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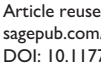

An International Validation of the "DECAF Score" to Predict Disease Severity and Hospital Mortality in Acute Exacerbation of COPD in the UAE

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Abstract

The DECAF score (the Dyspnea, Eosinopenia, Consolidation, Academia, and Atrial fibrillation score) has been adopted in some hospitals to predict the severity of Acute Exacerbation of Chronic Obstructive Pulmonary Disease (AECOPD). However, DECAF score has not been widely evaluated or used in Middle Eastern countries. The present study aimed to validate the DECAF score for predicting in-hospital mortality in patients with AECOPD in the United Arab Emirates (UAE). This was a retrospective, observational study conducted in 19 hospitals in the UAE. Data were retrieved from the electronic records of patients admitted for AECOPD in 17 hospitals across the country. Patients aged more than 35 years who were diagnosed with AECOPD were included in the study. The validation of the DECAF Score for inpatient death, 30-days death, and 90-day readmission was conducted using the Area Under the Receiver Operator curve (AUROC). The AUROCDECAF curves for inpatient death, 30-days death, and 90-day readmission were 0.8 (95% CI: 0.8-0.9), 0.8 (95% CI: 0.7-0.8), and 0.8 (95% CI: 0.8-0.8), respectively. The model was a satisfactory fit to the data (Hosmer–Lemeshow statistic = 0.195, Nagelkerke $R^2 = 31.7\%$). There were significant differences in means of length of stay across patients with different DECAF score ($P = .008$). Patients with a DECAF score of 6 had the highest mean length of stay, which was 29.8 ± 31.4 days. Patients with a DECAF score of 0 had the lowest mean length of stay, which was 3.6 ± 2.0 days. The DECAF score is a strong predictive tool for inpatient death, 30 days mortality and 90-day readmission in UAE hospital settings. The DECAF score is an effective tool for predicating mortality and other disease outcomes in patients with AECOPD in the UAE; hence, clinicians would be more empowered to make appropriate clinical decisions by using the DECAF score.

Keywords
COPD, AECOPD, DECAF score, UAE

Introduction

There is a scarcity of research concerning Chronic Obstructive Pulmonary Disease (COPD) and its health consequences in the United Arab Emirates (UAE). The prevalence of COPD in the UAE was estimated to be between 3.7% and 5.3%.[1] Male, smokers, and those exposed to gasoline fumes or dust were at high risk of developing COPD.

The predominant features of COPD are structural changes, inflammation and muco-ciliary dysfunction.[2] Acute Exacerbations of COPD (AECOPD) are linked with severe respiratory problems leading to deterioration in patients' quality of life and death in 4.4% to 7.7% of AECOPD cases.[3] AECOPD has received priority for research in the last few decades with potential insights for reducing lung deterioration, increasing survival, improving patients' quality of life and saving healthcare resources.

In 2016, the Dyspnea, Eosinopenia, Consolidation, Academia, and Atrial fibrillation (DECAF) score was developed to predict hospital mortality, disease severity, readmission, and early discharge of patients with AECOPD.[4] The DECAF score helps healthcare providers stratify the patient into risk categories- DECAF 0 to 1 (low risk); DECAF 2 (Moderate risk); and DECAF 3 to 6 (high risk)- to thereby reduce mortality and morbidity through appropriate

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treatment and patient stratification.[5] The DECAF score assimilates typical available indicators at admission, and it assists in deciding the level of care, augmenting the care with ventilator[4,5] Thus, it helps in directing health care professionals to the most rational use of resources, reducing mortality and morbidity.

Several studies validating the DECAF score have been conducted in the United Kingdom,[4,6,7] China,[8,9] Egypt,[10] and India.[11] Overall, the DECAF score has been shown to be effective and feasible in predicting mortality and early discharge in patients hospitalized with AECOPD. A systematic review and meta-analysis[12] screened 17 studies comprising 8329 patients, and found that the DECAF score has a strong predictive performance for inpatient and 30-day mortality. Additionally, the DECAF score exhibited more accurate prognostic values compared to other tools such as the COPD, Asthma, and The APACHE II Acute Physiology Score. However, most of the previous studies were either unicentric or recruited small sample of patients.

It is thought that mortality related to AECOPD could be improved, if accurate and early prediction and interventions are adopted. However, the performance of the tools required to predict these cases cannot be guaranteed and require validation. Although the DECAF score was recommended by health authorities in the UK and has been used in some countries, it needs validation to ensure its predictive effectiveness and accuracy, before being formally adopted in the Middle Eastern healthcare setting. Most of the studies in the Middle East focused clinical practice using observational studies[13-16] or simple interventional studies.[17-19]

Therefore, this multicentric study aimed to validate the DECAF score and assess its predictive effectiveness for short, medium and long mortality in patients with AECOPD in the United Arab Emirates.

Methods

Study Design and Participation

This was a retrospective, observational study conducted between 2019 and 2021 in 18 hospitals in the UAE. Data were retrieved from the electronic records of patients with AECOPD admitted to the Al-Amal, Al-Kuwait, Al-Qassimi, Al-Dhaid, Khorfakkan, Kalba, Kuwait, Ibrahim Bin Hamad Obaidullah, Abdullah Omran, Obaidalla Geriatric, Shaam and Saqr, Masafi, Dibba, Fujairah, Dubai, Rashid, Latifa Women and Children, and Hatta hospitals. These hospitals were distributed in 6 UAE Emirates: Dubai, Sharjah, Ajman, Umm Al-Quwain, Fujairah, and Ras Al Khaimah. This study aimed to include patients who were diagnosed with AECOPD (non-pneumonic or pneumonic), aged more than 35 years. Patients who had other illnesses that could limit survival to less than 1 year were excluded from the study. Excluding patients with a short life expectancy due to other illnesses helps to eliminate confounding variables, solve the ethical concerns, and provide clearer data interpretation. Life-limited disease is a medical condition that, despite treatment, is expected to result in a shortened lifespan. For example, Alzheimer's disease and end-stage cancer.

Data Collection

Electronic records of all patients who met the above criteria were screened, retrieved, and analyzed. The screening was identified by searching the number of the patients admitted with a COPD exacerbation. Then, routinely recorded admission DECAF indices and mortality were checked using data which were frequently updated. Some variables were frequently modified based on the latest information available about patients. This includes their breathing capacity, recovery, and some lab results.

Study Outcomes

There were 3 main outcomes; (1) the validation of the DECAF Score for inpatient death, 30-days death, and 90-day readmission, (2) an analysis of the patient length of stay across DECAF score, and (3) differences in means of PH, Eosinophil numbers, C-reactive protein (CRP), and Urea levels across patients with different DECAF scores. Secondary outcomes were the proportions of patients with atrial fibrillation across DECAF score and the differences in needing assistance for doing activities across DECAF score. Additionally, in this study, we described the gender, age, smoking status, mortality rate, markers of disease severity, exercise tolerance, body mass index (BMI), vital signs, laboratory findings (sodium, potassium, Urea, Creatinine, Albumin, Bilirubin, Troponin, CRP, Hemoglobin, WBC, Hematocrit, Platelet, Neutrophil Eosinophil, PH, PaO_2, $PaCo_2$, HCO_3, and medical history (medications and comorbidities) of participants. Smokers were either active, which refers to the direct inhalation of tobacco smoke by the person who is smoking, or passive, which refers to the involuntary inhalation of tobacco smoke by non-smokers who are near active smokers.

Also, we reported the extended Medical Research Council Dyspnea Scale (eMRCD), which assesses the severity of breathlessness in patients with COPD. It is a 5-point scale gaging a patient's ability to perform daily activities over the past 3 months on their better days. The scale ranges from patients not too breathless to leave their house to those too breathless to leave unassisted and needing help with basic self-care.

Statistical Analysis

After the completion of the data collection step, data were entered into an Excel sheet (Microsoft Corporation, 2018) and cleaned. Then, the excel sheet was imported into the Statistical Package for the Social Sciences (SPSS) version 24 (Armonk, NY: IBM Corp). The first step in data analysis was

assessing the missing values patterns and dropping all variables with more than 50% missing data. Then, we used the Markov Chain Monte Carlo approach to impute the data into the study variables.

The second step was to perform a descriptive analysis of data, in which demographic and medical information of participants were described as absolute numbers (n) with proportions (%). Continuous variables were presented as means with standard deviations.

The third step was comparing the means length of stay and laboratory markers (pH, eosinophil counts, CRP, and urea levels) across patients with different DECAF scores using the ANOVA test (*P*-values of less than .05 were considered significant results). The error bars test with a 95% confidence interval (CI) was used to measure differences in the proportions of patients with atrial fibrillation and the level of needing assistance across the DECAF score.

The fourth step was validating the DECAF score using the Area under the Receiver Operator (AUROC) curve for inpatient death, 30-days death, and 90-day readmission. Hosmer–Lemeshow and Nagelkerke statistics were used to assess the model fitness.

Results

General Characteristics of Participants

Of the 512 participants, 169 (33.0%) were females and 64 (12.5%) were smokers (Table 1). The means (SD) age and length of stay at hospital were 73.3 (11.9) years and 14.3 (32.5) days, respectively. The incidence of inpatient death and 90-day readmission was 24% and 36%, respectively. The median DECAF score was 3. The findings of this study showed that more than half of patients (56.4%) had DECAF score values between 3 and 6. Across the study participants, 195 (38%) had eMRCD score (0-4), 165 (32%) had eMRCD (5a), and 152 (30%) had eMRCD (5b). Among participants, 303 (60%) needed assistance in washing, 300 (59%) needed assistance in dressing, and only 39 (7.6%) tolerated exercise. Upon admission, the means (SD) BMI and pulse rate were 30.7 (13.6) kg/m^2 and 106 (32) beat per minute, respectively. Furthermore, 15% had acute confusion, 46% had lung consolidation, and 63% had PH less than 7.35. The top 3 comorbidities were hypertension (48%), diabetes (45%), and atrial fibrillation (45%) (Figure 1). Of the 512 patients included in this study, 61% were on diuretics, 40% were on statins, and 30% were on beta blockers (Figure 2).

Validation of the DECAF Score

The AUROC DECAF curves for inpatient death, 30-days death, and 90-day readmission were 0.8 (95% CI: 0.8-0.87), 0.8 (95% CI: 0.7-0.8), and 0.8 (95% CI: 0.8-0.8), respectively (Table 2 and Figure 3). The model was a satisfactory fit to the data (Hosmer–Lemeshow statistic = 0.195, Nagelkerke R^2 = 31.7%).

Table 1. General Characteristics of Patients (n = 512).

Parameters	Total, n (%)
Gender	
Male	343 (67.0)
Female	169 (33.0)
Age, mean (SD)	73.3 (11.9)
Smoking	
Yes, current	64 (12.5)
Yes, former	352 (68.7)
No, never	96 (18.8)
Inpatient death	125 (24.4)
90-days readmission	184 (35.9)
DECAF, median (range)	3 (6)
DECAF (0-1)	112 (21.9)
DECAF (2)	111 (21.7)
DECAF (3-6)	189 (56.4)
Markers of disease severity	
eMRCD score (0-4)	195 (38.1)
eMRCD (5a)	165 (32.4)
eMRCD (5b)	152 (29.6)
Needing assistance in performing activities	
Washing, yes	303 (59.6)
Dressing, yes	300 (58.5)
Feeding, yes	312 (60.8)
Exercise tolerance, yes	39 (7.6)
Clinical data on admission	
BMI, kg/m^2, mean (SD)	30.7 (13.6)
Acute confusion	75 (14.6)
Pulse rate (bpm), mean (SD)	106.4 (32.2)
sBP (mm Hg), mean (SD)	126.2 (36.1)
dBP (mm Hg), mean (SD)	77.8 (20.7)
Temperature (°C), median (range)	36.9 (4.9)
Oxygen saturation, median (range)	91 (60.0)
Length of stay at hospital (days), mean (SD)	14.3 (32.5)
Lung consolidation, yes, n (%)	236 (46.0)
Lab findings on admission	
Na (mmol/L), mean (SD)	136.6 (5.7)
K (mmol/L), mean (SD)	4.6 (7.7)
Urea (mmol/L) mean (SD)	16.1 (21.3)
Creatinine (μmol/L), mean (SD)	157.4 (248.3)
Albumin (g/L), mean (SD)	31.9 (19.6)
Bilirubin (μmol/L), mean (SD)	16.4 (18.5)
Troponin (ng/mL), mean (SD)	631.9 (1573.2)
CRP (mg/L), mean (SD)	74.6 (83.7)
Hemoglobin (g/dL), mean (SD)	12.6 (9.4)
WBC ($\times 10^3$/mcL), mean (SD)	10.5 (5.0)
Hematocrit (%)	37.2 (11.0)
Platelet ($\times 10^3$/mcL)	252.9 (98.8)
Neutrophil ($\times 10^3$/mcL)	11.8 (48.3)
Eosinophil ($\times 10^3$/mcL)	2.1 (2.4)
pH, median (range)	7.3 (1.3)
PaO_2 (mmHg), median (range)	70.0 (49.9)
$PaCo_2$ (mmHg), median (range)	55.8 (21.9)
HCO_3 (Mmol/L)	28.1 (7.4)
PH < 7.35, n (%)	322 (62.9)

Note. SD = standard deviation; BMI = body mass index; bpm = beats per minute; sBP = systolic blood pressure; dBP = diastolic blood pressure; °C = degree celsius; Na = Sodium; K = Potassium; CRP = C-reactive protein; WBC = white blood cell; pH = potential Hydrogen; PaO_2 = partial pressure of Oxygen; $PaCO_2$ = partial pressure of Carbon Dioxide; HCO_3 = Bicarbonate Ion.

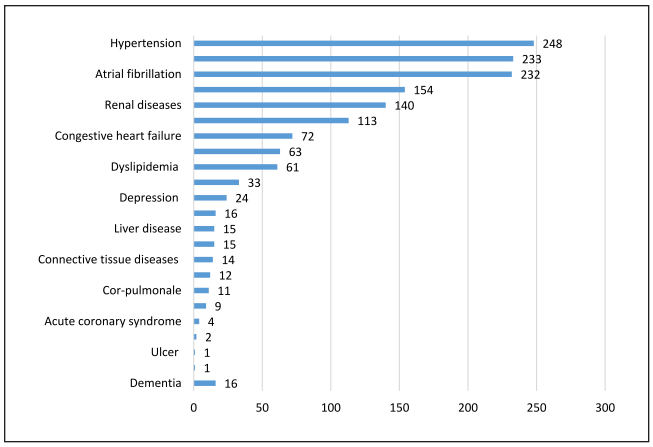

Figure 1. The distribution of Comorbidities (each patient can have more than 1).

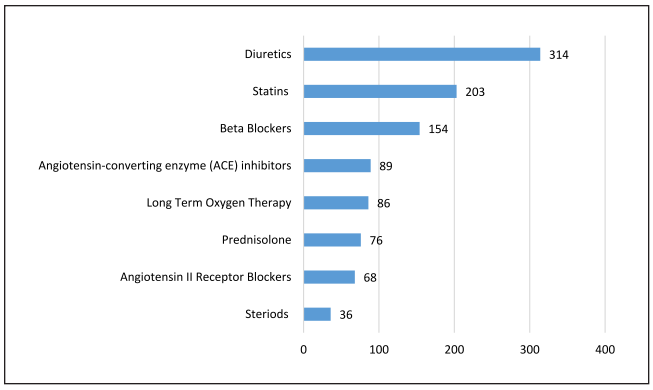

Figure 2. The frequency of medications used (each patient can take more than 1 medication.

DECAF Score Versus Study Outcomes

The mean PH was significantly decreased with the increase in DECAF score ($P = .001$) (Table 3). The lowest mean (SD) PH was reported in patients with 6 DECAF score 7.2 (0.1) and the highest among patients with 0 DECAF score 7.4 (0.03). The PH value dropped below 7.35 between DECAF scores 1 and 2 (7.36 vs 7.34). There was a significant difference in mean eosinophil counts across DECAF scores ($P = .041$). The lowest mean eosinophil count was found in patients with a DECAF score of 6, 0.01×10^9/L (0.1) and the highest was seen in patients with 0 DECAF score 0.4 (1.1). The mean CRP (mg/L) level was significantly increased with the increase in DECAF score ($P = .004$).

The study findings showed that the proportions of patients having atrial fibrillation increased with the increase in DECAF score (Figure 4). Furthermore, we noticed that the proportions having atrial fibrillation were statistically similar across consecutive DECAF scores. The proportions of patients having atrial fibrillation across patients with DECAF scores of 6 and 0 were 90% versus 8.3% ($P < .05$), respectively. The proportions of patients having atrial fibrillation across patients with DECAF scores of 6 and 5 were 90% versus 78% ($P > .05$), respectively.

Discussion

COPD is increasingly recognized to have a profound effect on the overall health and economy globally and in the Gulf Cooperation Council (GCC) region. In 2021, the World Health Organization (WHO) declared that COPD is the third leading cause of death, and the seventh-leading cause of morbidity worldwide. Acute exacerbation of the disease affects health status and leads to a faster deterioration in lung function with associated morbidity and mortality. Additionally, exacerbations are associated with a decline in daily physical activity and the overall quality of life. Currently, the use of predictive tools in AECOPD patients in the United Arab Emirates setting is limited; conventional scores with different indices and risk-stratifying are achievable but are not widely used in the UAE and have modest accuracy. The lack of effective predictive scores in the hospitals may lead to improper risk-stratification in AECOPD patients. This situation may confuse decision-making regarding treatment escalation, early discharge, and severity categorization. In 2012, Steer et al[6] developed the DECAF score as a predictive tool for AECOPD outcomes. The DECAF score has been shown as a robust tool that has been initiated in the AECOPD care pathway in some hospital settings.

Although the DECAF score was validated in UK, China, and India settings, there have been no studies investigating its effectiveness in the UAE. Additionally, most of the previous studies included limited number of patients admitted to a single hospital setting. Therefore, to our knowledge, this is the first multicentric centric study in the Middle East to validate the DECAF score and measure its effectiveness in predicating AECOPD outcomes.

An important finding of this work was that overall mortality is considerably higher in the UAE AECOPD population compared to the UK study.[20] It has been shown that the DECAF score has an advantage over other conventional scores like APACHE II, BAP-65, CAPS, and CURB-65 in the UK DECAF study.[4] The DECAF score in our study showed relatively similar discriminatory power (against 30-day mortality) to a previous UK study (AUORC 0.8 (95% CI 0.7-0.8) vs 0.83 ((95% CI 0.78-0.87)). A Chinese study reported that a modified v-DECAF score has slightly higher discriminatory power (AUROC 0.85) than DECAF score. Overall, the DECAF score tested in our study demonstrated a good predicative performance for inpatient mortality. Our findings indicate the validity of the DECAF score in the UAE region. Moreover, our research may serve as a base for future studies on disease predictive scoring systems, due to the importance of COPD in the personal, health, and economic sectors in the UAE and the Middle Eastern countries.

Table 2. Validation of DECAF Score Against Inpatient Death, 30-Day Death, and 90-Day Readmission.

Score	AUROC curve (95% CI) inpatient death	AUROC curve (95% CI) 30-days death[a]	AUROC curve (95% CI) 90-days readmission
DECAF	0.8 (0.8-0.87)	0.8 (0.7-0.8)	0.8 (0.8-0.8)

Note. AUROC = area under the receiver operating characteristic; CI = confidence interval.
[a]30-Day death had more than 50% missing values.

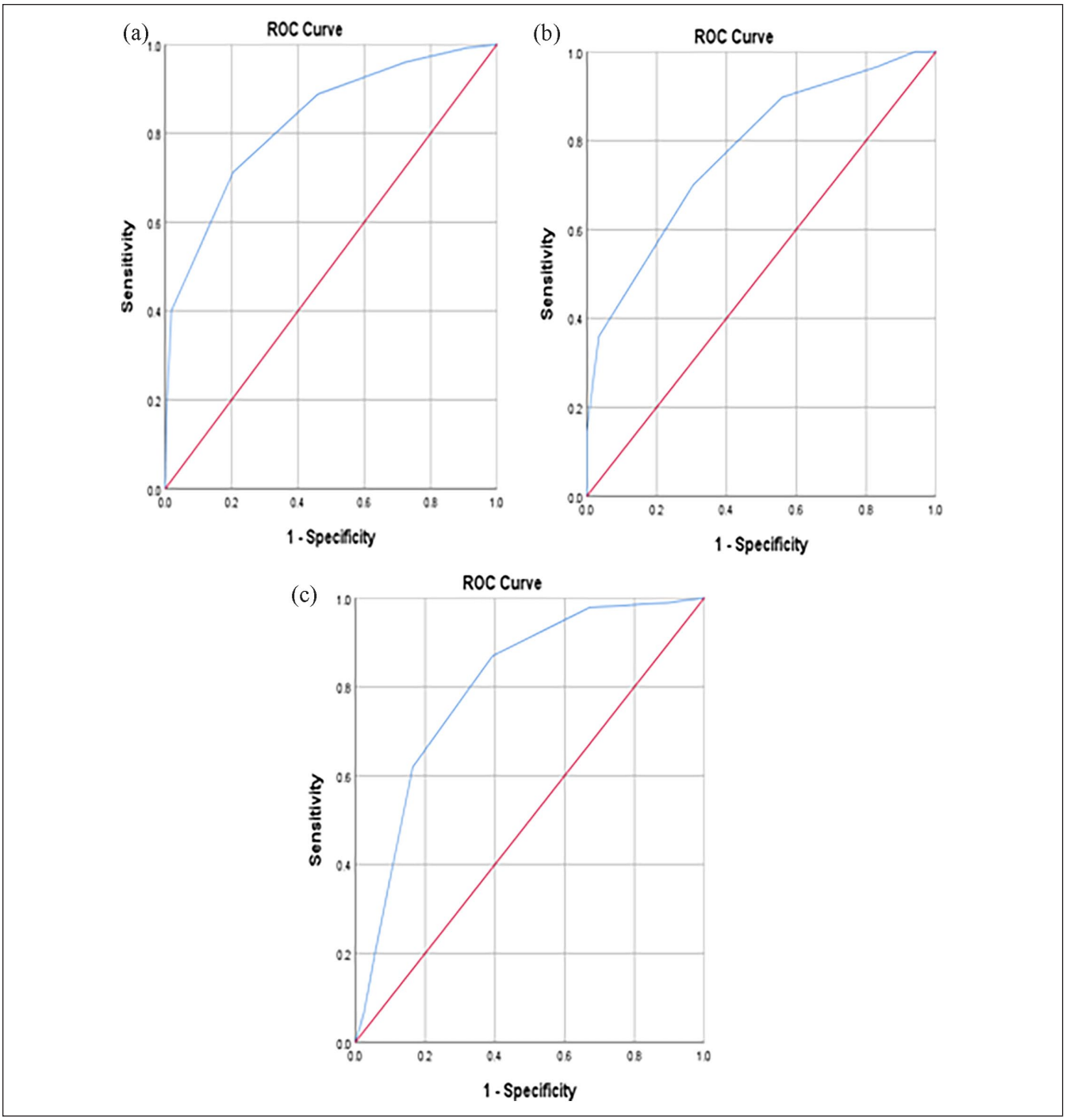

Figure 3. ROC curves for inpatient death, 30-day death, and 90-day death. This graph depicts the performance of the DECAF score model for predicting different death outcomes at 3 specific time points: during the hospital stay (inpatient death), within 30 days, and within 90 days. The curve plots the true positive rate (sensitivity) against the false positive rate (1-specificity) at various threshold settings. (a) ROC curve for inpatient death, (b) ROC curve for 30-day death, and (c) ROC curve for 90-day death.

Table 3. Association of DECAF Score With Laboratory Markers.

	Number of patients				Mean (SD)				95% CI (lower-upper)			
DECAF	pH	Eos*	CRP	Urea	pH	Eos*	CRP	Urea	pH	Eos*	CRP	Urea
0	6	32	26	31	7.39 (0.03)	0.42 (1.1)	33.14 (32.84)	9.70 (8.36)	7.35-7.43	0.02-0.83	19.87-46.40	6.64-12.77
1	36	64	54	59	7.36 (0.07)	0.28 (0.38)	47.77 (55.73)	10.90 (15.84)	7.34-7.39	0.18-0.37	32.55-62.98	6.78-15.03
2	66	96	87	90	7.34 (0.09)	0.31 (0.97)	59.30 (79.71)	14.05 (16.69)	7.31-7.36	0.12-0.51	42.31-76.29	10.56-17.55
3	80	111	93	105	7.30 (0.09)	0.20 (0.24)	65.07 (75.27)	14.00 (16.30)	7.28-7.32	0.16-0.25	49.57-80.57	10.85-17.16
4	87	108	90	104	7.29 (0.10)	0.14 (0.20)	85.97 (109.39)	21.93 (25.67)	7.27-7.32	0.10-0.18	63.06-108.88	16.93-26.92
5	28	30	25	31	7.24 (0.14)	0.10 (0.15)	78.07 (90.13)	21.69 (20.53)	7.18-7.29	0.04-0.15	40.86-115.27	14.16-29.22
6	19	19	18	18	7.17 (0.12)	0.01 (0.04)	117.01 (92.34)	47.71 (74.86)	7.11-7.23	0.00-0.04	71.08-162.93	23.90-71.51

*ANOVA *P*-values for pH, eosinophil count, CRP, and urea levels were .001, .041, .004, and .001, respectively.

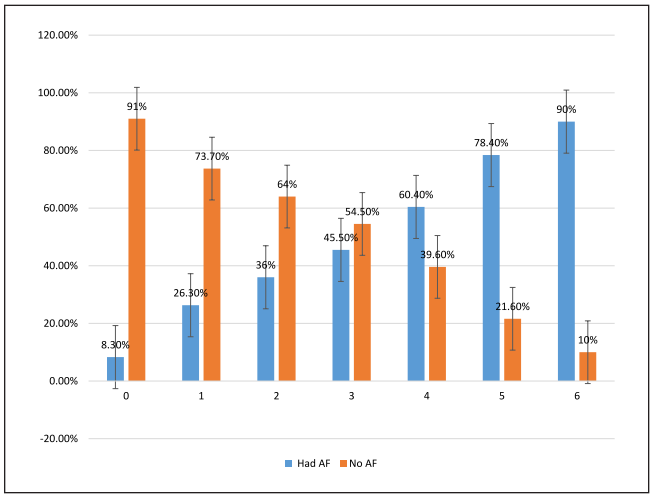

Figure 4. DECAF score versus the proportions of participants having arterial fibrillation (AF). Bars are calculated using standard deviation.

The findings of this study demonstrated a significant association between urea level and the DECAF score, which is novel. Urea level was used as an indicator of AECOPD severity in the Blood urea nitrogen, Altered mental status, Pulse, and Age ≥65 years (BAP-65) score and as an index of pneumonia severity in the Confusion, Uremia, Respiratory rate, Blood pressure, Age ≥65 years (CURB-65) score[21] found that elevated level of BUN is significantly associated with inpatient death in patients with AECOPD.

To sum up, the DECAF score has an advantage over previous predictive scores in predicting short- and medium-term mortality in a multicentre cohort of patients admitted with AECOPD.[4] Overall these data indicate that a useful function of the DECAF score in the UAE could be specifying which patients may be eligible for earlier escalation in treatment or palliative care.

Limitations of the Study

Although this study provides substantial theoretical and practical contributions to the current research efforts for COPD and is the first such study in the UAE, it should be considered in light of its limitations. First, although this study covers most hospitals in Dubai and the Northern areas of the UAE, most AECOPD admitted patients are located in the studies 2 health authorities; the Ministry of health and prevention and the Dubai health authority hospitals. AECOPD patients in Abu Dhabi hospitals, the capital of the UAE, were not included in this study due to difficulties in obtaining ethical approvals despite many attempts. Thus, the findings of this study may not be generalizable to all UAE hospitals. Second, the retrospective nature of the study, which may also be a possible advantage; the retrospective study can assist in identifying feasibility issues and developing a forthcoming prospective study and this yielded "real world" data. Third, assessing the impact of missing data on our findings was beyond the scope of this study, which could influence the validity of our outcomes. Nonetheless, to mitigate this, we imputed the missing data and enhanced the statistical power by using a statistical test such as the Markov method

Conclusion

This study shows that the DECAF score has efficient predictive performance for inpatient mortality and readmission in AECOPD management in the UAE. Thus, it has promising utility in the UAE and could be used throughout the UAE and may help COPD research in the Middle East. This is relevant to males and the increasing number of females who smoke or are exposed to environmental smoke. The calculation of the DECAF scores can easily stratify the patients into groups which allows timely prediction of the disease severity informing treatment choices.

Declaration of Conflicting Interests

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References

1. Razzak H, Harbi A, Ahli S, Shelpai W. Chronic obstructive pulmonary disease; prevalence and associated risk factors in the United Arab Emirates. *Hamdan Med J*. 2020;13(1):20-26. doi:10.4103/HMJ.HMJ_27_19
2. Ruvuna L, Sood A. Epidemiology of chronic obstructive pulmonary disease. *Clin Chest Med*. 2020;41(3):315-327. doi:10.1016/j.ccm.2020.05.002
3. MacNee W. Pathogenesis of chronic obstructive pulmonary disease. *Proc Am Thorac Soc*. 2005;2(4):251-258. doi:10.1513/pats.200504-045SR
4. Echevarria C, Steer J, Heslop-Marshall K, et al. Validation of the DECAF score to predict hospital mortality in acute exacerbations of COPD. *Thorax*. 2016;71(2):133-140. doi:10.1136/thoraxjnl-2015-207775
5. Echevarria C, Gray J, Hartley T, et al. Home treatment of COPD exacerbation selected by DECAF score: a non-inferiority, randomised controlled trial and economic evaluation. *Thorax*. 2018;73(8):713-722. doi:10.1136/thoraxjnl-2017-211197
6. Steer J, Gibson J, Bourke SC. The DECAF score: predicting hospital mortality in exacerbations of chronic obstructive pulmonary disease. *Thorax*. 2012;67(11):970-976. doi: 10.1136/thoraxjnl-2012-202103
7. Nadeem I, Light A, Donaldson C, et al. Use of DECAF scoring system to facilitate early discharge in acute exacerbation of COPD patients: a quality improvement project at a district general hospital. *Futur Heal J*. 2021;8(1):e123-e126. doi:10.7861/fhj.2020-0097
8. Dong F, Ren X, Huang K, et al. Development and validation of risk prediction model for In-hospital mortality among patients hospitalized with acute exacerbation chronic obstructive pulmonary disease between 2015 and 2019. *Front Med*. 2021;8:630870. doi:10.3389/fmed.2021.630870
9. Shi QF, Sheng Y, Zhu N, et al. The v-DECAF score can predict 90-day all-cause mortality in patients with COPD exacerbation requiring invasive mechanical ventilation. *Clin Respir J*. 2019;13(7):438-445. doi:10.1111/crj.13028
10. 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):579-584. doi:10.1016/j.ejcdt.2016.03.003
11. Malik R, Sangwan V, 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):671-677. doi:10.4103/ijccm.IJCCM_148_17
12. Huang Q, He C, Xiong H, et al. DECAF score as a mortality predictor for acute exacerbation of chronic obstructive pulmonary disease: a systematic review and meta-analysis. *BMJ Open*. 2020;10:e037923. doi:10.1136/bmjopen-2020-037923
13. Abdel-Qader DH, Albassam A, Ismael NS, et al. Community pharmacists' knowledge of and attitudes toward antibiotic use, resistance, and self-medication in Jordan. *Drugs Ther Perspect*. 2021;37:44-53. doi:10.1007/s40267-020-00797-9
14. Al Meslamani AZ, Aldulaymi R, El Sharu H, et al. The patterns and determinants of telemedicine use during the COVID-19 crisis: a nationwide study. *J Am Pharm Assoc*. 2022;62(6):1778-1785. doi:10.1016/j.japh.2022.05.020
15. Abu-Naser D, Gharaibeh S, Al Meslamani AZ, Alefan Q, Abunaser R. Assessment of extrapyramidal symptoms associated with psychotropics pharmacological treatments, and associated risk factors. *Clin Pract Epidemol Ment Health*. 2021;17(1):1-7. doi:10.2174/1745017902117010001
16. Al Meslamani AZ, Abu-Naser D, Abdel-Qader DH, et al. Assessment of inappropriate prescribing of QT interval-prolonging drugs in end-stage renal disease patients in Jordan. *Drugs Ther Perspect*. 2021;37:87-93. doi:10.1007/s40267-020-00806-x
17. Al Mazrouei N, Ibrahim RM, Al Meslamani AZ, Abdel-Qader DH, Mohamed Ibrahim O. Virtual pharmacist interventions on abuse of over-the-counter medications during COVID-19 versus traditional pharmacist interventions. *J Am Pharm Assoc*. 2021;61(3):331-339. doi:10.1016/j.japh.2021.02.003
18. Abdel-Qader DH, Hayajneh W, Albassam A, et al. Pharmacists-physicians collaborative intervention to reduce vaccine hesitancy and resistance: a randomized controlled trial. *Vaccine*. 2022;10:100135. doi:10.1016/j.jvacx.2021.100135
19. Al Meslamani AZ, Kassem AB, El-Bassiouny NA, Ibrahim OM. An emergency plan for management of COVID-19 patients in rural areas. *Int J Clin Pract*. 2021;75:e14563. doi:10.1111/ijcp.14563
20. Echevarria C, Steer J, Heslop K, et al. Validation of the DECAF score to predict hospital mortality in acute exacerbations of COPD. *Thorax*. 2016;71:133–140. doi:10.1136/thoraxjnl-2015-207775
21. Chen L, Chen L, Zheng H, Wu S, Wang S. The association of blood urea nitrogen levels upon emergency admission with mortality in acute exacerbation of chronic obstructive pulmonary disease. *Chron Respir Dis*. 2021;18. doi:10.1177/14799731211060051