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# Serial score measures of the national early warning score, the fast sequential organ failure evaluation, and the systemic inflammatory response syndrome have prognostic significance in determining clinical outcome in early sepsis.

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***ABSTRACT***
***Background and Significance***
*Sepsis is a frequent and possibly fatal disease, and early detection is important to preventing further progression. However, the current scores for recognizing sepsis lack predictive accuracy.*
***Objective***
*To find the best time to calculate NEWS, qSOFA, and SIRS for predicting clinical deterioration in early sepsis, and to see if changes in these scores over time increase their predictive accuracy.*
***Design***
*Post-hoc analysis of data collected prospectively.*
***Participants and Settings***
*The research was carried out in a tertiary-care teaching hospital's emergency department (ED). Adult medical patients with (possible) sepsis were included in the study.*
***Metrics and Analysis of Outcomes***
*The primary outcome was clinical worsening within 72 hours of admission, defined as organ failure development, ICU-admission, and death. Secondary outcomes included an increase in SOFA of at least 2 and a composite of ICU admission/death. At the ED, scores were calculated at 30-minute intervals. To compare the prognostic accuracy of the scores, ROC analyses were created.*
***Results***
*In total, 1750 individuals were included in the study, with 360 (20.6%) deteriorating and 79 (4.5%) being admitted to the ICU or dying within 72 hours. NEWS at triage (AUC, 0.62; 95% CI, 0.59-0.65) predicted worsening more accurately than qSOFA (AUC, 0.60; 95% CI, 0.56-0.63) and SIRS (AUC, 0.59; 95% CI, 0.56-0.63). The AUC of the NEWS was greater at 1 hour (0.65; 95% CI, 0.63-0.69) and 150 minutes after triage (0.64; 95% CI, 0.61-0.68) than at triage. The qSOFA had the highest AUC 90 minutes after triage (0.62; 95% CI, 0.58-0.65), while the SIRS had the highest AUC 60 minutes after triage (0.60; 95% CI, 0.56-0.63); both were not statistically different from triage. NEWS outperformed qSOFA and SIRS in predicting ICU admission/death after 72 hours (AUC difference, 0.092). (AUC difference, 0.137). There were no differences in the scores for predicting a rise in SOFA of at least 2 within 72 hours. Patients who improved the most in any of the ratings were more likely to worsen.*
***Conclusion***
*When compared to SIRS and qSOFA, NEWS had a greater prognostic accuracy in predicting worsening; the maximum accuracy was at 1 hour after triage.*
***Keywords: C****linical Deterioration; Emergency Department; National early warning score; Quick sequential organ failure assessment; Repeated measurements; Sepsis; Systemic inflammatory response syndrome*

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## I. Introduction

Sepsis is a potentially fatal, life-threatening dysregulated host response to infection that results in organ failure and mortality [1,2]. In 2017, there were 48.9 million sepsis cases and 11 million sepsis-related fatalities reported globally, accounting for 19.7% of all global deaths [3]. Approximately 21% of all adults enter the emergency department (ED) due to a serious infection, with 11% suffering from severe sepsis and a 13% in-hospital mortality rate [4]. Fluid resuscitation, antibiotics, and, if necessary, vasoconstrictive medicine, supplementary oxygen, and organ support are the current treatments. Antibiotics administered late to individuals with severe sepsis are associated with an increased risk of organ damage [5,6] and fatality [7]. In patients with nonsevere sepsis, antibiotic therapy within 4 hours is associated with a shorter length of stay and lower death [8]. Furthermore, early fluid resuscitation and norepinephrine delivery to patients with severe sepsis reduce mortality [9,10]. Early detection is vital for initiating appropriate therapy on time and preventing organ damage and death.

The fast Sequential Organ Failure Assessment (qSOFA), the systemic inflammatory response syndrome (SIRS)-criteria, and the national early warning score are the most commonly used clinical scoring systems for detecting early sepsis (NEWS). The SIRS has a relatively high sensitivity (86%) to predict death but a low specificity (29%). The qSOFA, on the other hand, has a higher specificity (83%) but a lower sensitivity (51%), when it comes to predicting in-hospital mortality [11,12]. The NEWS strikes a balance between the SIRS and the qSOFA: the sensitivity for mortality or ICU admission is 74%, and the specificity for these outcomes is 43% [13]. Their practical usefulness in early sepsis is restricted, however, due to the low prognostic accuracy in predicting ICU admission and mortality, as well as a lack of understanding in the prognostic accuracy in predicting other clinically significant outcomes such as organ dysfunction progression.

To appropriately assist clinical decision making in the ED, it is critical to understand the predictive accuracy of sepsis scores in predicting organ failure development and the requirement for escalated therapy. Even though patients' clinical conditions change over time, it is currently unknown when sepsis scores should be calculated. There is little evidence about which time-point best predicts deterioration and the significance of a trend in scores [14]. As a result, sepsis is a prevalent and potentially fatal illness, and early detection is crucial for the commencement of appropriate treatment to avert organ failure. However, available scores to aid in the detection of early sepsis lack discriminative significance, and their effectiveness in predicting (progressive) organ dysfunction at different points in time is unknown. The goal of this study was to determine the best time to calculate NEWS, qSOFA, and SIRS for predicting deterioration, defined as organ failure, ICU admission, and mortality, and to see if their change over time increases prognostic value for deterioration by examining serial data at the ED.

## II. Methods

**Design and Setting of the Study**

This study is a follow-up to a prospective observational study (Sepsis Clinical Pathway Database) conducted in the ED of the University Medical Center Luhansk, LSMU, a tertiary-care teaching hospital [15]. According to the LSMU's Institutional Review Board, the Ukraine Medical Research Involving Human Subjects Act does not apply to this study. All participants signed written informed consent forms.

**Study Population**

Data for the study population were collected between March 2016 and July 2020. Medical patients who visited the emergency department between 08.00 and 21.00 h were screened for inclusion. The following criteria were required for inclusion: (a) being 18 years or older, (b) having a fever (≥ 38 °C) or a suspected infection or sepsis (as determined by the coordinating internist urgent medicine), and (c) being able to provide informed permission. Aside from triage, only patients with at least one vital sign measurement were included. All patients were treated in accordance with the protocol.

**Data Collection**

To eliminate bias owing to inter-observer variability, all data were gathered at the ED by trained study personnel during the patients' stay. Following that, the database was supplemented with electronic medical records. Every half hour, vital parameters were measured. qSOFA, NEWS, and SIRS were estimated based on these throughout the first 4 hours (or until ED discharge).

**Missing Data**

Missing values were estimated by taking the average of the measurements 30 minutes before and 30 minutes after the missing value. Data were not calculated if either was missing. After computing the average, missing half-hour values of the Glasgow Coma Scale and supplementary oxygen were declared normal or not present. SPSS's multiple imputations function was used to compute the remaining missing values.

**Endpoint Definitions**

The primary outcome was worsening within 72 hours of ED admission. Deterioration was defined as the onset of (multi)organ failure, which could be acute kidney injury (AKI), liver failure, and/or respiratory failure, ICU admission, or death. AKI was defined as a rise in serum creatinine 1.5 times the baseline (presumed or observed within the last 7 days) and/or an increase of 26.5 ≥ µmol/l within 48 hours using the renal disease improvement global outcomes criteria [16]. The presence of a SOFA score of at least 1 within the same category compared to the score at the ED was used to diagnose liver failure (bilirubin and respiratory failure (PaO2/FiO2 ≤ 300) without respiratory support or PaO2/FiO2 ≤ 200 with respiratory support [17]. Our secondary goal was ICU admission/mortality in fewer than 72 hours. In comparison to the normal technique, a two-point increase in SOFA score was included as the subsequent outcome.

**Statistical Analysis**

The Mann-Whitney U test was used to evaluate continuous data, which were provided as median with interquartile range. The Chi-square test was used to assess categorical data, which were reported as counts with percentages. The area under the receiver operating characteristics (AUROC) curve was used to investigate the link between scoring systems and degradation. SPSS's 'paired-sampled area difference under the ROC curve' function was used to compare the areas under the ROC (AUCs). The power of the used sample size was determined via post hoc power analysis using a univariate model. The sensitivity, specificity, and positive and negative predictive values were computed. The sample size was determined using post hoc power analysis. IBM SPSS Statistics version 26 was used for statistical analysis (Armonk, New York, USA).

## III. Results

**Patient Characteristics**

In total, 1750 patients were included, of which 360 (20.6%) deteriorated within 72 h, 68 (3.9%) necessitated ICU-admission and 15 (0.9%) died within 72 h (Fig. 1 and Table 1). Patients who deteriorated were on average older (P < 0.001) and were more often tobacco (P = 0.003) or alcohol users (P = 0.029), and a higher number of patients had chronic obstructive pulmonary disease (P = 0.002), diabetes (P = 0.009) or chronic kidney disease (P = 0.009). The length of stay in hospital was longer among patients who deteriorated (median, 7 and 3 days, respectively, P < 0.001) (Table 1).

**Table 1 - Main characteristics of the study population N = 1750**

| Variable (% missing) | Overall | No deterioration <72 h | Deterioration <72 h | *P*-value | No ICU or mortality <72 h | ICU or mortality <72 h | *P*-value |
|---|---|---|---|---|---|---|---|
| Number of patients (*n*) | 1750 | 1390 (79.4) | 360 (20.6) | ND | 1671 (95.5) | 79 (4.5) | ND |
| Demographics | | | | | | | |
| Age (0.0) [median (IQR)] | 63 (53–73) | 62 (51–63) | 67 (58.1–75.9) | <0.001* | 63 (52.5–73.5) | 68 (59–77) | 0.001* |
| Male (0.0) [*n* (%)] | 997 (57.0) | 781 (44.6) | 216 (12.3) | 0.193 | 949 (54.2 | 48 (2.7) | 0.486 |
| Living at home (4.0) [*n* (%)] | 1533 (87.6) | 109 (6.5) | 38 (2.3) | 0.083 | 133 (7.9) | 14 (0.8) | 0.001* |
| Smoker[1] (7.1) [*n* (%)] | 240 (13.7) | 174 (10.7) | 66 (4.1) | 0.003* | 227 (14.0) | 13 (0.8) | 0.330 |
| Alcohol user[2] (7.7) [*n* (%)] | 469 (26.8) | 389 (24.1) | 80 (5.0) | 0.029* | 454 (28.1) | 15 (0.9) | 0.151 |
| Comorbidity [*n* (%)] | | | | | | | |
| Cardiac disease (1.9) | 315 (18.0) | 240 (14.0) | 75 (4.4) | 0.123 | 298 (17.4) | 17 (1.0) | 0.388 |
| COPD (0.0) | 159 (9.1) | 111 (6.3) | 48 (2.7) | 0.002* | 151 (8.6) | 8 (0.5) | 0.674 |
| Diabetes (1.7) | 409 (23.4) | 306 (17.8) | 103 (6.0) | 0.009* | 384 (22.3) | 25 (1.5) | 0.078 |
| Chronic kidney disease (1.9) | 251 (14.3) | 184 (10.7) | 67 (3.9) | 0.009* | 237 (13.8) | 14 (0.8) | 0.366 |
| Chronic liver disease (0.0) | 237 (13.5) | 198 (11.3) | 39 (2.2) | 0.092 | 234 (13.4) | 3 (0.2) | 0.010* |
| Organ transplant (2.1) | 300 (17.1) | 238 (13.9) | 62 (3.6) | 0.956 | 293 (17.1) | 7 (0.4) | 0.047* |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Malignancy (1.1) | 698 (39.9) | 552 (31.9) | 146 (8.4) | 0.767 | 660 (38.1) | 38 (2.2) | 0.099 |
| None of the above (1.8) | 368 (21.0) | 308 (17.9) | 60 (3.5) | 0.022* | 355 (20.7) | 13 (0.8) | 0.322 |
| Scoring systems[3] [median (IQR)] | | | | | | | |
| SOFA (0.0) | 2 (1–3) | 1 (0–2) | 2 (0.5–3.5) | <0.001* | 1 (−1 to 1) | 4 (0–8) | <0.001* |
| qSOFA (0.0) | 0 (−0.5 to 0.5) | 0 (−0.5 to 0.5) | 1 (0.5–1.5) | <0.001* | 0 (−0.5 to 0.5) | 1 (−0.5 to 0.5) | <0.001* |
| NEWS (0.0) | 3 (1–5) | 2 (0–4) | 4 (2–6) | <0.001* | 3 (1–5) | 7 (2–12) | <0.001* |
| SIRS (0.0) | 2 (0–4) | 2 (1–3) | 2 (0–4) | <0.001* | 2 (0–4) | 3 (2–4) | <0.001* |
| Length of stay (days) (0.0) [median (IQR)] | 4 (2–6) | 3 (−0.5 to 6.5) | 7 (3–11) | <0.001* | 4 (0–8) | 8 (2.5–13.5) | <0.001* |

Deterioration; death, ICU-admission or development of organ failure (respiratory, liver and/or kidney) <72h. 1≥1 cigarette a day; 2≥1 unit of alcohol per week; 3 during triage; Percentages of total is shown within parentheses.

COPD, chronic obstructive pulmonary disease; IQR, interquartile range; NEWS, national early warning score; ND, no data; qSOFA, quick sequential organ failure assessment; SIRS, systemic inflammatory response syndrome.

*$P < 0.05$.

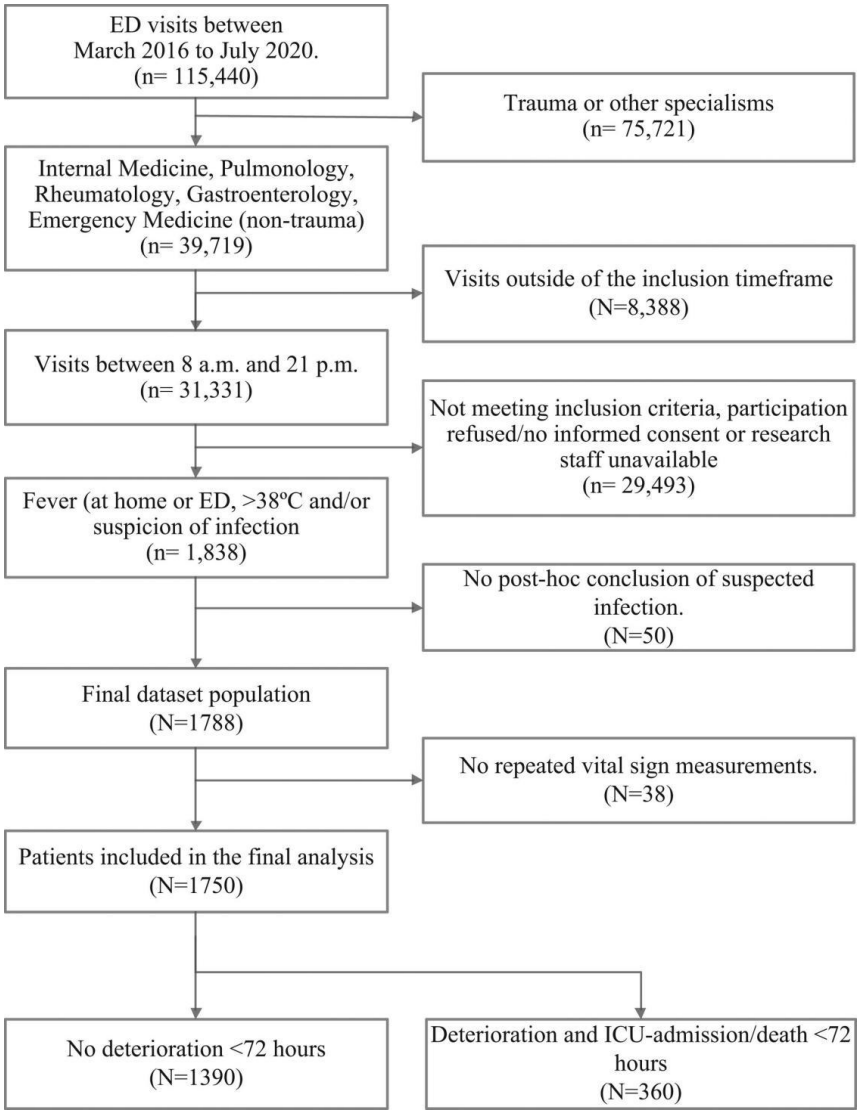



**Fig. 1:** Flowchart of patient selection. Adult medical patients visiting the emergency department (ED) between March 2016 and July 2020 were screened for inclusion. Deterioration: death, ICU-admission, development of new kidney failure (defined following the kidney disease improvement global outcomes criteria), respiratory failure [an increase of one of more points in the sequential organ failure assessment (SOFA) score for this category] and liver failure (an increase of one of more points in the SOFA score for this category) within 72 h after admission to the ED.

**Sepsis scoring systems per time-point as predictor of deterioration**

All three measures predicted worsening, ICU admission/mortality, and a two-point increase in SOFA score (P 0.05) (Fig. 2; Supplementary Tables 1-3, Supplementary digital content 1, https://links.lww.com/EJEM/A330). When compared to qSOFA and SIRS, the NEWS had a higher prognostic accuracy to predict deterioration (i.e. development of organ failure, ICU-admission and/or mortality; P 0.05) and ICU-admission/mortality (P 0.001), whereas the prognostic accuracy to predict a rise in SOFA score of at least 2 points was not different (Supplementary Table 4, Supplemental digital content 1, https://link

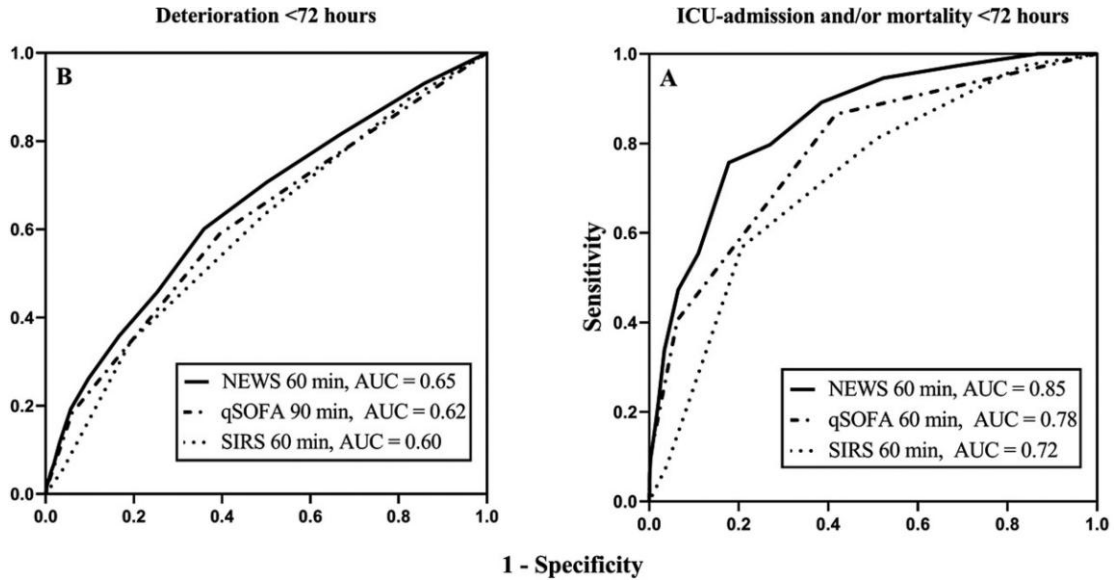
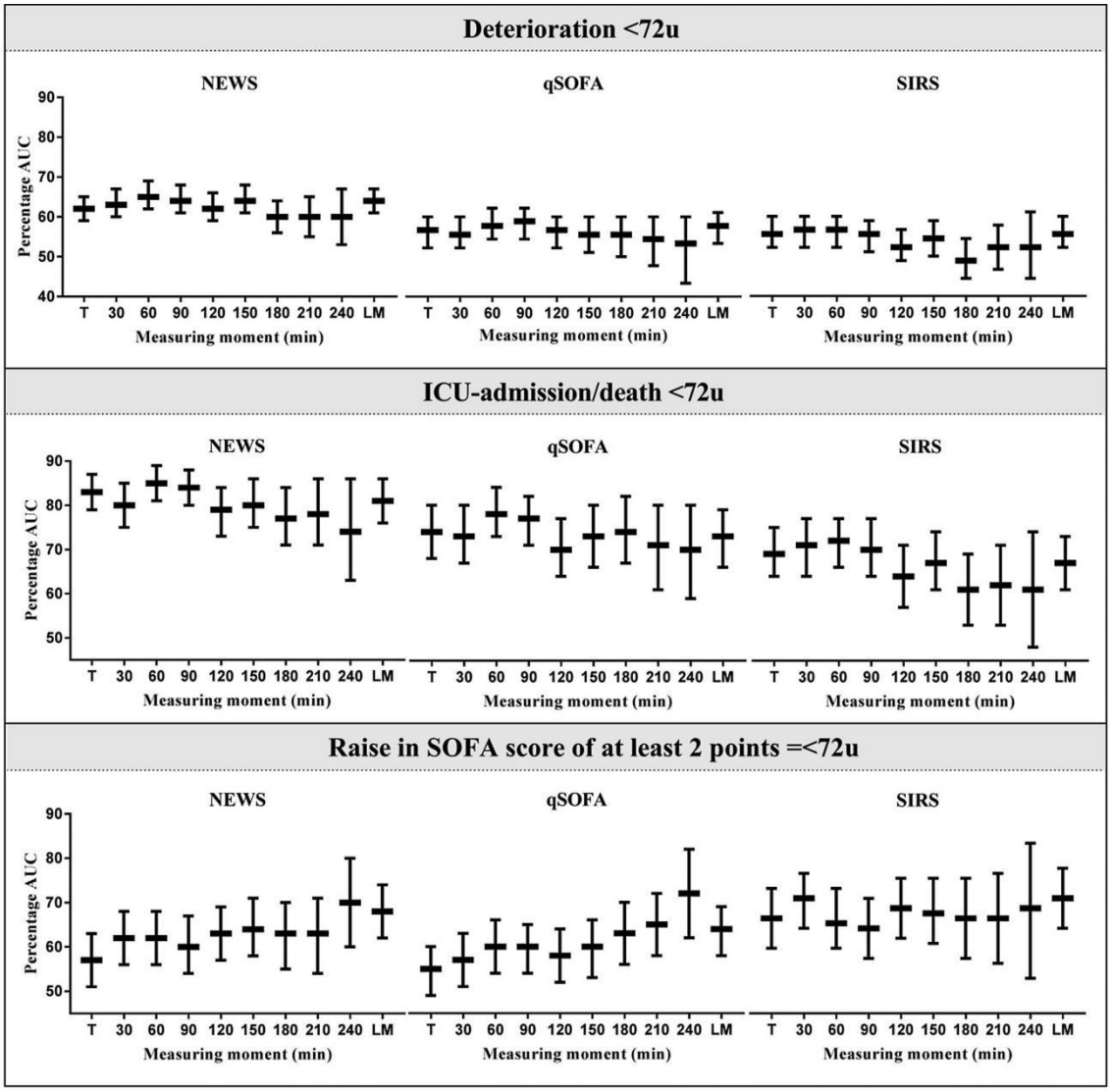



**Fig. 2:** Receiver operating curves of the prediction of deterioration and mortality and/or ICU admission. The best performing measuring moment per score is showed in the figure. For deterioration (a), NEWS at 1 h (AUC, 0.65; 95% CI, 0.62–0.69), qSOFA at 90 min (AUC, 0.62; 95% CI, 0.59–0.65) and SIRS at 1 h (AUC, 0.60; 95% CI, 0.56–0.63). For ICU-admission or mortality (b), NEWS at 1 h (AUC, 0.85; 95% CI, 0.81–0.89), qSOFA at 1 h (AUC, 0.78; 95% CI, 0.73–0.84) and SIRS at 1 h (AUC, 0.72; 95% CI, 0.66–0.78). AUC, area under the ROC; CI, confidence interval; NEWS, national early warning score; qSOFA, quick sequential organ failure assessment; SIRS, systemic inflammatory response syndrome.

NEWS reached the highest accuracy to predict deterioration [AUC, 0.65; 95% confidence interval (CI), 0.62–0.69; significant vs. triage] and ICU-admission/mortality at 1 h (AUC, 0.85; 95% CI, 0.81–0.89; NS different vs. triage) and to predict a rise in SOFA of at least 2 points at 4 h (AUC, 0.70; 95% CI, 0.60–0.80; significant vs. triage) (Figs 2 and 3; Supplementary Tables 1–3 and 5–7, Supplemental digital content 1, https://links.lww.com/EJEM/A330). Thus, the accuracy of NEWS to predict deterioration or a rise in SOFA score of at least 2 is higher at 1 h after triage compared with triage, whereas the association with ICU-admission/mortality is not different between time-points from triage up to ED discharge.

**Fig. 3:** AUC for each individual score and measuring moment per different outcome. AUC with 95% confidence interval of the NEWS, qSOFA and SIRS per measuring moment, for all different outcomes. First row is the AUC for the prediction of deterioration <72 h, the second shows the AUC for the prediction of ICU-admission/mortality <72 h and the third shows the AUC for the prediction of a raise in SOFA score of at least 2 points <72 h. For exact number, see Supplemental Table 1–3. AUC, area under the ROC; NEWS, national early warning score; qSOFA, quick sequential organ failure assessment; SIRS, systemic inflammatory response syndrome.




The prognostic accuracy of the qSOFA to predict deterioration or ICU-admission/mortality was highest at 90 min to predict deterioration (AUC, 0.62; 95% CI, 0.58–0.65; NS different vs. triage), at 1 h to predict ICU-admission/mortality (AUC, 0.78; 95% CI, 0.73–0.84; NS different vs. triage) and at 4 h to predict a rise in SOFA score of at least 2 (AUC, 0.72; 95% CI, 0.62–0.82; significant vs. triage) (Figs 2 and 3; Supplementary Tables 1–7, Supplemental digital content 1, https://links.lww.com/EJEM/A330). However, the accuracy of the qSOFA to predict these outcomes was not significantly different between the time-points from triage until ED discharge.

The accuracy of the SIRS score was highest at 1 h after arrival to predict deterioration (AUC, 0.60; 95% CI, 0.56–0.63, NS different vs. triage) and ICU-admission/mortality at (AUC, 0.72; 95% CI, 0.66–0.77; NS different vs. triage), and at 30 min after triage to predict a rise in SOFA score of at least 2 (AUC, 0.63; 95% CI, 0.57–0.68, $P < 0.001$; NS different vs. triage) (Figs 2 and 3; Supplementary Tables 1–7, Supplemental digital content 1, https://links.lww.com/EJEM/A330). Of the measurements obtained after triage, we had to omit measurements taken at 3 h and later due to insufficient power based on a post hoc power analysis (Supplementary Table 8, Supplemental digital content 1, https://links.lww.com/EJEM/A330). Thus, the time-point between triage and ED discharge of the SIRS score does not affect its accuracy.

**Association between change in the scores over time and deterioration**

To determine whether the change in NEWS, qSOFA or SIRS over time affects their prognostic accuracy for deterioration, the change in these scores from triage up to 3 h after arrival to the ED was analyzed. The NEWS score was unchanged in 170 patients (20.2%), lowered in 348 (41.4%) patients and rose in 322 (38.3%). The qSOFA was unchanged in 474 patients (64.4%), lowered in 122 (16.6%) patients and increased in

140 (19.0%). The SIRS score remained unchanged in 354 patients (42.1%) up to 3 h after ED arrival, decreased in 289 (25.8%) and rose in 194 (23.1%) patients (Fig. 4).

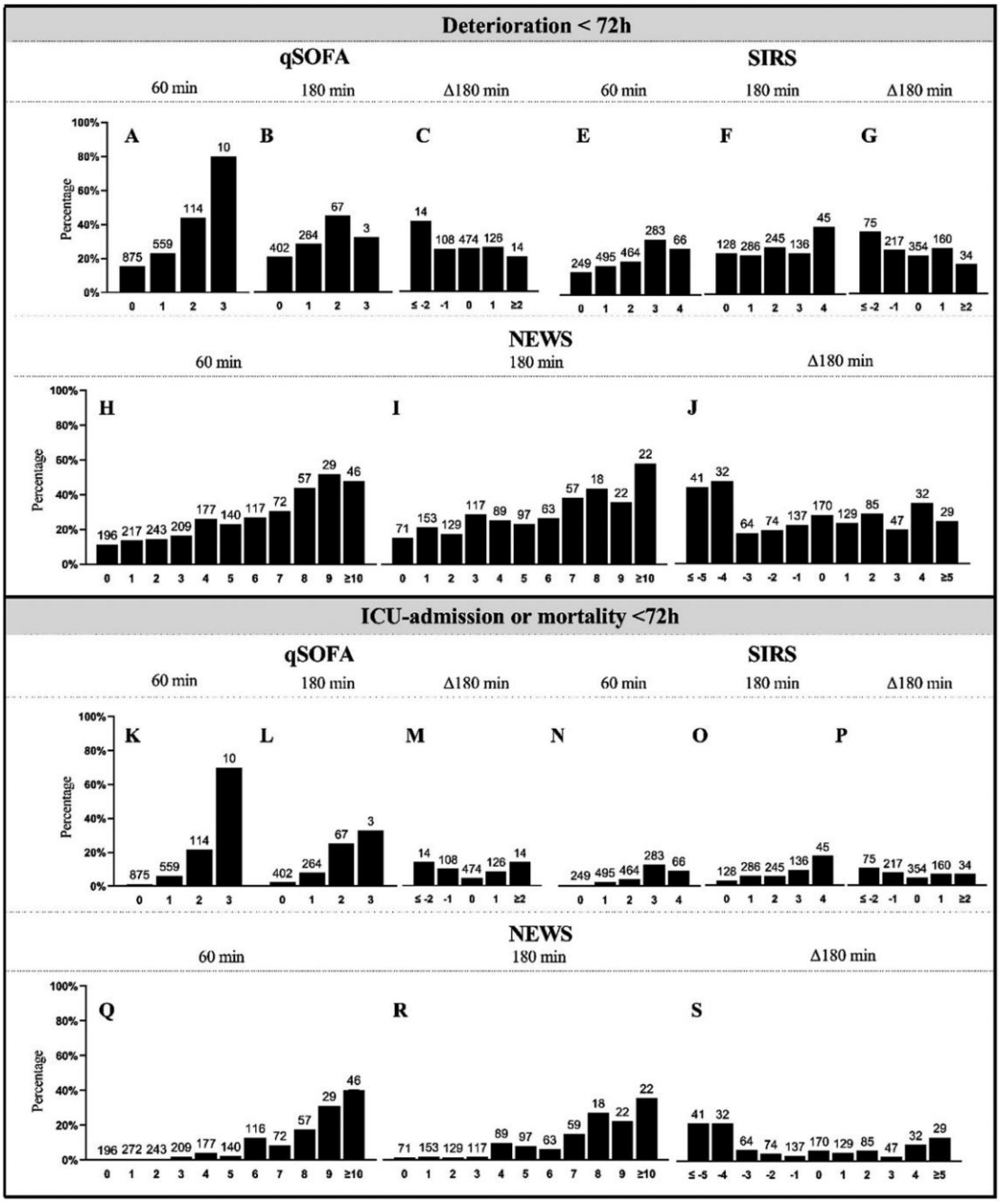



**Fig. 4:** qSOFA, SIRS and NEWS at 1 h, 3 h and Δ3 h. Percentages per score per moment in time annotated for deterioration <72 h and ICU-admission/mortality <72 h. The sample size of each group is annotated above each bar. Δ180, 180 – triage; AUC, area under the ROC; NEWS, national early warning score; qSOFA, quick sequential organ failure assessment; SIRS, systemic inflammatory response syndrome.

Patients whose scores abated were less likely to deteriorate. Among 73 patients with a decrease in NEWS of at least 4, 45.2% deteriorated and 21.9% went to the ICU or died, whereas among 61 patients with a rise in NEWS of at least 4, only 29.5% deteriorated and 11.5% went to the ICU or died. In line with these observations, 42.9% of patients with a decrease in qSOFA of at least 2 and 21.4% of patients with a rise in qSOFA of at least 2 deteriorated. Further, 37.3% of patients with a decrease in SIRS of at least 2 and 17.6% of patients with a similar rise in SIRS score deteriorated (Fig. 4). Next, we calculated the delta of each score from triage up to ED discharge at 30 min intervals and associated these with the outcomes. Only NEWS up to

NEWS150, calculated by subtracting the NEWS at triage from the NEWS at the moment in time, was significantly associated with deterioration albeit with a very low predictive accuracy. Together, the NEWS and SIRS changed in the majority of the patients, in contrast to the qSOFA that remained unchanged in the majority; both a decrease as well as an increase in sepsis scores were associated with deterioration and ICU-admission/mortality.

## IV. Discussion

The time-dependent impacts on the prognostic accuracy of NEWS, qSOFA, and SIRS to predict clinical deterioration, as well as ICU-admission/mortality and a rise in SOFA score of at least 2, were investigated in this post-hoc analysis of prospectively collected data. Upon triage, all measured scores were associated with clinical worsening, and the NEWS had a higher predictive accuracy than qSOFA and SIRS. When compared to triage, the NEWS had the highest prognostic accuracy at 1 hour following triage. As a result, physicians working in the ED should use the NEWS 1 hour after ED entry to anticipate the course of early sepsis and guide treatment decisions.

We proved the accuracy of NEWS, qSOFA, and SIRS in predicting clinical deterioration defined as the composite endpoint of (multi)organ failure, ICU-admission, or fatality in this investigation, whereas previous studies mostly focused on mortality or a change in SOFA score. All scores predicted worsening somewhat well. As expected, SIRS had the highest sensitivity (63% sensitivity and 51% specificity), qSOFA had the highest specificity (18% sensitivity and 94% specificity), and NEWS had a more balanced accuracy (45% sensitivity and 75% specificity). Although being a secondary outcome in our study, the accuracy to predict mortality is in line with previous studies [13,14,18,19,20], where NEWS had a higher prognostic accuracy compared with qSOFA and SIRS to predict mortality (i.e. sensitivity 74% and specificity of 43%) [13,14]. Thus, consistent with previous studies describing the prognostic accuracy to predict mortality, we revealed qSOFA to have high specificity at the cost of low sensitivity, which may be explained by qSOFA lacking important variables (e.g. temperature and heart rate) [2,18]. NEWS outperforms both qSOFA and SIRS, probably due to the inclusion of mental status, blood pressure and oxygenation [18]. The qSOFA (high specificity) is excellent for identifying individuals at risk of deterioration, whereas SIRS (high sensitivity) can be utilised to identify patients who are not at danger of deterioration. Given the balance of sensitivity and specificity, as well as the AUC of the NEWS, we believe this is the best tool for facilitating early sepsis detection in the ED.

Given the dynamic characteristics of the clinical course in early sepsis, as indicated by changes in vital measures and, consequently, sepsis scores based on these data, the timing of assessments will most likely alter their predictive accuracy. We expected that a change in sepsis scores during the ED stay would be more significantly related with clinical deterioration than the score itself. This theory was corroborated by the discovery that a reduction in oxygen saturation or blood pressure among sepsis patients in the ED was related with higher mortality [21,22]. Furthermore, failure to normalize vital signs in sepsis patients in the emergency department is related with increased mortality [23]. We established that NEWS at 150 minutes, and hence the shift in NEWS from ED arrival to 150 minutes, could considerably predict worsening. These findings support prior research among sepsis patients in the emergency department: (a) a reduction in qSOFA among patients with qSOFA of at least 2 [24], and (b) a reduction in NEWS among patients with NEWS of at least 5 is related with a lower mortality risk [25]. However, it should be highlighted that in the latter trial, measures were taken pre-hospital, during triage, and on the ward, and thus less often than in our current investigation.

Surprisingly, the groups with the greatest change in NEWS, qSOFA, or SIRS, whether an increase or decrease, had the highest chance of worsening, annihilating the overall predictive usefulness of risk score changes. Patients with a big rise (i.e. NEWS4, qSOFA2, or SIRS2), as well as those with a similar large reduction, were at a high risk of clinical deterioration and ICU admission/mortality. It should be noted that in order to have a substantial reduction, the baseline score must be high, and so there is a strong a priori chance of worsening. The vital indicators that comprise the sepsis scores upon entry to the ED most likely represent cellular harm that is not reversed by resuscitation at the ED, but resuscitation may improve vital signs and lower scores. As a result, the initial improvement in vital indicators and sepsis scores may not be matched by relevant change on a cellular level, putting the patient at risk of subsequent clinical deterioration. ED staff should examine the clinical status and be aware that the risk of deterioration differs between patients with normalized sepsis scores and those without aberrant scores.

Developing a system for stratifying patients with early sepsis in the emergency department is critical for timely commencement of appropriate therapy to prevent organ failure and mortality. We show that nearly one in every four patients deteriorates within 72 hours of admission. NEWS had a better prognosis accuracy than qSOFA and SIRS, and its accuracy increased over time, achieving its best predictive performance 1 hour after triage. As a result, risk categorization of early sepsis patients is best accomplished by reassessing the NEWS at numerous time intervals.

## V. Limitations

Adult medical patients admitted for internal medicine (including nephrology, haematology, oncology, general medicine, allergology, and infectiology), rheumatology, gastroenterology, pulmonology, and emergency medicine are excluded from the study. Patients admitted to the ED for other specialties were not tested because the prevalence of infections and sepsis among these patients is relatively low. The study's primary outcome is a composite of organ failure, ICU hospitalization, or death within 72 hours of admission. Given that the vast majority of patients with sepsis are treated on the ward, either because ICU admission is not yet indicated based on the level of organ failure or because ICU treatment is unwelcome by the patient, we believe that this composite outcome accurately reflects deterioration in all patients. We included more regularly used outcomes (i.e. ICU-admission and death 72 h) as secondary outcomes because this outcome limits comparability with other studies. All data utilised for this study were obtained prospectively by a trained team of medical student researchers to limit bias owing to inter-observer variability, which may impair generalizability to routine clinical treatment, as values are obtained by multiple health care practitioners. The scores were computed after the fact, utilizing all available data at each time point. However, we discovered missing data because measurements were not obtained in individual patients or patients had already been discharged from the ED. As a result, the respiratory rate was frequently missing and had to be guessed. However, this reflects the reality of the ED and, therefore, makes the data relevant for real practice [26,27]. Further, this study was performed in an academic tertiary-care teaching hospital, which can limit generalizability to small rural hospitals. Nonetheless, this hospital has a substantial geographical spread in a rural area, ensuring a diverse population.

## VI. Conclusion

When compared to qSOFA and SIRS, NEWS at triage has the highest prognostic accuracy for predicting clinical deterioration. When compared to triage, the NEWS had the highest prognostic accuracy at 1 hour following triage. Aside from the link between NEWS at one point in time and deterioration, the shift in NEWS from triage to 150 minutes was also predictive of deterioration. Furthermore, the incidence of clinical worsening was higher among patients with lower sepsis levels compared to those with higher scores. A lower score may mistakenly soothe the physician, whereas a higher score is regarded worrying.

**Conflicts of interest**

There are no conflicts of interest.

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