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Original Article

OCRS, DECAF, and BAP-65 scores for predicting the outcomes of acute COPD exacerbation: A prognostic accuracy study

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Abstract

Objective: Acute exacerbation of chronic obstructive pulmonary disease (COPD) is a significant healthcare burden. This study aimed to compare three risk assessment tools in predicting the outcomes of COPD exacerbation.

Methods: This prospective cohort study was conducted between October 2023 and November 2024 at five hospitals in Iran (three in Tehran, one in Shahr-e-Rey, and one in Nehbandan). A total of 392 patients admitted with acute exacerbation of COPD were enrolled using consecutive sampling. The predictive accuracy of the Ottawa COPD Risk Scale (OCRS), DECAF, and BAP-65 for adverse outcomes (ICU admission, mechanical ventilation, and mortality) was assessed. The area under the receiver operating characteristic curve (AUC-ROC) and performance metrics (sensitivity, specificity, predictive values, and likelihood ratios) were calculated for each score. AUCs were compared using paired sample ROC analysis with significance set at $P < 0.05$.

Results: The AUCs for OCRS, DECAF, and BAP-65 in predicting cumulative adverse outcomes (CAO) were 0.78 (95% CI: 0.73–0.83), 0.79 (95% CI: 0.74–0.83), and 0.79 (95% CI: 0.74–0.83), respectively ($P < 0.05$). For CAO, DECAF and BAP-65 demonstrated the most balanced performance at optimal cutoff, with sensitivities of 69.8% (95% CI: 61.9–75.4) and 68.2% (95% CI: 59.7–75.6) and specificities of 78.7% (95% CI: 0.74.5–0.81.8) and 78% (95% CI: 72.5–82.5). OCRS had a sensitivity of 61.2% (95% CI: 52.6–0.77) and a specificity of 84.8% (95% CI: 80.3–89.5). No significant confounding or effect modifications from demographics, lifestyle factors, or comorbidities were found except for age with DECAF, which performed better in younger patients.

Conclusion: DECAF and BAP-65 showed the most balanced performances in predicting CAO amongst the three tools. Paired with a clinician's judgment, these tools offer valuable insights for better triage and clinical decision-making in managing acute COPD exacerbation.

Keywords: Pulmonary disease, Chronic obstructive, ROC curve, Prospective studies, Intensive care units

Introduction

Chronic obstructive pulmonary disease (COPD) is a primary contributor to global morbidity and mortality and signifies a substantial and growing challenge to public health (1). COPD is characterized by progressive airflow limitation, gradually leading to decreased respiratory and physical function, reducing patients' quality of life (2). Acute exacerbations of COPD often lead to emergency hospital admissions and are marked by a sudden worsening of respiratory symptoms such as dyspnea, increased sputum production, and cough (3). These exacerbations, particularly severe episodes requiring hospitalization, are associated with an increased risk of adverse outcomes such as intensive care unit (ICU) admission, need for mechanical ventilation, and mortality (4, 5).

Iran is a country where widespread cigarette smoking, inhalation of drugs such as opioids, high air pollution in industrial cities all year long, and occupational hazards significantly contribute to the incidence of COPD and promote exacerbation, resulting in a high prevalence of

COPD cases (5). As in any region with high prevalence rates of COPD, early risk stratification and effective management of exacerbations are essential (6).

The unpredictable progression of COPD frequently complicates the effective management of exacerbations. In addition, a lack of standardized protocol to assess severity and the presence of frequent comorbidities commonly seen in patients adds to this complication (7). Clinicians must make rapid, evidence-based decisions regarding patient care, often with limited information. Therefore, easy-to-use and validated risk stratification tools are invaluable in predicting outcomes, guiding management decisions, preventing unnecessary admissions, and ensuring optimal and timely use of critical care resources.

Several risk stratification models, such as the Ottawa COPD Risk Scale (OCRS), DECAF score, and BAP-65, have been developed to assess severity and predict outcomes in COPD exacerbations (7-10). These tools use clinical, laboratory, and radiologic parameters to aid clinicians in risk stratification and decision-making. While OCRS, DECAF, and BAP-65 have shown predictive utility in different clinical settings, their comparative effectiveness in a high-risk, diverse population such as Iran remains unexplored. Also, there is a limited understanding of how demographic and clinical factors such as sex, age, comorbidities, and environmental exposures might impact the predictive validity of these scores (11). This study aimed to compare the performance of these three scores in predicting the adverse outcomes of patients with acute COPD exacerbation in the emergency department.

Methods

This is a prospective cohort study conducted at five hospitals in Iran (Shohade-ye-Tajrish, Firoozgar, and Rasool Akram Hospitals in Tehran, Firoozabadi Hospital in Shahr-e-Rey, and Shahid Atashdast Hospital in Nehbandan County, South Khorasan). The predictive accuracy of OCRS, DECAF, and BAP-65 to predict the adverse outcomes (need for ICU admission, mechanical ventilation (MV), and mortality) was evaluated by calculating and comparing the area under the receiver operating characteristic curve (AUC-ROC) and screening performance metrics for each score. Each patient's risk score was evaluated upon admission to the emergency department.

This study was approved by the Research Ethics Committees of the Directorate of Health, Rescue and Treatment of Police Headquarters of the Islamic Republic of Iran, and Shahid Beheshti University of Medical Sciences (approval Number: IR.SBMU.TEB.POLICE.REC.1402.078). Informed consent was obtained from all participants or their legal representatives. The study complies with the Declaration of Helsinki for research involving human subjects. All patient data were anonymized before analysis, with identifiers removed to ensure confidentiality. Data were stored on a secure, password-protected server accessible only to authorized research staff. Confidentiality was maintained per national data protection regulations.

The cohort consisted of patients admitted to the mentioned hospitals between October 2023 and November 2024. Patients aged over 30 years who were admitted with AECOPD were eligible for inclusion. A pulmonologist or internal medicine specialist diagnosed COPD based on clinical and paraclinical findings or a previously established diagnosis, supported by spirometry data when available. AECOPD was defined as a sudden increase in dyspnea, sputum production, or a change in sputum color and consistency. This diagnosis was confirmed by a physician not involved in the study, based on patient history or new clinical findings, as spirometry was not universally accessible. All included patients were managed under the supervision of pulmonologists or internal medicine specialists throughout their hospitalization, and their care was not limited to the emergency department.

Patients were excluded if they were discharged from the emergency department without hospital admission, had an anticipated life expectancy of less than 12 months (primarily due to metastatic cancer), were undergoing long-term dialysis, were admitted for non-COPD-related conditions or acute myocardial infarction requiring treatment, or had long-term residence in a care facility or a diagnosis of dementia.

Data collection involved direct history-taking, physical examination, and extraction of results from initial laboratory tests, electrocardiograms, and chest radiographs conducted upon the patient's arrival in the emergency department (ED). The scoring of all three models (OCRS, DECAF, BAP-65) was performed in a blinded manner, with researchers unaware of the final clinical outcomes at the time of data extraction and score calculation. Follow-up data, including patient outcomes, were collected via medical records throughout the hospital stay and, in cases of mortality post-discharge, through follow-up phone calls and hospital database records. Given the prospective design, data collection was conducted accurately to minimize missing data.

The risk assessment tools compared in this study are as follows:

OCRS: A validated tool for assessing short-term adverse outcomes in acute COPD exacerbations, incorporating 10 clinical variables from history, examination, and investigations, with scores ranging from 0 to 16. Scores ≥ 2 are recommended for hospitalization, as validated by Stiell et al. (2014) (7) in a prospective cohort of 945 patients, demonstrating risk stratification from 2.2% (score 0) to 91.4% (score 10) for 15- to 30-day outcomes (Appendix A.1).

DECAF: Developed and validated by Steer et al. (2012) (8) using data from 920 patients, it assesses in-hospital and 30-day mortality risk in COPD exacerbations, with scores ranging from 0 to 6 (Appendix A.2).

BAP-65: Developed and validated in 2009 by Tabak et al. (10), it predicts mortality and MV need in COPD patients. It categorizes patients into five classes based on age and clinical variables, with classes 1 and 2 recommended for routine treatment and classes 3–5 suggesting NIV and/or ICU admission (Appendix A.3).

Patients were monitored for key outcomes, including in-hospital mortality, 30-day mortality, need for MV during hospitalization, and need for ICU admission. The cumulative adverse outcome (CAO) was defined as the presence of any one of the individual outcomes. For patients discharged, follow-up for mortality within 30 days was conducted through hospital records or phone calls.

The sample size was calculated using the formula $N=(Z^2 \times P \times (1 - P))/d^2$ appropriate for a prospective cohort study (12). Here, N is the sample size, Z represents the confidence level (1.96 for 95%), P represents each primary outcome's estimated incidence, and d denotes the allowable error. For this study, primary outcomes included in-hospital mortality, short-term (30-day) mortality, the need for MV, and ICU admission during hospitalization. Based on estimated event rates (13, 14), a sample size of 324 was required. To account for potential dropouts and increase the study's power, we included 392 patients in the final collected sample.

Data analysis was performed using SPSS software version 27. The predictive performance of OCRS, DECAF, and BAP-65 was assessed for all studied outcomes, calculating the AUC and determining the optimal cutoff points for each tool. To compare the accuracy of the scoring systems, the AUC and screening performance characteristics (sensitivity, specificity, positive predictive value [PPV], negative predictive value [NPV], positive likelihood ratio [PLR], and negative likelihood ratio [NLR]) of each score at the best cutoff points were calculated. Comparisons between AUCs were tested using SPSS paired sample ROC analysis, with statistical significance set as $P<0.05$ for the AUC difference between scores. To interpret the clinical utility of AUC values, we used the classification proposed by Çorbacıoğlu and Aksel (15), categorizing discrimination as $0.9 \leq$ AUC: Excellent, $0.8 \leq$ AUC < 0.9: Good, $0.7 \leq$ AUC < 0.8: Fair, $0.6 \leq$ AUC < 0.7: Poor, and $0.5 \leq$ AUC < 0.6: Fail.

Results

During the study period, 392 patients were admitted with acute COPD exacerbations (Figure 1). The mean age was 68.45 ± 11.52 years (65.1% male). Three hundred patients were enrolled from Tehran, and 92 from the Nehbandan county. Smoking history was present in 63.5%, while 53.1% had a history of opioid use. The most common comorbidity was hypertension (49.7%), followed by ischemic heart disease (33.7%). In-hospital mortality occurred in 7.4% of patients, while 30-day mortality was 3.1%. ICU admission was required for 30.6% of cases, and the need for MV was 10.2%. Overall, 32.9% of cases experienced adverse outcomes during the study period. Table 1 provides a detailed representation of patients' characteristics, distribution, and frequency of variables and outcomes.

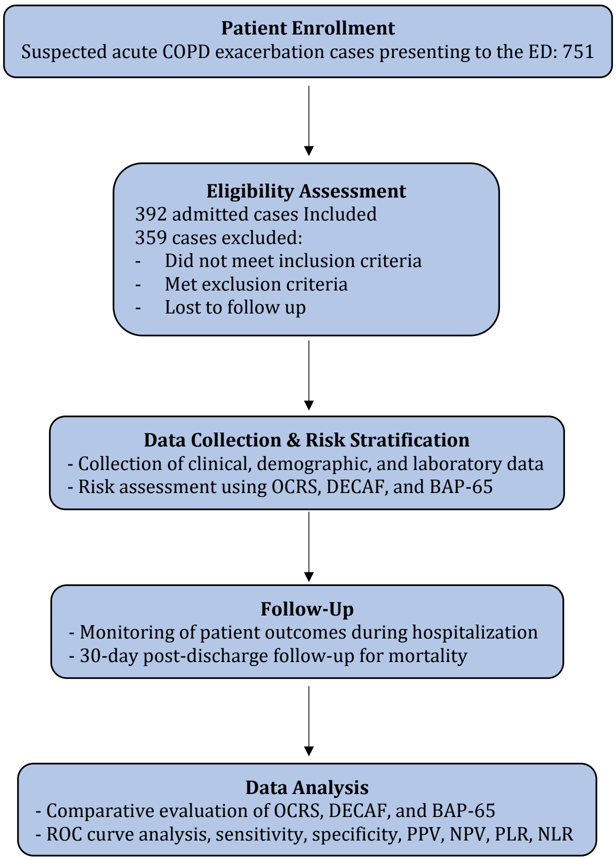

Figure 1. Study flow chart

The OCRS had a mean score of 2.81 ± 1.99, ranging from 0 to 10. Its AUC was 0.85 (95% CI: 0.78–0.92, $P<0.001$) for in-hospital mortality, 0.69 (95% CI: 0.51–0.87, $P=0.042$) for 30-day mortality, 0.78 (95% CI: 0.73–0.83, $P<0.001$) for ICU admission, and 0.86 (95% CI: 0.80–0.91, $P<0.001$) for need for MV. Its accuracy in the prediction of CAO was 0.78 (95% CI: 0.73–0.83, $P<0.001$).

The DECAF score had a mean of 1.35 ± 1.13, ranging from 0 to 5. Its AUC was 0.80 (95% CI: 0.71–0.90, $P<0.001$) for in-hospital mortality, 0.72 (95% CI: 0.61–0.83, $P<0.001$) for 30-day mortality, 0.79 (95% CI: 0.73–0.83, $P<0.001$) for ICU admission, 0.81 (95% CI: 0.74–0.84, $P<0.001$) for need for MV, and 0.79 (95% CI: 0.74–0.83, $P<0.001$) for CAO.

The BAP-65 score had a mean of 2.19 ± 0.97, ranging from 1 to 5. Its AUC was 0.82 (95% CI: 0.76–0.89, $P<0.001$) for in-hospital mortality, 0.72 (95% CI: 0.60–0.83, $P<0.001$) for 30-day mortality, 0.78 (95% CI:

Table 1. Baseline characteristics of patients and clinical outcomes

Characteristics/outcomes	No. (%) of 392 patients
Demographics and history	
Gender (Male)	255 (65.1%)
Age	68.45 ± 11.52 (Range: 34–100)
Exacerbation count during the last year	0.63 ± 1.27 (Range: 0–10)
Arrival vital signs	
Heart rate (/minute)	89.68 ± 15.60
Respiratory rate (/minute)	19.35 ± 3.88
Systolic BP (mmHg)	131.77 ± 22.53
Diastolic BP (mmHg)	79.66 ± 13.24
Temperature (Celsius)	36.96 ± 0.49
Oxygen saturation (percent)	83.33 ± 9.69
GCS	14.73 ± 1.04 (Range: 5–15)
Arrival functional classification (FC)	
FC I	0 (0%)
FC II	20 (5.1%)
FC III	176 (44.9%)
FC IV	196 (50.0%)
Main laboratory data at arrival	
Hemoglobin (mg/dL)	13.78 ± 2.29
Partial pressure of CO_2 (mmHg)	54.15 ± 14.87
White blood cell count (× 10^3/μL)	9.59 ± 4.42
Platelet count (× 10^3/μL)	207.11 ± 86.94
C-reactive protein (mg/L)	40.66 ± 48.11
Lifestyle factors	
Body Mass Index (BMI)	24.73 ± 5.36
Smoker (positive cases)	249 (63.5%)
Smoking (pack Year)	25.92 ± 27.92
Opioid use (positive cases)	208 (53.1%)
Main comorbidities	
Ischemic heart disease	132 (33.7%)
Heart failure	36 (9.2%)
Hypertension	195 (49.7%)
Diabetes	71 (18.1%)
Chronic kidney disease	12 (3.1%)
Cancer	8 (2%)
OCRS parameters	
History of CABG	19 (4.8%)
History of PVD	3 (0.7%)
History of intubation	8 (2%)
HR ≥ 110 (/minute)	48 (12.24%)
O2 < 90% or HR ≥ 120 after initial ED treatment	172 (43.87%)
Acute ischemic changes in ECG	55 (14.03%)
Pulmonary congestion on CXR	66 (16.83%)
Hemoglobin < 10 g/dL	18 (4.6%)
BUN > 34 mg/dL	33 (8.4%)
pCO_2 > 35 mmHg	364 (92.85%)

Table 1. Continued.

Characteristics/outcomes	No. (%) of 392 patients
DECAF parameters	
eMRCD 5a	105 (26.78%)
eMRCD 5b	53 (13.5%)
Eosinopenia (< 50 cells/mm³)	62 (15.8%)
Consolidation on CXR	39 (9.9%)
Atrial fibrillation	20 (5.1%)
Acidemia (pH < 7.35)	199 (50.76%)
BAP-65 parameters	
BUN > 25 mg/dL	94 (23.97%)
Impaired consciousness	42 (10.7%)
Heart rate > 109 (/minute)	48 (12.24%)
Age > 65 years	234 (59.7%)
Hospital site	
Shohade-ye-Tajrish, Tehran	73 (18.6%)
Firoozgar, Tehran	91 (23.2%)
Rasool Akram Hospital, Tehran	111 (28.3%)
Firoozabadi Hospital, Shahr-e-Rey	25 (6.4%)
Shahid Atashdast Hospital, Nehbandan County	92 (23.5%)
Outcomes	
In-hospital mortality	29 (7.4%)
30-day mortality	12 (3.1%)
ICU admission	120 (30.6)
Mechanical ventilation	40 (10.2%)
Cumulative adverse outcomes	129 (32.9%)

Data are presented as mean ± standard deviation or frequency (%). BAP-65: blood urea nitrogen, altered mental status, pulse, and age over 65; BUN: blood urea nitrogen; BP: blood pressure; CABG: coronary artery bypass graft; CXR: chest X-ray; DECAF: dyspnea, eosinopenia, consolidation, acidemia, and atrial fibrillation score; ECG: electrocardiogram; eMRCD: extended Medical Research Council Dyspnea scale; ED: emergency department; HR: heart rate; OCRS: Ottawa COPD Risk Scale; PVD: peripheral vascular disease.

0.73–0.83, $P < 0.001$) for ICU admission, 0.81 (95% CI: 0.74–0.88, $P < 0.001$) for need for MV, and 0.79 (95% CI: 0.74–0.83, $P < 0.001$) for CAO.

Table 2 illustrates the screening performance characteristics (sensitivity, specificity, PPV, NPV, PLR, and NLR) for each tool at the optimal cutoff points based on ROC curve analysis. Figure 2 shows the ROC curves comparing the models' performance in predicting outcomes.

Paired AUC comparative analyses of the three scores across all examined outcomes were statistically non-significant ($P > 0.05$), demonstrating no meaningful difference (Table 3).

For the outcomes of in-hospital mortality and need for MV, OCRS had the highest AUC value with good discrimination, with sensitivity and specificity of 86.2% and 74.1% for in-hospital mortality and 82.5% and 75.6% for need for MV at optimal cutoff points. DECAF and

Table 2. Performance of risk scores (OCRS, DECAF, and BAP-65) and classification indices with 95% confidence intervals at optimal cutoff points for predicting clinical outcomes

Score	Outcome	AUC	Int.*	Cut.&	Sens.	Spec.	PPV	NPV	PLR	NLR
OCRS	HM	0.85 (0.78–0.92)	Good	3.5	86.2% (69.4–94.5)	74.1% (69.4–78.3)	21% (14.7–29.2)	98.5% (96.3–99.4)	3.33 (3.21–3.08)	0.18 (0.07–0.44)
	30-M	0.69 (0.51–0.87)	Poor		66.7% (39.1–86.2)	75.5% (70.7–79.7)	8.5% (4.4–15.9)	98.5% (96.2–99.4)	2.72 (1.92–2.94)	0.44 (0.17–0.86)
	ICU add	0.78 (0.73–0.83)	Fair		60.8% (51.9–69.1)	83.1% (78.2–87.7)	61.3% (52.4–69.6)	82.8% (77.9–86.8)	3.59 (3.17–4.02)	0.47 (0.35–0.62)
	MV	0.86 (0.80–0.91)	Good		82.5% (68.1–91.3)	75.6% (70.8–79.8)	27.7% (20.5–36.4)	97.4% (94.8–98.8)	3.38 (3.36–3.13)	0.23 (0.11–0.45)
	CAO	0.78 (0.73–0.83)	Fair		61.2% (52.6–77.0)	84.8% (80.3–89.5)	66.4% (58.5–74.2)	81.6% (77.6–85.1)	4.02 (3.56–4.62)	0.45 (0.27–0.53)
DECAF	HM	0.80 (0.71–0.90)	Good	2.5	65.5% (47.3–80.1)	86% (81.0–89.1)	27.2% (18.1–38.5)	96.8% (94.4–98.3)	4.67 (4.36–4.45)	0.40 (0.22–0.64)
	30-M	0.72 (0.61–0.83)	Fair	1.5	66.7% (39.1–86.2)	67.5% (62.5–72.2)	6.5% (3.4–12.4)	98.3% (95.8–99.4)	2.05 (1.41–2.30)	0.49 (0.19–0.98)
	ICU add	0.79 (0.73–0.83)	Fair		71.7% (63.0–79.0)	77.9% (73.6–81.6)	58.8% (52.3–65.4)	86.1% (82.6–89.1)	3.24 (2.89–3.59)	0.36 (0.26–0.51)
	MV	0.81 (0.74–0.84)	Good		85% (70.9–92.9)	68.2% (63.1–73.3)	23.3% (17.2–31.2)	97.5% (94.8–99.2)	2.67 (2.61–2.52)	0.21 (0.10–0.46)
	CAO	0.79 (0.74–0.83)	Fair		69.8% (61.9–75.4)	78.7% (74.5–81.8)	61.6% (56.8–66.2)	84.1% (80.3–87.9)	3.27 (2.93–3.59)	0.38 (0.26–0.51)
BAP-65	HM	0.82 (0.76–0.89)	Good	2.5	82.8% (65.5–92.4)	66.4% (61.4–71.1)	16.4% (11.3–23.3)	98.0% (95.3–99.1)	2.46 (2.26–2.39)	0.26 (0.11–0.56)
	30-M	0.72 (0.60–0.83)	Fair		66.7% (39.1–86.2)	67.5% (62.5–72.2)	6.6% (3.4–12.4)	98.3% (95.8–99.4)	2.05 (1.41–2.30)	0.49 (0.19–0.98)
	ICU add	0.78 (0.73–0.83)	Fair		69.2% (60.4–76.7)	76.8% (71.5–81.5)	56.8% (48.7–64.6)	85.0% (80.0–88.9)	2.99 (2.69–3.26)	0.40 (0.29–0.55)
	MV	0.81 (0.74–0.88)	Good		82.5% (68.1–91.3)	67.9% (62.8–72.6)	22.6% (16.6–30.0)	97.2% (94.2–98.6)	2.57 (2.46–2.48)	0.26 (0.12–0.51)
	CAO	0.79 (0.74–0.83)	Fair		68.2% (59.7–75.6)	78.0% (72.5–82.5)	60.3% (52.2–67.8)	83.3% (78.2–87.5)	3.09 (2.75–3.42)	0.41 (0.29–0.55)

*: Interpretation of AUC's clinical significance; &: optimal cutoff point based on ROC analysis; 30-M: 30-day mortality; AUC: The area under the receiver operating characteristic curve; BAP-65: blood urea nitrogen, altered mental status, pulse, and age over 65; CAO: cumulative adverse outcome; DECAF: dyspnea, eosinopenia, consolidation, acidemia, and atrial fibrillation score; HM: in-hospital mortality; ICU add: intensive care unit admission; MV: need for mechanical ventilation; OCRS: Ottawa COPD Risk Scale; PPV: positive predictive value; NPV: negative predictive value; PLR: positive likelihood ratio; NLR: negative likelihood ratio.

BAP-65 also had good discrimination for these outcomes.

For the 30-day mortality outcome, BAP-65 had the highest AUC value with fair discrimination, with 66.7% sensitivity and 67.5% specificity at the optimal cutoff point. DECAF and OCRS had fair and poor discrimination for this outcome, respectively.

All three scores had fair discrimination for the outcome of ICU admission, with similar AUC values. DECAF and BAP-65 had better sensitivity and specificity balance, with 71.7% and 77.9%, respectively, for DECAF, and 69.2% and 76.8%, respectively, for BAP-65 at the optimal cutoff point.

For the CAO, all three scores had fair discrimination, with similar AUC values. Again, DECAF and BAP-65 showed more balanced sensitivity and specificity, with 69.8% and 78.7%, respectively, for DECAF, and 68.2% and 78%, respectively, for BAP-65. Furthermore, DECAF showed better overall predictive values, especially in ruling out CAO in low-risk patients.

The OCRS, DECAF, and BAP-65 baseline regression models significantly predicted CAO. For OCRS, the odds ratio (OR) was 1.89 ($B = 0.63$, $P < 0.001$, 95% CI: 1.63–2.18), indicating an 89% increased likelihood of adverse outcomes with each unit increase in the score. For DECAF, the OR was 2.86 ($B = 1.05$, $P < 0.001$, 95% CI: 2.24–3.65), reflecting a 186% increased risk for each unit increase. BAP-65 also predicted CAO significantly with an OR of 4.03 ($B = 1.39$, $P < 0.001$, 95% CI: 2.95–5.50), meaning a 303% increased risk per unit increase.

The effects of demographics (age and sex), lifestyle factors (BMI, smoking, and opioid use), and the presence of each comorbidity on the performance of the risk scores were examined, and potential confounding effects were evaluated.

Interaction terms between each score and each variable showed no significant effect modifications (all P values > 0.05). The only exception was age, which showed a significant interaction with DECAF ($B = -0.027$, $P = 0.024$, OR = 0.97, 95% CI: 0.95–0.99), indicating better predictive performance in younger patients, but this did

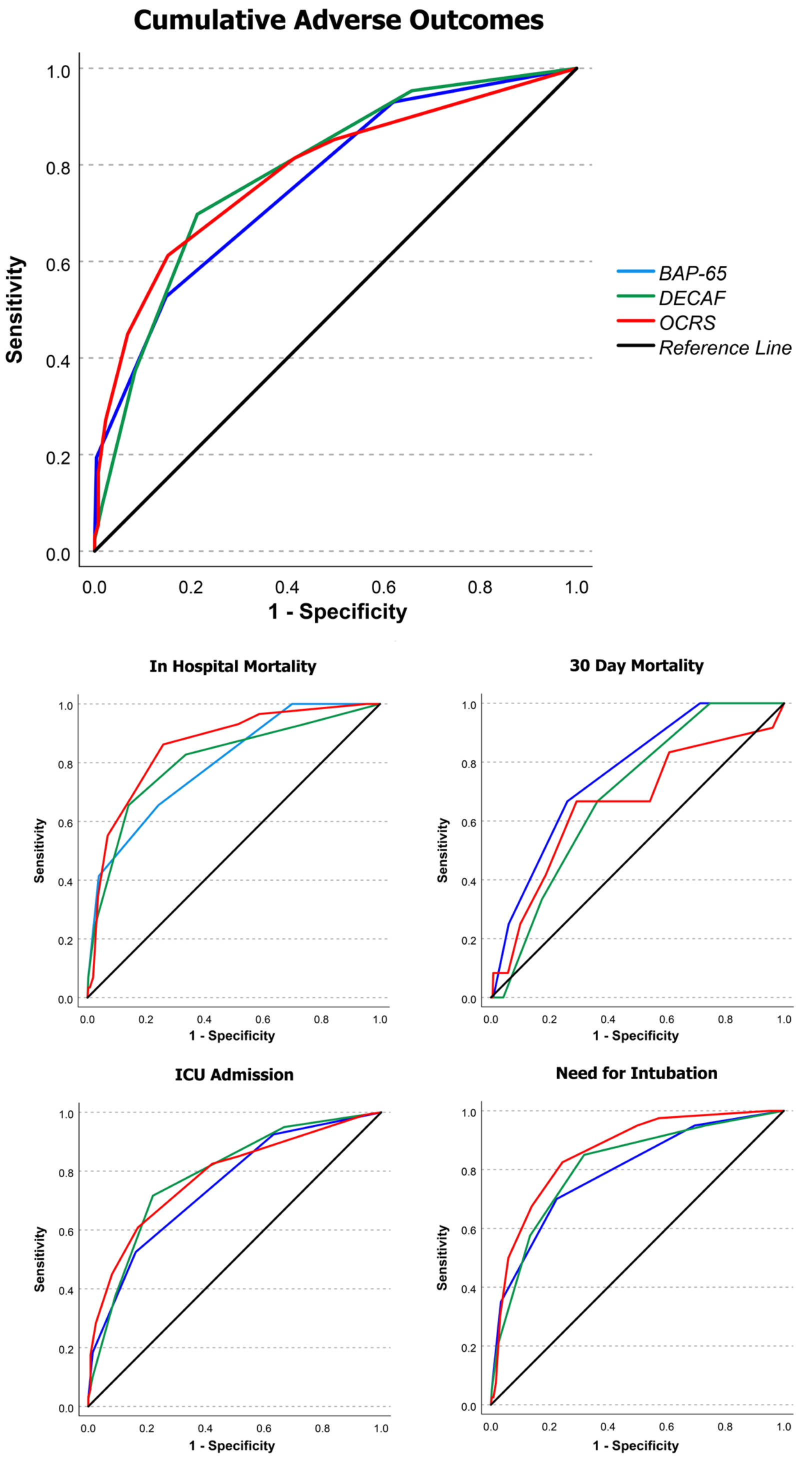

Figure 2. Receiver Operating Characteristic Curves for Predicting Adverse Outcomes for four risk stratification tools—OCRS (red), DECAF (green), and BAP-65 (blue) across different outcomes. The diagonal black line represents the reference (chance) line. CAO: Cumulative Adverse Outcomes; OCRS: Ottawa COPD Risk Scale

not alter the overall model stability. Due to the inclusion of age as a component of the BAP-65 score, no interaction analysis was performed for age.

After adjusting for these variables, the relationships between the scores and CAO remained significant, with no meaningful change in regression coefficients (less than 10%). Bootstrap resampling with 1,000 iterations confirmed the stability of the findings and the absence of significant bias.

Discussion

In this prospective cohort study of 392 patients hospitalized with acute COPD exacerbation, OCRS, DECAF, and BAP-65 each demonstrated acceptable

Table 3. Paired-sample AUC differences across outcomes

	Results across outcomes (shown as: p^*, ΔAUC[#] [95% CI[&]])				
Compared scores	**HM**	**30-M**	**ICU**	**MV**	**CAO**
OCRS/DECAF	0.40, 0.05 (–0.07,0.17)	0.78, –0.03 (–0.24,0.18)	0.89, –0.00 (–0.07,0.06)	0.30, 0.05 (–0.04,0.14)	0.97, –0.00 (–0.06, 0.06)
OCRS/BAP65	0.50, 0.03 (–0.06,0.12)	0.41, –0.06 (–0.19,0.08)	0.95, 0.00 (–0.05,0.05)	0.26, 0.05 (–0.03,0.13)	0.92, 0.00 (–0.05, 0.06)
DECAF/BAP65	0.74, –0.02 (–0.14,0.10)	0.76, –0.03 (–0.19,0.13)	0.85, –0.01 (–0.06,0.06)	0.98, 0.00 (–0.10,0.10)	0.96, 0.00 (–0.06, 0.06)

*: Statistically significant as ($p<0.05$); #: AUC differences &: 95% confidence intervals; 30-M: 30-day mortality; AUC: the area under the receiver operating characteristic curve; BAP-65: blood urea nitrogen, altered mental status, pulse, and age over 65; CAO: cumulative adverse outcome; DECAF: dyspnea, eosinopenia, consolidation, acidemia, and atrial fibrillation score; HM: In-hospital mortality; ICU: intensive care unit admission; MV: need for mechanical ventilation; OCRS: Ottawa COPD Risk Scale.

discriminatory performance for major adverse outcomes, with no statistically significant differences between their AUCs. However, the three scores differed in clinical performance: DECAF and BAP-65 offered the most balanced sensitivity and specificity for predicting cumulative adverse outcomes (CAO), while OCRS had higher specificity but lower sensitivity. For individual outcomes, OCRS best predicted in-hospital mortality and need for mechanical ventilation, DECAF and BAP-65 performed better for ICU admission, and BAP-65 performed best for 30-day mortality.

Acute COPD exacerbations are often associated with a high risk of adverse outcomes. Timely and accurate risk stratification is crucial for effective patient management, ensuring that resources are allocated optimally and patients receive appropriate care tailored to their clinical needs. To that end, practical risk assessment tools are beneficial for making timely and evidence-based clinical decisions.

Although no significant differences in the AUCs across outcomes were identified between the three models, given the importance of identifying actual positive cases, we believe both DECAF and BAP-65 are better suited to predict CAO in hospitalized acute COPD exacerbation patients. In most individual outcomes, all three tools showed high NPVs and low PPVs, indicating their effectiveness in identifying low-risk patients and aiding in triage, with the drawback of a high rate of false positives. Therefore, while these tools would help avoid unnecessary interventions and prolonged hospitalizations, many patients identified as high risk. This issue highlights the models' limitations in predicting the individual outcomes in our population and underscores the need for clinical judgment in decision-making. With the outcomes combined, the positive and negative predictive values balanced significantly across models (approximately 60% for PPVs and 80% for NPVs), which is to be expected as they are reliant on the prevalence of outcomes (16). These findings suggest that while these tools may not always effectively distinguish high-risk patients in the Iranian population, they remain helpful for the overall triage process in acute COPD exacerbation.

Multiple studies have examined the performance of these tools either alone or in comparison with each other. DECAF has shown strong performance in predicting in-hospital mortality, particularly in two prospective studies by Steer et al. and Nafae et al., with AUCs of 0.86 and 0.83, respectively (8, 17). BAP-65 has also demonstrated the ability to identify those at risk of MV and in-hospital mortality in the works of Shore et al. and Tabak et al., with AUCs ranging between 0.72 and 0.81 (10, 14, 18). In four comparative studies, BAP-65 and DECAF showed strong predictive abilities for in-hospital mortality and MV need. Lolah et al. (19) and Sangwan et al. (20) reported 100% sensitivity for predicting in-hospital mortality with both tools, with BAP-65 demonstrating higher specificity than DECAF. For MV, DECAF performed better in the former study, while BAP-65 had higher sensitivity but lower specificity in the latter study. In a large cohort by Yousif et al. (21), BAP-65 was superior in predicting in-hospital mortality (AUC 0.86, 95% specificity). However, Manchu et al. found that both tools performed similarly in predicting in-hospital mortality and MV (22). In our study, both tools showed similar accuracy based on AUC for predicting in-hospital mortality and need for MV, with BAP-65 showing better sensitivity for in-hospital mortality, while both showed high sensitivity for MV.

OCRS, developed and validated in Canadian emergency departments (7, 9), covers a wide range of predictive factors in acute COPD exacerbation. As a newer tool, it has been evaluated in a few studies with conflicting results. Kocak et al. found OCRS more discriminative than the Integrated Pulmonary Index in predicting outcomes (23). Alavi-Moghaddam et al. also highlighted its efficacy in reducing unnecessary hospitalizations of acute COPD exacerbation patients (24). Conversely, Doers et al. reported poor performance of OCRS in an American cohort (11). Compared with DECAF for short-term outcomes, OCRS showed higher sensitivity, while DECAF outperformed in specificity and risk stratification (25, 26). To our knowledge, no study has compared OCRS with BAP-65 until now. As mentioned earlier, in our study, all three tools were relatively similar in predicting CAO, with OCRS having less sensitivity and higher specificity than the others, even though we did not examine the complete list of short-term outcomes used to develop OCRS.

Despite the overall performance of the tools in predicting adverse outcomes, their screening metrics were not ideal for our population and could be improved, probably due to several reasons. First, some parameters in these tools were less discriminative in our sample due to their high or low prevalence. For instance, the CO2 and history of peripheral vascular surgery parameters in OCRS were positive and negative, respectively, in most patients. Additionally, the Iranian population differs significantly from those for which these tools were designed, with factors such as high occupational and life stress, severe air pollution (27), biomass exposure, such as in traditional bread baking, in rural areas (28), and widespread opioid use among COPD patients. While our analysis did not show significant impacts for these factors on the tools' performances, their potential influence on disease progression cannot be entirely dismissed.

Longitudinal studies are warranted to evaluate the tools' ease of use and impact on clinical decision-making. Integration into electronic medical records would also facilitate these investigations while improving efficiency, particularly in high-volume centers. Future research to refine acute COPD exacerbation risk assessment by integrating local clinical and environmental variables is recommended to improve predictive accuracy in Iranian healthcare settings. Developing a more tailored model may enhance risk stratification and better support decision-making in managing acute COPD exacerbation.

This study's strengths include its prospective design and multicenter data collection across two cities, which ensures high data reliability. The findings are relevant for hospitalized acute COPD exacerbation patients and can aid in triage, ICU admission, and clinical decision-making.

However, there are limitations. Excluding emergency department-discharged patients limits the generalizability of the tools to outpatient settings. While this exclusion ensured a more homogeneous sample of more severe cases – which we believe is important in resource-limited settings where ICU and medication shortages can affect access to critical care, as observed during the COVID-19 pandemic (29) – it may reduce applicability to patients at risk of rapid deterioration post-discharge. Although variability in diagnostic and treatment practices among the participating hospitals may exist, all diagnoses were confirmed by internal medicine/pulmonary specialists using standardized clinical criteria. This multicenter design, while introducing some heterogeneity, enhances the generalizability of our findings to diverse real-world settings. Despite geographic and demographic diversity across five hospitals, broader studies across multiple provinces are recommended for wider generalization.

Conclusion

DECAF and BAP-65 showed the most balanced performances in terms of AUC and screening metrics in predicting CAO among the three tools. The OCRS also showed acceptable performance, yet demonstrated lower sensitivity but higher specificity. While valuable for better triage and clinical decision-making, these tools may not be optimal for the Iranian population. Thus, their utility is dependent on the practitioners' clinical judgment.

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Competing Interests

None.

Ethical Approval

This study was approved by the Research Ethics Committees of the Directorate of Health, Rescue, and Treatment of Police Headquarters of the Islamic Republic of Iran and Shahid Beheshti University of Medical Sciences (approval number: IR.SBMU.TEB.POLICE.REC.1402.078).

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References

1. World Health Organization (WHO). Chronic Obstructive Pulmonary Disease (COPD) [Internet]. Geneva: WHO; 2024. Available from: https://www.who.int/news-room/fact-sheets/detail/chronic-obstructive-pulmonary-disease-(copd). Updated November 6, 2024.
2. Jameson JL, Fauci AS, Kasper DL, Hauser SL, Longo DL, Loscalzo J. Chronic obstructive pulmonary disease. In: Harrison's Manual of Medicine. 20th ed. New York, NY: McGraw-Hill Education; 2020.
3. Wedzicha JA, Seemungal TA. COPD exacerbations: defining their cause and prevention. Lancet. 2007;370(9589):786-96. doi: 10.1016/s0140-6736(07)61382-8.
4. Raji H, Riahi A, Borsi SH, Masoumi K, Khanjani N, Ahmadi Angali K, et al. Acute effects of air pollution on hospital admissions for asthma, COPD, and bronchiectasis in Ahvaz, Iran. Int J Chron Obstruct Pulmon Dis. 2020;15:501-14. doi: 10.2147/copd.S231317.
5. Sharifi H, Ghanei M, Jamaati H, Masjedi MR, Aarabi M,

Sharifpour A, et al. Burden of obstructive lung disease in Iran: prevalence and risk factors for COPD in north of Iran. Int J Prev Med. 2020;11:78. doi: 10.4103/ijpvm.IJPVM_478_18.
6. Echevarria C, Steer J, Bourke SC. Comparison of early warning scores in patients with COPD exacerbation: DECAF and NEWS score. Thorax. 2019;74(10):941-6. doi: 10.1136/thoraxjnl-2019-213470.
7. Stiell IG, Perry JJ, Clement CM, Brison RJ, Rowe BH, Aaron SD, et al. Clinical validation of a risk scale for serious outcomes among patients with chronic obstructive pulmonary disease managed in the emergency department. CMAJ. 2018;190(48):E1406-13. doi: 10.1503/cmaj.180232.
8. Steer J, Gibson J, Bourke SC. The DECAF Score: predicting hospital mortality in exacerbations of chronic obstructive pulmonary disease. Thorax. 2012;67(11):970-6. doi: 10.1136/thoraxjnl-2012-202103.
9. Stiell IG, Clement CM, Aaron SD, Rowe BH, Perry JJ, Brison RJ, et al. Clinical characteristics associated with adverse events in patients with exacerbation of chronic obstructive pulmonary disease: a prospective cohort study. CMAJ. 2014;186(6):E193-204. doi: 10.1503/cmaj.130968.
10. Tabak YP, Sun X, Johannes RS, Gupta V, Shorr AF. Mortality and need for mechanical ventilation in acute exacerbations of chronic obstructive pulmonary disease: development and validation of a simple risk score. Arch Intern Med. 2009;169(17):1595-602. doi: 10.1001/archinternmed.2009.270.
11. Doers ME, Zafar MA, Stolz U, Eckman MH, Panos RJ, Loftus TM. Predicting adverse events among patients with COPD exacerbations in the emergency department. Respir Care. 2022;67(1):56-65. doi: 10.4187/respcare.09013.
12. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? Indian J Psychol Med. 2013;35(2):121-6. doi: 10.4103/0253-7176.116232.
13. Poucineau J, Delory T, Lapidus N, Hejblum G, Chouaïd C, Le Cœur S, et al. Hospital admissions and mortality for acute exacerbations of COPD during the COVID-19 pandemic: a nationwide study in France. Front Med (Lausanne). 2022;9:995016. doi: 10.3389/fmed.2022.995016.
14. Shorr AF, Sun X, Johannes RS, Derby KG, Tabak YP. Predicting the need for mechanical ventilation in acute exacerbations of chronic obstructive pulmonary disease: comparing the CURB-65 and BAP-65 scores. J Crit Care. 2012;27(6):564-70. doi: 10.1016/j.jcrc.2012.02.015.
15. Çorbacıoğlu Ş K, Aksel G. Receiver operating characteristic curve analysis in diagnostic accuracy studies: a guide to interpreting the area under the curve value. Turk J Emerg Med. 2023;23(4):195-8. doi: 10.4103/tjem.tjem_182_23.
16. Monaghan TF, Rahman SN, Agudelo CW, Wein AJ, Lazar JM, Everaert K, et al. Foundational statistical principles in medical research: sensitivity, specificity, positive predictive value, and negative predictive value. Medicina (Kaunas). 2021;57(5):503. doi: 10.3390/medicina57050503.
17. Nafae R, Embarak S, Gad DM. Value of the DECAF score in predicting hospital mortality in patients with acute exacerbation of chronic obstructive pulmonary disease admitted to Zagazig university hospitals, Egypt. Egypt J Chest Dis Tuberc. 2015;64(1):35-40. doi: 10.1016/j.ejcdt.2014.10.007.
18. Shorr AF, Sun X, Johannes RS, Yaitanes A, Tabak YP. Validation of a novel risk score for severity of illness in acute exacerbations of COPD. Chest. 2011;140(5):1177-83. doi: 10.1378/chest.10-3035.
19. Lolah MA, El-Habashy MM, Gadallah MT. Comparative study between BAP65 score and DECAF score in assessment of acute exacerbation of chronic obstructive pulmonary disease. Egypt J Chest Dis Tuberc. 2022;71(2):242-7. doi: 10.4103/ecdt.ecdt_17_20.
20. Sangwan V, Chaudhry D, Malik R. Dyspnea, eosinopenia, consolidation, acidemia and atrial fibrillation score and BAP-65 score, tools for prediction of mortality in acute exacerbations of chronic obstructive pulmonary disease: a comparative pilot study. Indian J Crit Care Med. 2017;21(10):671-7. doi: 10.4103/ijccm.IJCCM_148_17.
21. Yousif M, El Wahsh RA. Predicting in-hospital mortality in acute exacerbation of COPD: is there a golden score? Egypt J Chest Dis Tuberc. 2016;65(3):579-84. doi: 10.1016/j.ejcdt.2016.03.003.
22. Manchu S, Srinivasa SV, Vishwanath Reddy N, Jaya Prasad V, Prasanna Kumar N, Phaneesh Bharadwaj BS, et al. Prediction of outcomes in acute exacerbation of COPD with DECAF score and BAP 65 score in a rural population. Int J Res Med Sci. 2020;8(12):4296-301. doi: 10.18203/2320-6012.ijrms20205009.
23. Kocak AO, Cakir Z, Akbas I, Akgol Gur ST, Kose MZ, Can NO, et al. Comparison of two scores of short-term serious outcome in COPD patients. Am J Emerg Med. 2020;38(6):1086-91. doi: 10.1016/j.ajem.2019.158376.
24. Alavi-Moghaddam M, Partovinezhad H, Dasdar S, Farjad M. Ottawa risk scale in predicting the outcome of chorionic obstructive pulmonary disease exacerbation in emergency department; a diagnostic accuracy study. Arch Acad Emerg Med. 2023;11(1):e32. doi: 10.22037/aaem.v11i1.2023.
25. Marathe M, Oh S, Leech K, Stone H, Hussain I. P253 Evaluation of the Ottawa COPD Risk Scale (OCRS) at Royal Stoke University Hospital (RSUH), UK in predicting adverse outcome in COPD exacerbation. Thorax. 2019;74(Suppl 2):A227. doi: 10.1136/thorax-2019-BTSabstracts2019.396.
26. Unal A, Bayram B, Ergan B, Can K, Ergun YK, Kilinc O. Comparison of two scores for short-term outcomes in patients with COPD exacerbation in the emergency department: the Ottawa COPD Risk Scale and the DECAF score. ERJ Open Res. 2023;9(2):00436-2022. doi: 10.1183/23120541.00436-2022.
27. Taghizadeh F, Mokhtarani B, Rahmanian N. Air pollution in Iran: the current status and potential solutions. Environ Monit Assess. 2023;195(6):737. doi: 10.1007/s10661-023-11296-5.
28. Aghaeimeybodi F, Samadzadeh G, Haji Safari Z, Nouri S, Talebi HR, Shahcheraghi SH. Comparison of chronic obstructive pulmonary diseases induced by wood smoke and tobacco smoke. Tanaffos. 2021;20(3):268-76.
29. Khosravi S, Izadpanah M, Mirzaei S, Rahmani H, Oroomiei N. Challenges faced by the Iranian health system in containing COVID-19: insights from a conventional content analysis. BMC Health Serv Res. 2025;25(1):60. doi: 10.1186/s12913-025-12223-9.

Appendix 1. Ottawa COPD Risk Scale (OCRS). *From Stiell et al, 2018. (7)*

Parameter	Points
Patient History	
Coronary artery bypass graft (CABG)	1
Peripheral vascular surgical intervention	1
Previous mechanical ventilation due to respiratory distress	2
Clinical Examination	
Heart rate ≥ 110 beats/min at ED admission	2
SaO_2 < 90% or HR ≥ 120 after initial ED management	2
Initial Investigations	
Acute ischemic changes on ECG	2
Marked pulmonary congestion on chest X-ray	1
Hemoglobin < 100 g/L	3
Urea ≥ 12 mmol/L or BUN ≥ 34 mg/dL	1
Serum CO_2 ≥ 35 mmol/L	1
Total OCRS Scoring Range	0–16

Appendix 2. DECAF Score. *From Steer et al, 2012. (8)*

Parameter	Points	Notes
eMRCD 5a (Dyspnea)	1	Modified MRC scale; 5a indicates severe dyspnea restricting daily activities
eMRCD 5b (Dyspnea)	2	Indicates very severe dyspnea (often bedbound); if using a single 5-point scale, these may be combined
Eosinopenia (< 0.05 × 10^9/L)	1	Based on local lab references
Consolidation on chest X-ray	1	Presence of lobar or segmental consolidation
Acidemia (pH < 7.3)	1	Arterial blood gas measurement
Atrial fibrillation	1	Documented by ECG
Total DECAF Scoring Range	0-6	

Appendix 3. BAP-65 Classification. *From Tabak et al, 2009. (10)*

Class	Description	Parameters Included
1	0 BAP present, age ≤ 65 y	None
2	0 BAP present, age > 65 y	Age > 65 y
3	1 BAP present	BUN > 25 mg/dL *or* Urea > 9 mmol/L, Altered mental status (GCS < 15, disorientation, or decreased alertness), or Pulse > 109 bpm
4	2 BAP present	
5	3 BAP present	
Total BAP-65 Scoring Range		1-5