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Comparison of five early warning scores in predicting mortality risk in patients presenting to the emergency department with acute dyspnea: qSOFA, NEWS2, MEWS, HASI, and SIL

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ABSTRACT

Objectives: This study aimed to compare five early warning scores - Quick Sequential Organ Failure Assessment (qSOFA), National Early Warning Score 2 (NEWS2), Modified Early Warning Score (MEWS), Hospital Alert Severity Index (HASI), and Shock Index-Lactate (SIL) - in predicting 30-day mortality in elderly patients presenting to the emergency department (ED) with acute dyspnea.

Methods: This was a single-center, retrospective observational study. A total of 764 patients aged 65 years or older presenting to the emergency department with acute dyspnea over a five-year period were included in this study. The predictive accuracy of each score was evaluated using AUROC analysis and logistic regression.

Results: Our findings demonstrated that the qSOFA score had the highest accuracy in predicting 30-day mortality (AUROC: 0.768). Among these scores, qSOFA showed the best performance in predicting mortality with a sensitivity of 72.9% and specificity of 74.6%. In logistic regression analysis, the qSOFA score demonstrated the strongest independent association with 30-day mortality (odds ratio [OR]: 5.23, P<0.001). The SIL score also showed a significant association with mortality (OR: 1.29, P=0.035). However, the HASI (P=0.092), MEWS (P=0.726), and NEWS2 (P=0.344) scores were not independently significant in multivariable analysis. Regarding mortality timing, qSOFA was identified as the most robust predictor for early death (within the first 3 days) with an AUROC of 0.801. It also demonstrated superior performance in predicting late in-hospital death (after 3 days) with an AUROC of 0.632 and post-discharge mortality within 30 days with an AUROC of 0.788. Other scores (HASI, MEWS, NEWS2, SIL) demonstrated lower performance in predicting mortality across different time intervals.

Conclusions: qSOFA demonstrated the most consistent and accurate performance among the evaluated scores. It may serve as a practical tool for early risk stratification in elderly patients with acute dyspnea in ED settings.

Keywords: Dyspnea, elderly, emergency department, qSOFA, early warning score

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Acute dyspnea is a prevalent and concerning symptom in emergency medicine, being one of the most frequent reasons for presentation to the emergency department (ED). In the United States alone, dyspnea accounts for approximately three to four million ED visits annually. Similarly, in the Asia-Pacific region, it constitutes around 5% of all ED presentations [1, 2]. In the ED setting, dyspnea is not only associated with high rates of admission to both general wards and intensive care units (ICU) but also serves as an independent predictor of poor clinical outcomes, including hospital readmissions, intubation, and increased mortality [3-5]. This high morbidity and mortality risk necessitates prompt diagnosis and efficient management by emergency physicians (EPs) [6].

For EPs, the primary goal when managing patients presenting with acute dyspnea in the ED is to rapidly optimize arterial oxygenation, assess the need for emergency airway management and respiratory support, and promptly identify life-threatening conditions[7, 8]. Additionally, it is essential to establish the most likely etiology of dyspnea, initiate appropriate treatment, and stabilize the patient if they are critically ill [7, 9-12]. However, achieving these objectives poses a significant challenge, given the often-limited clinical data available upon initial assessment. Accurate and timely triage and management decisions are crucial for improving patient outcomes, particularly in the elderly, who represent a significant proportion of patients presenting with acute dyspnea.

Epidemiological data indicate that the demographic profile of ED visits is shifting, with a growing proportion of elderly patients. In 2022, approximately one in ten ED visits involved patients aged 65 years or older, a figure projected to rise to one in six by 2050 [13]. Age-related deterioration in pulmonary and cardiovascular function complicates dyspnea management in the elderly [14]. Age-related physiological changes can obscure the clinical presentation, affecting physical examination findings, vital signs, and laboratory parameters, thereby increasing diagnostic complexity [15, 16].

Given the diagnostic challenges associated with acute dyspnea, particularly among older adults, the use of clinical and biochemical scoring systems has been advocated to aid EPs in risk stratification and management decisions. Several scoring systems, including the quick Sequential Organ Failure Assessment (qSOFA), National Early Warning Score 2 (NEWS2), Modified Early Warning Score (MEWS), Hospital Alert Severity Index (HASI), and the Shock Index-Lactate (SIL) score, have been evaluated for their prognostic utility in predicting mortality in critically ill patients presenting to the emergency department [17-19]. However, evidence remains limited regarding the comparative effectiveness of these scoring systems, particularly in elderly populations in acute dyspnea case.

This study aims to evaluate the prognostic accuracy of these five scoring systems in predicting 30-day mortality among elderly patients presenting to the ED with acute dyspnea.

METHODS

Study Design and Setting

This study was a retrospective, single-center observational analysis conducted in the ED of a tertiary care hospital. This study was approved by the Memorial Şişli Hospital Ethics Committee (Decision No: 004, Date: 26.12.2024). The primary objective of this study was to compare the prognostic accuracy of five commonly used risk assessment and decision-making tools (qSOFA, NEWS2, MEWS, HASI, and SIL) in predicting 30-day mortality among elderly patients presenting to the ED with acute dyspnea. The study specifically focused on assessing early death, late in-hospital death, and post-discharge death, aiming to determine the most reliable scoring system for mortality prediction in this vulnerable population.

Definition of Acute Dyspnea

Acute dyspnea was defined as "a subjective experience of breathing discomfort that consists of qualitatively distinct sensations that vary in intensity", in accordance with the consensus statement by the American Thoracic Society [20]. Acute dyspnea was defined as the sudden onset or worsening of breathing difficulty within the past 96 hours, based on institutional clinical protocols, differentiating it from chronic dyspnea, which persists for more than four to eight weeks. Patients with known chronic dyspnea (e.g., Chronic obstructive pulmonary disease [COPD], Congestive heart failure) were included only if there was a documented acute deterioration in symptoms within this period, accompanied by clinical signs of respira-

tory distress. Patients with missing data essential for the calculation of any of the five scores or for outcome analysis were excluded from the study

Missing Data Management

Patients with missing data essential for the calculation of any of the five scores or for outcome analysis (e.g., 30-day mortality) were excluded from the study. No data imputation techniques were applied due to the retrospective nature of the study.

Study Population:

Patients aged 65 years and older who presented to the ED with a chief complaint of acute dyspnea between January 1, 2019, and December 31, 2024, were eligible for inclusion in the study, and a total of 764 patients met the inclusion criteria. Exclusion criteria included patients who had experienced dyspnea symptoms for more than four days prior to admission, those with incomplete or missing medical records, and patients whose dyspnea was attributable to non-respiratory causes, such as traumatic injuries. Additionally, patients who were transferred from other healthcare facilities and those with documented palliative care status or end-of-life directives that limited aggressive treatment were also excluded. Data for the study were retrospectively collected from the hospital's electronic medical record (EMR) system, encompassing relevant demographic, clinical, and laboratory variables.

The following variables were extracted:

(a) Demographic data: Age, sex;

(b) Vital signs on ED admission: Systolic blood pressure (SBP) and diastolic blood pressure (DBP), respiratory rate (RR), heart rate (HR), peripheral oxygen saturation (SpO_2), and temperature;

(c) Neurological status: Glasgow Coma Scale (GCS);

(d) Laboratory data: Lactate levels, arterial blood gas (ABG) analysis, serum creatinine, estimated glomerular filtration rate (eGFR), B-type natriuretic peptide (BNP), C-reactive protein (CRP), and partial pressure of carbon dioxide (pCO_2);

(e) Comorbidities: Congestive heart failure, chronic kidney disease, diabetes mellitus;

(f) Medication history: Use of anticoagulants, diuretics, and home oxygen therapy;

(g) Outcomes: 30-day mortality, early death (within 3 days), late in-hospital death (after 3 days but before discharge), and post-discharge death (within 30 days after discharge);

(h) Intervention data: Requirement for oxygen therapy, mechanical ventilation, intensive care unit (ICU) admission, and vasopressor support.

Risk Assessment Scores

Five commonly used scoring systems were calculated for each patient upon ED admission:

(1) qSOFA: Systolic blood pressure, respiratory rate, and altered mental status [21].

(2) NEWS2: Respiratory rate, oxygen saturation, supplemental oxygen, systolic blood pressure, heart rate, consciousness (ACVPU=Alert, Confusion, Verbal, Pain, and Unresponsive), temperature [22].

(3) MEWS: Systolic blood pressure, heart rate, respiratory rate, temperature, consciousness (AVPU) [23].

(4) HASI: The HASI score is calculated using the formula: SpO_2 / (age × shock index), where shock index = heart rate / systolic blood pressure [24].

(5) SIL: The SIL score is calculated as: serum lactate level × shock index where shock index = heart rate / systolic blood pressure [17].

Statistical Analysis

All statistical analyses were performed using R version 4.4.2 (R Foundation for Statistical Computing, Vienna, Austria). Continuous variables were summarized using mean ± standard deviation or median with interquartile ranges, based on visual assessment of distribution. Categorical variables were reported as counts and percentages. Between-group comparisons for continuous variables were conducted using Student's t-test or the Wilcoxon rank-sum test, as appropriate. Categorical variables were compared using Pearson's chi-squared test or Fisher's exact test when expected counts were low. To assess the prognostic accuracy of five scoring systems AUROC values with 95% confidence intervals were calculated. Optimal thresholds were identified using Youden's index, and corresponding sensitivity, specificity, and positive and negative likelihood ratios were reported. Pairwise comparisons between AUROCs were conducted using DeLong's test for correlated ROC curves. A multivariable logistic regression model was built to evaluate the independent association of each scoring system with 30-day mortality. All five scores were included in the

model simultaneously. Model performance was internally validated using 10-fold cross-validation on the training dataset (80% of the sample), and tested on a hold-out test dataset (20%). Discriminative performance was summarized using AUROC. Model calibration was assessed using the Hosmer-Lemeshow goodness-of-fit test, Brier score, calibration intercept and slope, Emax, and Eavg statistics. To investigate associations between scoring systems and the timing of mortality, a multinomial logistic regression model was fitted with "Survived" as the reference category. The dependent outcome included three mortality subtypes: early death, late in-hospital death, and post-discharge death. Adjusted odds ratios with 95% confidence intervals were reported. Additionally, AUROC values for each score were calculated using one-vs-rest binary ROC analyses for each outcome subtype.

Post-hoc power and effect size analyses were conducted to evaluate the adequacy of the sample. For the primary comparison between survivors and deceased patients, standardized mean differences (Cohen's d) were calculated for each score. The qSOFA score yielded a Cohen's d of 0.77, indicating a large effect size. The NEWS2, MEWS, and HASI scores demon-

Table 1. Baseline characteristics of patients stratified by 30-day mortality status

Variable	30-day survivors (n=657)	30-day deceased (n=107)	Mean difference OR (95% CI)	P value
Age (years)	76.6±7.4	81.0±7.8	4.35 (2.76-5.95)	**<0.001**
Female sex, n (%)	295 (44.9%)	57 (53.3%)		0.132
Systolic blood pressure (mm Hg)	146.3±29.2	128.1±33.7	18.15 (11.33-24.97)	**<0.001**
Diastolic blood pressure (mm Hg)	75.4±15.1	71.1±17.7	4.39 (0.84-7.94)	**0.017**
Heart rate (beats/min)	97.7± 1.2	99.6±23.4		0.420
Respiratory rate (breaths/min)	16.0 [16.0-18.0]	18.0 [16.0-22.0]		**<0.001**
Peripheral oxygen saturation (%)	93.0 [90.0-96.0]	91.0 [87.5-96.0]		0.134
Body temperature (°C)	36.3 [36.0-37.0]	36.3 [36.1-36.8]		0.705
Shock index	0.7 [0.6-0.8]	0.8 [0.6-1.0]		**<0.001**
GCS	15.0 [15.0-15.0]	14.0 [12.0-15.0]		**<0.001**
Lactate, mmol/L	1.6 [1.3-2.3]	2.1 [1.3-3.2]		**0.003**
Serum creatinine (mg/dL)	1.2 [1.0-1.5]	1.7 [1.4-2.2]		**<0.001**
eGFR (mL/min/1.73m²)	56.6±18.3	36.7±15.2	19.82 (16.61-23.02)	**<0.001**
BNP (pg/mL)	1189.0 [710.0-2502.0]	1957.0 [1021.0-3300.5]		**<0.001**
CRP (mg/L)	34.3 [22.2-50.2]	93.4 [52.5-162.4]		**<0.001**
Arterial pH	7.4 [7.3-7.4]	7.3 [7.2-7.3]		**<0.001**
Arterial pCO_2 (mm Hg)	42.1±7.9	49.8±12.0	7.76 (5.40-10.11)	**<0.001**
Urine output on arrival (mL/h)	49.6±14.8	25.1±9.3	24.44 (22.34-26.54)	**<0.001**
Charlson comorbidity index	4.0±2.1	6.0±2.7	1.97 (1.44-2.50)	**<0.001**

Data are shown as mean±standard deviation or median [interquartile range] or n (%). BNP=B-type natriuretic peptide, CRP=C-reactive protein; eGFR=estimated glomerular filtration rate; GCS=Glasgow Coma Scale, pCO_2=partial pressure of carbon dioxide, OR=odds ratio

strated moderate-to-large effect sizes (Cohen's d ranging from 0.45 to 0.70). For subgroup comparisons, the largest and smallest diagnostic categories were acute heart failure (n=218) and pulmonary embolism (n=41). Assuming a two-sided alpha of 0.05 and a power of 80%, the study had sufficient power to detect an absolute mortality difference of 20% between these groups.

RESULTS

A total of 764 elderly patients presenting to the emergency department with dyspnea were included in the final analysis. Of these, 107 (14.0%) died within 30 days, and 657 (86.0%) survived. Based on available discharge diagnoses, 218 patients (28.5%) were classified as having acute heart failure, 165 (21.6%) had pneumonia, 112 (14.7%) had COPD exacerbation, 41 (5.4%) had pulmonary embolism, and 86 (11.3%) had other or mixed causes. In 142 patients (18.5%), no definitive etiology could be identified. The corresponding 30-day mortality rates were 14.2%, 12.1%, 11.7%, 15.8%, 12.8%, and 13.4%, respectively. No subgroup showed a markedly different mortality profile (P>0.05). Table 1 presents the baseline characteristics stratified by 30-day mortality status. Deceased patients were older and exhibited lower blood pressures, lower urine output, higher lactate and creatinine levels, and greater comorbidity burden compared to survivors. Significant differences were also observed in mental status, respiratory rate, Glasgow Coma Scale

Table 2. Clinical status, risk scores, and outcomes by 30-day mortality status

Variable	30-day survivors (n=657)	30-day deceased (n=107)	Mean difference OR (95% CI)	P value
Clinical frailty scale	4.7±1.1	6.1±0.6	1.39 (1.25-1.53)	**<0.001**
HASI score	1.5±0.6	2.0±0.9	0.47 (0.31-0.64)	**<0.001**
NEWS2 score	3.1±2.3	4.8±2.8	1.77 (1.20-2.34)	**<0.001**
MEWS score	1.9±1.5	2.8±1.6	0.94 (0.62-1.27)	**<0.001**
qSOFA score	0.0 [0.0-1.0]	1.0 [0.0-2.0]		**<0.001**
SIL score	6.1±1.3	6.5±1.5	0.38 (0.07-0.69)	**0.017**
Congestive heart failure	242 (36.8%)	68 (63.6%)		**<0.001**
Chronic kidney disease	413 (62.9%)	101 (94.4%)		**<0.001**
Diabetes mellitus	221 (33.6%)	31 (29.0%)		**0.400**
Dependent mobility	202 (30.7%)	91 (85.0%)		**<0.001**
Delirium at presentation	74 (11.3%)	37 (34.6%)		**<0.001**
Home oxygen therapy	56 (8.5%)	22 (20.6%)		**<0.001**
Diuretic use	416 (63.3%)	85 (79.4%)		**0.002**
Anticoagulant use	165 (25.1%)	38 (35.5%)		**0.032**
Oxygen use in ED	47 (7.2%)	17 (15.9%)		**0.005**
Oxygen delivery (mechanical)	13 (2.0%)	25 (23.4%)		**<0.001**
ICU admission	191 (29.1%)	45 (42.1%)		**0.010**
Oliguria	57 (8.7%)	74 (69.2%)		**<0.001**
Discharged from ED	434 (66.1%)	26 (24.3%)		**<0.001**

Data are shown as mean±standard deviation or n (%). ED=Emergency department, HASI=Hospital Alert Severity Index, ICU=intensive care unit, MEWS=Modified Early Warning Score, NEWS2=National Early Warning Score 2, qSOFA=Quick Sequential Organ Failure Assessment, SIL=Shock Index-Lactate score, GCS=Glasgow Coma Scale, CI=Confidence interval, OR=odds ratio

Table 3. Performance metrics of scoring systems for predicting 30-day mortality

Score	AUROC (95% CI)	Cut-off	Sensitivity (95% CI)	Specificity (95% CI)	+LR OR (95% CI)	–LR OR (95% CI)
HASI	0.650 (0.594-0.707)	≥3.0	24.3% (16.5-33.5%)	97.3% (95.7-98.4%)	8.87 (5.04-15.61)	0.78 (0.70-0.87)
MEWS	0.671 (0.621-0.722)	≥2.0	75.7% (66.5-83.5%)	51.0% (47.1-54.9%)	1.54 (1.35-1.76)	0.48 (0.34-0.67)
qSOFA	0.768 (0.720-0.817)	≥1.0	72.9% (63.4-81.0%)	74.6% (71.1-77.9%)	2.87 (2.41-3.42)	0.36 (0.27-0.50)
SIL score	0.566 (0.503-0.628)	≥7.47	28.0% (19.8-37.5%)	87.4% (84.6-89.8%)	2.22 (1.54-3.19)	0.82 (0.73-0.93)
NEWS2	0.687 (0.631-0.743)	≥4.0	67.3% (57.5-76.0%)	65.3% (61.5-68.9%)	1.94 (1.64-2.30)	0.50 (0.38-0.66)

HASI=Hospital Alert Severity Index, MEWS=Modified Early Warning Score, qSOFA=Quick Sequential Organ Failure Assessment, SIL=Shock Index-Lactate, NEWS2=National Early Warning Score 2, AUROC=Area under the receiver operating characteristic curve; +LR=Positive likelihood ratio, –LR=Negative likelihood ratio, CI=Confidence interval, OR=odds ratio

scores, and key laboratory markers such as BNP, CRP, and pCO_2.

As summarized in Table 2, all five risk scores were significantly higher in the deceased group. The median [interquartile ranges] qSOFA score was 1.0 [0.0-2.0] in deceased patients versus 0.0 [0.0-1.0] among survivors (P<0.001). Similar differences were seen across HASI, MEWS, NEWS2, and SIL scores, as well as in frailty, mobility status, and the frequency of acute interventions.

Table 3 outlines the diagnostic performance of each scoring system for predicting 30-day mortality. The qSOFA score showed the highest discriminative ability with an AUROC of 0.768 (95% confidence interval [CI]: 0.720-0.817), followed by NEWS2 (0.687), MEWS (0.671), HASI (0.650), and SIL (0.566). Cut-off values based on the Youden index, corresponding sensitivities, specificities, and likelihood ratios are also provided.

Fig. 1 displays the ROC curves with 95% confidence bands for all scores. Pairwise comparisons using the DeLong test are shown in Table 4. qSOFA outperformed all other scores except NEWS2 (P=0.010). MEWS and NEWS2 did not differ significantly (P=0.520), while HASI and SIL demonstrated significantly lower AUROCs than qSOFA and MEWS.

In the multivariable logistic regression analysis including all five scoring systems, only the qSOFA score and the SIL score were independently associated with 30-day mortality. Prior to modeling, collinearity was assessed; all variance inflation factors (VIFs) ranged from 1.3 to 2.1, indicating low collinearity and supporting the simultaneous inclusion of all scores. The qSOFA score demonstrated the strongest independent association with mortality, with an adjusted odds ratio (OR) of 5.23 (95% CI, 3.30-8.47;P<0.001), followed by the SIL score with an OR of 1.29 (95% CI, 1.02-1.63; P=0.035). The HASI score showed a borderline association (OR, 1.60; 95% CI, 0.93-2.77; P=0.092), while MEWS and NEWS2 were not statistically significant predictors in the adjusted model (P=0.726 and P=0.344, respectively) (Table 5).

The logistic model demonstrated strong discriminative ability, with an AUROC of 0.808 in the training set (10-fold cross-validation) and 0.833 in the test set. Calibration was satisfactory: the Brier score was 0.084 in the test set, the Hosmer-Lemeshow test was non-significant (χ^2 = 6.79, P=0.559), and the calibration

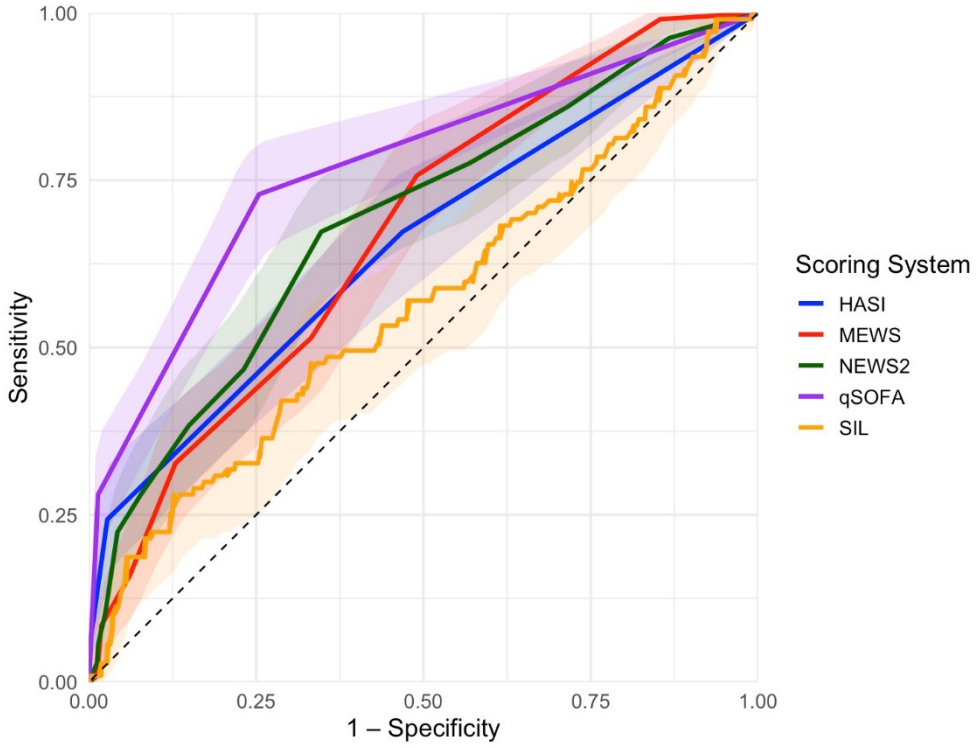

Fig. 1. Receiver Operating Characteristic (ROC) curves with 95% confidence interval for each scoring system.

slope and intercept were 1.22 and 0.32, respectively. Model calibration was assessed also using a LOESS-smoothed calibration curve comparing predicted probabilities with observed 30-day mortality. Visual inspection demonstrated good agreement with the ideal diagonal line, particularly in the low- and mid-risk ranges (Fig. 2). The model's maximum calibration error (Emax) was 0.263, with an average error (Eavg) of 0.025. The discrimination index (Dxy) was 0.666, and the Nagelkerke R^2 was 0.403, indicating moderate explanatory power.

To assess the relationship between each score and

Table 4. Pairwise comparisons of AUROC values for scoring systems (DeLong test)

Comparison	AUROC difference (95% CI)	P value
HASI vs MEWS	–0.021 (–0.089 to 0.047)	0.546
HASI vs qSOFA	–0.118 (–0.182 to –0.053)	**<0.001**
HASI vs SIL	0.085 (0.011 to 0.158)	**0.024**
HASI vs NEWS2	–0.036 (–0.080 to 0.008)	0.106
MEWS vs qSOFA	–0.097 (–0.154 to –0.040)	**<0.001**
MEWS vs SIL	0.105 (0.046 to 0.165)	**<0.001**
MEWS vs NEWS2	–0.015 (–0.062 to 0.031)	0.520
qSOFA vs SIL	0.203 (0.118 to 0.287)	<0.001
qSOFA vs NEWS2	0.082 (0.019 to 0.144)	**0.010**
SIL vs NEWS2	–0.121 (–0.182 to –0.060)	**<0.001**

AUROC=Area under the receiver operating characteristic curve, HASI=Hospital Alert Severity Index, MEWS=Modified Early Warning Score, qSOFA=Quick Sequential Organ Failure Assessment, SIL=Shock Index-Lactate, NEWS2=National Early Warning Score 2, CI=Confidence interval

Table 5. Independent association of each score with 30-day mortality in multivariable logistic regression

Scores	Adjusted Odds Ratio (95% CI)	P value
HASI	1.60 (0.93-2.77)	0.092
MEWS	1.05 (0.81-1.36)	0.726
qSOFA	5.23 (3.30-8.47)	**<0.001**
SIL score	1.29 (1.02-1.63)	**0.035**
NEWS2	0.91 (0.75-1.10)	0.344

HASI=Hospital Alert Severity Index, MEWS=Modified Early Warning Score, qSOFA=Quick Sequential Organ Failure Assessment, SIL=Shock Index-Lactate, NEWS20=National Early Warning Score 2, CI=Confidence interval

the timing of death, a multinomial logistic regression model was fitted using "Survived" as the reference category. Table 6 combines the adjusted odds ratios for early, late in-hospital, and post-discharge mortality for each score with their corresponding AUROC values based on one-vs-rest ROC analyses. The qSOFA score showed the strongest and most consistent predictive value across all mortality timing categories: early death (OR: 4.57, AUROC: 0.801), late in-hospital death (OR: 4.39, AUROC: 0.632), and post-discharge death (OR: 7.78, AUROC: 0.788). Other scores showed modest performance, and no additional score maintained independent significance across categories. To visualize these findings, Fig. 3 displays the distribution of survival outcomes across tertiles of each scoring system, allowing a visual assessment of how each score stratifies patients by mortality timing.

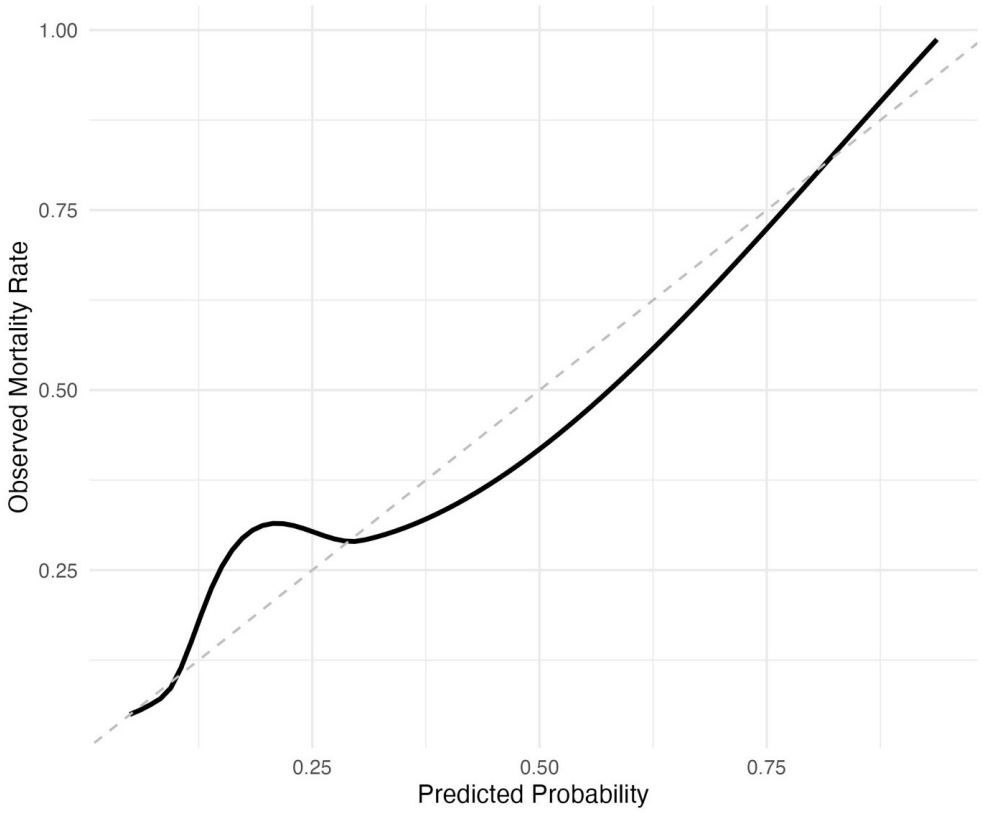

Fig. 2. Calibration plot of the multivariable logistic regression model including qSOFA, MEWS, NEWS2, HASI, and SIL scores.

Table 6. Multivariable logistic regression results and overall model performance metrics

Score	Early death OR (95% CI)	Early death AUROC (95% CI)	Late in-hosp death OR (95% CI)	Late in-hosp death AUROC (95% CI)	Post-discharge death OR (95% CI)	Post-discharge death AUROC (95% CI)
HASI	1.99 (0.87-4.54)	0.700 (0.574-0.825)	1.21 (0.55-2.67)	0.587 (0.504-0.669)	1.51 (0.83-2.76)	0.640 (0.557-0.724)
MEWS	1.41 (0.92-2.16)	0.727 (0.613-0.841)	0.67 (0.45-0.99)	0.505 (0.434-0.577)	1.11 (0.82-1.51)	0.718 (0.652-0.783)
qSOFA	4.57 (2.08-10.04)	0.801 (0.718-0.884)	4.39 (2.28-8.46)	0.632 (0.540-0.724)	7.78 (4.41-13.73)	0.788 (0.721-0.855)
SIL	1.00 (0.65-1.53)	0.561 (0.414-0.708)	1.30 (0.93-1.83)	0.521 (0.422-0.620)	1.23 (0.92-1.62)	0.583 (0.496-0.671)
NEWS2	0.96 (0.72-1.28)	0.741 (0.622-0.860)	1.01 (0.77-1.33)	0.576 (0.495-0.657)	0.95 (0.77-1.17)	0.696 (0.614-0.77

AUROC=Area under the receiver operating characteristic curve, HASI=Hospital Alert Severity Index, MEWS=Modified Early Warning Score, qSOFA=Quick Sequential Organ Failure Assessment, SIL=Shock Index-Lactate, NEWS2=National Early Warning Score 2, CI=Confidence interval, OR=odds ratio, hosp=hospital

DISCUSSION

In this study, we compared the prognostic values of five commonly used risk assessment and decision-making tools (qSOFA, NEWS2, MEWS, HASI, and SIL) for predicting mortality in elderly patients presenting to the ED with acute dyspnea. Among these tools, qSOFA demonstrated the highest performance in predicting 30-day mortality, as well as early death, late in-hospital death, and post-discharge death. qSOFA includes respiratory rate, systolic blood pressure, and mental status—three critical indicators of organ hypoperfusion and early sepsis, which are common pathways in acute dyspnea among elderly patients [25]. Conversely, composite scores like NEWS2 and MEWS incorporate variables such as temperature and supplemental oxygen use, which may not reflect immediate life-threatening derangements. This may reduce their discriminative power in high-risk elderly populations presenting with acute respiratory compromise. Similarly, SIL and HASI, though valuable in broader settings, rely on metrics (e.g., lactate, age, shock index) that may not respond as dynamically in early deterioration phases.

Compared to the other four scores, qSOFA emerged as the most effective tool in identifying elderly patients at risk of rapid deterioration during the hospital stay, as well as those who may experience worsening even after discharge. The key feature that makes qSOFA superior is its inclusion of low blood pressure, increased respiratory rate, and altered mental status, which are commonly encountered in elderly patients [26]. These parameters are closely associated with mortality in elderly patients presenting with dyspnea. Therefore, the use of qSOFA in the ED setting has proven to be highly valuable for rapid risk assessment and identifying patients requiring urgent intervention[27]. Recent literature on the use of qSOFA in the ED suggests that it outperforms other risk assessment tools in predicting mortality across various critical conditions, including trauma, pneumonia, sepsis, and infections [28-31]. Given the intersection of our study cohort - elderly patients with acute dyspnea presenting to the ED - we observed that the qSOFA score successfully identified mortality risk, proving to be a practical, cost-effective, and efficient tool for patient management. In contrast, the relatively lower performance of NEWS2 and MEWS may result from their re-

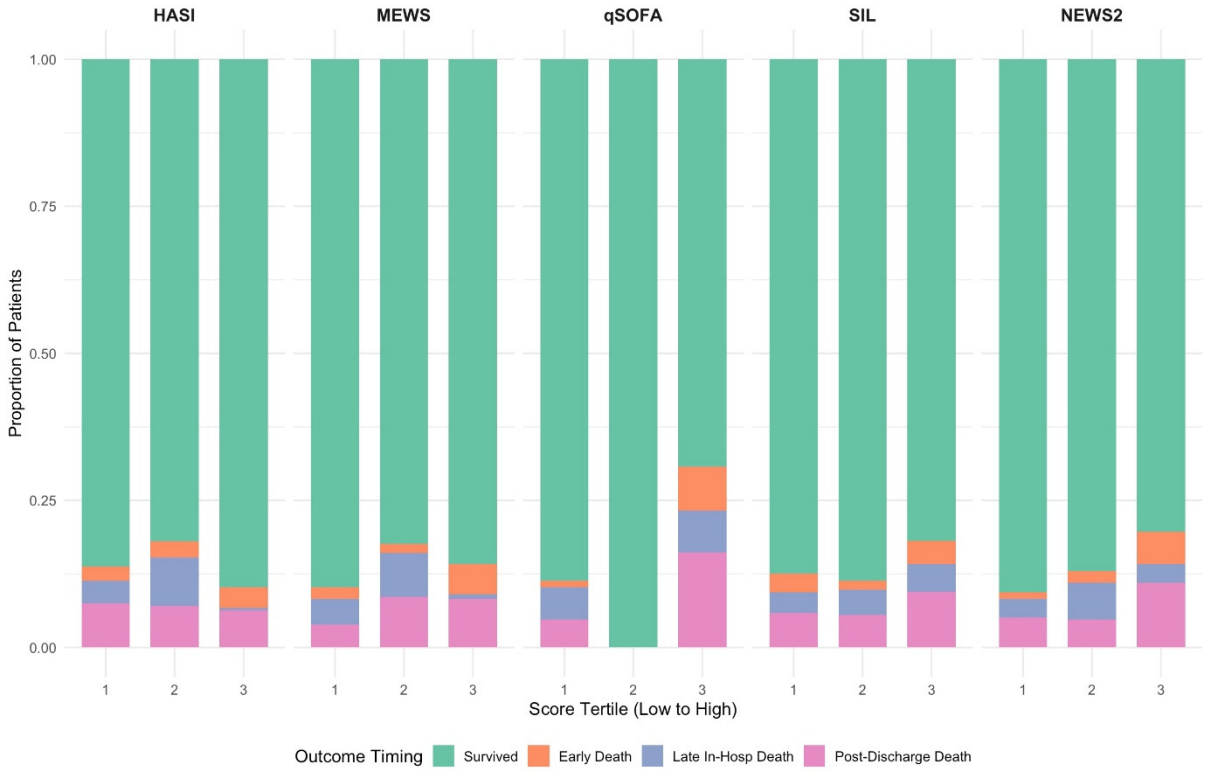

Fig. 3. Distribution of mortality timing across tertiles of each scoring system.

liance on parameters that may be chronically altered in the elderly, such as heart rate or baseline oxygen saturation, potentially limiting their discriminative power. Similarly, the HASI and SIL scores incorporate indices such as the shock index and lactate levels, which may fluctuate due to age-related physiological changes or chronic comorbidities, reducing their specificity in this patient group.

Our study revealed that SIL and HASI scores were inadequate for predicting mortality in elderly patients presenting with acute dyspnea. One of the main components of the SIL score, lactate level, can be elevated in conditions such as heart failure or chronic respiratory failure, even without sepsis or shock [32, 33]. This may lead to an inaccurate reflection of hemodynamic instability in elderly patients, thus compromising the reliability of the SIL score in this population. Similarly, the HASI score did not perform adequately in predicting mortality. The lower prognostic power of HASI, particularly in complex clinical scenarios such as acute dyspnea, limits its applicability in elderly patients [34]. Increased comorbidities and hemodynamic fluctuations in the elderly population may have contributed to HASI's limited predictive accuracy.

NEWS2 and MEWS scores also showed insufficient performance in predicting mortality related to acute dyspnea in elderly patients. The single parameters used in these scores may not adequately capture the multifactorial causes of dyspnea in the elderly, thereby limiting their prognostic accuracy. Frequent physiological changes and comorbid conditions encountered in elderly patients further restrict the utility of these scoring systems in clinical decision-making processes [35]. Therefore, when using NEWS2 and MEWS for managing acute dyspnea, it is crucial to take into account the unique clinical characteristics of elderly patients.

From a clinical perspective, the findings of this study suggest that incorporating qSOFA into the routine evaluation of elderly patients with acute dyspnea can enhance early identification of individuals at high risk of mortality. This is particularly relevant in resource-limited ED, where rapid and cost-effective tools are essential for prioritizing care. The simplicity of qSOFA - relying solely on systolic blood pressure, respiratory rate, and mental status - makes it a practical

triage tool even in settings with limited access to laboratory or imaging resources. By enabling faster decisions regarding the need for ICU admission, escalation of care, or early discharge planning, qSOFA can serve as a valuable aid in streamlining clinical workflows and improving patient outcomes in strained healthcare environments.

This study contributes to the existing literature by specifically focusing on elderly patients with acute dyspnea - a subgroup with unique physiological vulnerabilities and complex comorbid profiles often underrepresented in emergency risk stratification research. By evaluating multiple scoring systems in this context, our findings emphasize the utility of qSOFA as a simple, rapid, and cost-effective tool that can support clinical decision-making, particularly in emergency departments with limited resources. The results suggest that qSOFA may aid physicians in early identification of high-risk elderly patients, facilitate timely interventions, and optimize ICU triage pathways.

In summary, our study demonstrated that the qSOFA score is a robust tool for predicting mortality risk in elderly patients presenting to the ED with acute dyspnea. In particular, qSOFA showed clear superiority over other Early Warning Scores (EWS) in predicting critical outcomes, such as early death. In contrast, the SIL score, which relies heavily on lactate, proved to be less effective in this patient group. HASI, NEWS2, and MEWS also showed lower performance among elderly patients. Based on these results, it may be recommended to use qSOFA for rapid risk assessment and decision-making processes in elderly patients presenting with acute dyspnea in the ED. Performing quick and accurate risk stratification in this population can play a vital role in reducing mortality.

Limitations

This study has several limitations: (1) The study was conducted in a single tertiary care hospital and designed retrospectively, which may limit the generalizability of the findings; (2) The study did not stratify patients by the underlying etiology of dyspnea (e.g., acute heart failure, COPD exacerbation, pulmonary embolism), which may have influenced the performance of the evaluated scoring systems. Future research should consider diagnostic subgroup analyses to enhance the specificity and clinical applicability of early warning scores in heterogeneous dyspnea populations; (3) We also acknowledge the potential risk of missing data due to the retrospective nature of the study. To mitigate this, patients with incomplete data essential for score calculation or outcome assessment were excluded. Moreover, 30-day mortality follow-up was conducted using hospital electronic medical records, which are integrated with national death notification systems to capture out-of-hospital deaths as well; (4) Mortality data in the study were directly obtained from medical records, introducing the potential for subjective interpretation, which may affect the results; and (5) The study only assessed 30-day mortality; therefore, longer follow-up data are needed to provide more comprehensive insights into long-term survival and prognosis.

While our study underscores the prognostic utility of early warning scores - particularly Qsofa - in elderly patients presenting with acute dyspnea, its findings also have implications for improving clinical decision-making processes in emergency departments. Integrating validated scoring systems such as qSOFA into routine triage may support early identification of high-risk patients, allowing emergency physicians to prioritize resource allocation, determine the need for ICU admission, and initiate timely interventions. However, to enhance the external validity and generalizability of these results, future studies should adopt prospective, multicenter designs involving broader populations across different healthcare systems. Moreover, incorporating longer follow-up periods could provide additional insight into long-term mortality and morbidity outcomes, thereby strengthening the evidence base for integrating these tools into structured clinical algorithms and institutional protocols.

CONCLUSION

Among elderly patients presenting to the ED with acute dyspnea, qSOFA demonstrated the highest predictive accuracy for 30-day mortality compared to SIL, HASI, NEWS2, and MEWS. While it showed strong performance in identifying patients at risk of rapid deterioration and post-discharge events, further validation in more homogeneous diagnostic subgroups is warranted.

Ethics Approval and Consent to Participate

This study was approved by the Memorial Şişli

Hospital Ethics Committee (Decision No: 2024/004; date: 26.12.2024). All procedures were conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments. The retrospective observational study included patients who presented to the EDs of two tertiary care hospitals: istanbul Beykent University Hospital and Memorial Bahçelievler Hospital. Due to the retrospective design of the study, the institutional review board granted a waiver of informed consent.

Data Availability

All data generated or analyzed during this study are included in this published article. The data that support the findings of this study are available on request from the corresponding author, upon reasonable request.

Authors' Contribution

Study Conception: NES, ACT, SY; Study Design: NES, ACT, SA; Supervision: ACT, SY; SA; Funding: N/A; Materials: NES, ACT, SY; SA; Data Collection and/or Processing: NES, ACT; Statistical Analysis and/or Data Interpretation: NES, ACT, SA; Literature Review: NES, ACT, SY, SA; Manuscript Preparation: NES, ACT, SY, SA; and Critical Review: ACT, SY, NES, SA.

Conflict of Interest

The author(s) disclosed no conflict of interest during the preparation or publication of this manuscript.

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Generative Artificial Intelligence Statement

The author(s) declare that no artificial intelligence-based tools or applications were used during the preparation process of this manuscript. The all content of the study was produced by the author(s) in accordance with scientific research methods and academic ethical principles.

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