approval from the research ethics committee by Sumberglagah Hospital in Mojokerto.

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### Conflict of Interest Statement

We declare the following information regarding the specific conflicts of interest of authors of our aforementioned manuscript.

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