Original Article

Predictors of mortality in acute exacerbations of chronic obstructive pulmonary disease using the dyspnea, eosinopenia, consolidation, acidemia and atrial fibrillation score

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ABSTRACT

Background: Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) are common and often fatal; however, accurate prognosis of patients hospitalized with an exacerbation is difficult. The Dyspnea, Eosinopenia, Consolidation, Acidemia, and Atrial Fibrillation (DECAF) score uses indices routinely available at the time of hospital admission and can accurately predict the inhospital mortality and outcomes in patients hospitalized with AECOPD. **Methodology:** A cross-sectional study was conducted in Jawaharlal Nehru Medical College, Belagavi, from January 2016 to June 2018. Consecutive patients hospitalized with an exacerbation of chronic obstructive pulmonary disease were included. DECAF indices and inhospital death rates were recorded. The prognostic value of DECAF was assessed by comparing the total score with the inhospital mortality. Statistical analysis was done using SPSS version 20. **Results:** Two hundred and twenty-eight patients were recruited. The mean (standard deviation) age was 61.09 ± 10.6 years; 73.68% were male and 48 patients (21.05%) died in hospital. One hundred and twelve patients were identified as low risk (DECAF: 0–1) with 6 (5.4%) patients dying in the hospital and 56 patients were identified as high risk (DECAF: 3–6) with an inhospital mortality of 60.1%. Length of stay for scores of 0–1, 2, and ≥3 was 6.42, 7.47, and 9.64 days, respectively, with $P < 0.05$. The receiver operating characteristic curve analysis showed $P < 0.001$, thereby proving that the DECAF is a significant predictor of mortality in AECOPD. **Conclusion:** This study proved that with an increase in the DECAF score, the mortality among patients in AECOPD increased. The DECAF score helps clinicians predict prognosis accurately by identifying low-risk patients potentially suitable for home-based care or early hospital discharge and high-risk patients requiring escalated palliation with high-level care to improve their outcome.

KEY WORDS: AECOPD, DECAF Score, Inhospital Mortality

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INTRODUCTION

An acute exacerbation of chronic obstructive pulmonary disease (AECOPD) is an event characterized by the

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worsening of patients' respiratory symptoms that are beyond day-to-day changes and need a change in medication.[1] Despite exacerbations of chronic obstructive pulmonary disease (COPD) being both common and often fatal, accurate prognosis of patients hospitalized with an exacerbation is difficult.[2] Inhospital mortality of patients with AECOPD admitted with hypercapnic acidosis is approximately 10%. Mortality reaches 40% in those requiring mechanical ventilatory support, and all-cause mortality is as high as 49% over a period of 3 years. In stable COPD, prognostic indices have been thoroughly investigated, and tools predicting mortality risk, such as the BODE (Body mass index, airflow Obstruction, Dyspnea and Exercise capacity) score,[3] are well established. Prognostic research in exacerbations requiring hospitalization and stable patients is very less, and data available for predictors of mortality in stable disease and during AECOPD are scarce.[4]

Furthermore, none of the prognostic tools developed in stable disease have been tested on hospitalized patients, and most require clinical measurements not routinely available at the time of hospital admission. A simple clinical prediction tool, using indices routinely available at the time of hospital admission, can accurately stratify patients hospitalized with AECOPD into clinically relevant risk categories and could, therefore, assist clinicians managing this frequently fatal condition. The Dyspnea, Eosinopenia, Consolidation, Acidemia and Atrial Fibrillation (DECAF) score uses indices routinely available at the time of hospital admission and can accurately predict inhospital mortality and therefore the outcomes in patients hospitalized with an acute exacerbation of COPD.

The aim of this study was to study the predictors of inhospital mortality in patients hospitalized with AECOPD using the DECAF score.

METHODOLOGY

This study was conducted in the Department of Respiratory Medicine at KLE'S Jawaharlal Nehru Medical College, Belagavi. Consecutive patients with an exacerbation of COPD who were admitted from January 2016 to June 2018 were included in the study. Inclusion criteria were patients who were diagnosed as COPD in an acute exacerbation according to the Global Initiative for Chronic Obstructive Lung Disease Criteria 2015. Exclusion criteria were patients with a history of chronic lung disease other than COPD, patients with bronchial asthma, and patients on home-based noninvasive ventilation.

Patients admitted with repeated exacerbations of COPD during the study period were enrolled only once and that too at the time of the first presentation. Patients admitted with exacerbations before the study period were included only if they presented with AECOPD during the study period. At the time of admission, the first hematological, biochemical, arterial blood gas results; the presence of consolidation on a chest X-ray; and the presence of atrial fibrillation confirmed by an electrocardiogram were recorded. Based on the results of the investigations obtained, the DECAF score for each individual was calculated, and they were classified into low, intermediate, and high risk for inhospital mortality.

The DECAF score [Table 1] predicting the risk of inhospital mortality is as follows:

- 0–1 = Low risk
- 2 = Intermediate risk
- 3≥ = High risk
- Maximum score of 6 and a minimum score of 0.

Statistical methods

The categorical data were analyzed using the Chi-square test of independence and the continuous data were analyzed using the independent *t*-test. Multiple logistic regression analysis was done as a predictor of mortality using SPSS version 20. $P < 0.05$ was considered as statistically significant. All the patients fulfilling the selection criteria were explained about the nature of the study, and written informed consent was obtained before enrollment.

RESULTS

In all, 228 patients were recruited and enrolled in the study. Table 2 shows the baseline characteristics of the study population. The mean age of the study population was 61.09 ± 5.63 years (mean ± standard deviation), and the mean duration of the illness in the study population was 5.02 ± 3.59 years. Twenty-four patients (10.53%) had no previous history of COPD, 102 (44.74%) had a disease duration of 1–5 years, and 102 (44.74%) had a disease duration of ≥6 years with the disease duration of 0, 1–5, and ≥6 years taken randomly. Of the 228 patients, 84 (36.84%) patients had no history of exacerbations in the previous 1 year, 112 (49.12%) had one exacerbation in the past 1 year, and 32 (14.04%) patients had two or more exacerbations in the past 1 year.

Table 1: The Dyspnea, Eosinopenia, Consolidation, Acidemia, and Atrial Fibrillation score

Dyspnoea:eMRCD 5a	1
Dyspnoea:eMRCD 5b	2
Eosinopenia (<0.05×10^9/l)	1
Consolidation	1
Acidemia (pH <7.3)	1
Atrial fibrillation	1

eMRCD: Extended Medical Research Council Dysnpoea Score

Table 2: Baseline characteristics of the population

Number of patients	228
Males	168
Females	60
Smoking (PYH)	12.56 (only males)
Mean age (years)	61.09±5.63
BMI (kg/m^2)	21.07

BMI: Body mass index, PYH: Pack-year history

A total of 112 patients had a DECAF score of 0–1 (low risk) with a 5.4% mortality, 60 patients had a score of 2 (intermediate risk) with 13.33% mortality, and 56 patients had a score of 3 or more (high risk) with a 60.71% mortality [Tables 3-5]. It was observed that there was a significant relationship in the hospital mortality in patients with a previous history of COPD and in patients with a previous acute exacerbation of COPD [Tables 6-8].

Multiple logistic regression analysis of mortality showed that age, previous history of COPD, dyspnea, consolidation, acidemia, and the DECAF score were associated with increased mortality in patients with AECOPD ($P < 0.05$). Odds ratio is significant in and increases with the body mass index (BMI), smoking pack-year history (PYH), acidemia, fibrillation, dyspnea, and consolidation [Table 9].

The receiver operating characteristic (ROC) curve analysis was done for all variables independently and the DECAF score as a whole in predicting inhospital mortality, and it was observed that exacerbations/year, dyspnea, consolidation, acidemia, and the DECAF score were significantly associated with increased mortality, thus proving that the DECAF is an important and significant predictor of mortality in AECOPD [Table 10 and Figure 1].

Table 3: Length of stay and mortality for each value of the Dyspnea, Eosinopenia, Consolidation, Acidemia, and Atrial Fibrillation score

DECAF score	Patients	LOS (days)	Mortality (%)
0	40	5.55	0 (0)
1	72	6.91	6 (8.33)
2	60	7.47	8 (13.33)
3	36	9.11	18 (50)
4	12	10.33	8 (66.67)
5	6	12.33	6 (100)
6	2	7	2 (100)

LOS: Length of stay, DECAF: Dyspnea, Eosinopenia, Consolidation, Acidemia, and Atrial Fibrillation

Table 4: Length of stay (LOS) and Mortality for Low, Intermediate and High risk value of the DECAF Score

DECAF score	Patients	LOS (days)	Mortality
0-1	112	6.42	6 (5.4)
2	60	7.47	8 (13.33)
≥3	56	9.64	34 (60.71)

LOS: Length of stay, DECAF: Dyspnea, Eosinopenia, Consolidation, Acidemia, and Atrial Fibrillation

Table 5: Predictors of hospital mortality by the Dyspnea, Eosinopenia, Consolidation, Acidemia, and Atrial Fibrillation score

DECAF	No mortality (%)	Mortality (%)	Total (%)
0-1	106 (94.64)	6 (5.36)	112 (49.12)
2	52 (86.67)	8 (13.33)	60 (26.32)
≥3	22 (39.29)	34 (60.71)	56 (24.56)
Total	180 (78.95)	48 (21.05)	228 (100.00)
χ^2, P		35.8761, 0.0001*	

DECAF: Dyspnea, Eosinopenia, Consolidation, Acidemia, and Atrial Fibrillation, *Statistically significant

DISCUSSION

COPD represents a significant and growing health-care concern as a leading cause of morbidity and mortality worldwide. India contributes enormously to the COPD burden which is estimated to be among the highest in the world. Approximately half a million people die every year due to COPD in India, which is more than four times the number of people who died due to COPD in the USA and Europe.[5] This number is expected to rise owing to increasing exposure to tobacco smoke and biomass fuel.

The primary objective of this study was to predict the inhospital mortality in patients hospitalized with AECOPD. Of the 228 patients included in this study, 48 patients expired in the hospital with a mortality of 21.05%. Based on the risk stratification of the DECAF score, 112 patients were identified as low risk with a DECAF score of 0–1, 60 patients were identified as intermediate risk with a DECAF score of 2, and 56 patients were identified as having high risk based on the DECAF score of 3 or more.

The mortality observed in the low-, intermediate-, and high-risk groups was 5.4%, 13.33%, and 60.71%, respectively, implying that as the score increased, the mortality also increased. The findings of this study were consistent with those of Echevarria *et al*.[6,7] who observed a mortality of 1.4%, 8.4%, and 34.7% for low, intermediate, and high risks of the DECAF score, respectively.

On performing the Chi-square test, $P = 0.0001$ was obtained which was statistically significant, thereby proving that the

Table 6: Hospital mortality by chronic obstructive pulmonary disease history

COPD history	No mortality (%)	Mortality (%)	Total (%)
0	24 (100.00)	0 (0.00)	24 (10.53)
1-5	76 (74.51)	26 (25.49)	102 (44.74)
6+	80 (78.43)	22 (21.57)	102 (44.74)
Total	180 (78.95)	48 (21.05)	228 (100.00)

COPD: Chronic obstructive pulmonary disease

Table 7: Number of exacerbations and chronic obstructive pulmonary disease history

Exacerbations/year	COPD history			Total
	0 years	1-5 years	≥6 years	
0	24	35	25	84
1	0	53	59	112
2	0	14	18	32
Total	24	102	102	228

COPD: Chronic obstructive pulmonary disease

Table 8: Hospital mortality by exacerbations/year

Exacerbations/year	No mortality (%)	Mortality (%)	Total (%)
0	78 (92.86)	6 (7.14)	84 (36.84)
1	86 (76.79)	26 (23.21)	112 (49.12)
2	16 (50.00)	16 (50.00)	32 (14.04)
Total	180 (78.95)	48 (21.05)	228 (100.00)

Table 9: Multiple logistic regression analysis of mortality by other variables

Independent variables	Estimates	SE of estimates	Wald statistic	*P*	OR	95% CI for OR	
						Lower	Upper
Age	−2.40	0.80	9.0950	0.0030*	0.09	0.02	0.43
Sex	−2.91	1.60	3.3210	0.0680	0.06	0.00	1.25
Smoking PYH	0.47	1.55	0.0900	0.7650	1.59	0.08	33.33
BMI	1.33	0.82	2.6270	0.1050	3.77	0.76	18.80
COPD history	−4.43	1.19	13.7980	0.0001*	0.01	0.00	0.12
Exacerbations/year	−0.18	0.78	0.0530	0.8180	0.84	0.18	3.84
Dyspnea	5.54	1.49	13.8080	0.0000	254.19	13.70	4717.86
Eosinopenia	−1.03	1.39	0.5460	0.4600	0.36	0.02	5.45
Consolidation	4.01	1.23	10.5740	0.0010*	55.36	4.93	622.17
Acidemia	4.78	1.48	10.3920	0.0010*	119.22	6.52	2181.43
Fibrillation	1.70	1.08	2.4940	0.1140	5.46	0.66	44.84
DECAF	−3.15	1.62	3.7830	0.0500*	0.04	0.01	1.03

PYH: Pack-year history, BMI: Body mass index, COPD: Chronic obstructive pulmonary disease, CI: Confidence interval, DECAF: Dyspnea, Eosinopenia, Consolidation, Acidemia, and Atrial Fibrillation, SE: Standard error, OR: Odds ratio, *Statistically significant

Table 10: Area under curve by receiver operating characteristic

Test result variable(S)	Area	SE	*P*	Asymptotic 95% CI	
				Lower bound	Upper bound
Age	0.48	0.07	0.7540	0.35	0.61
Sex	0.54	0.07	0.6020	0.41	0.66
Smoking PYH	0.53	0.07	0.6320	0.40	0.66
BMI	0.54	0.07	0.5590	0.41	0.67
COPD history	0.57	0.06	0.3170	0.45	0.69
Exacerbations/year	0.65	0.06	0.0210*	0.54	0.77
Dyspnea	0.75	0.06	0.0001*	0.62	0.87
Eosinopenia	0.52	0.07	0.8020	0.38	0.65
Consolidation	0.71	0.06	0.0020*	0.59	0.82
Acidemia	0.72	0.05	0.0010*	0.63	0.82
Fibrillation	0.58	0.07	0.2350	0.44	0.72
DECAF	0.73	0.05	0.0001*	0.63	0.84

PYH: Pack-year history, COPD: Chronic obstructive pulmonary disease, CI: Confidence interval, DECAF: Dyspnea, Eosinopenia, Consolidation, Acidemia, and Atrial Fibrillation, SE: Standard error, BMI: Body mass index, *Statistically significant

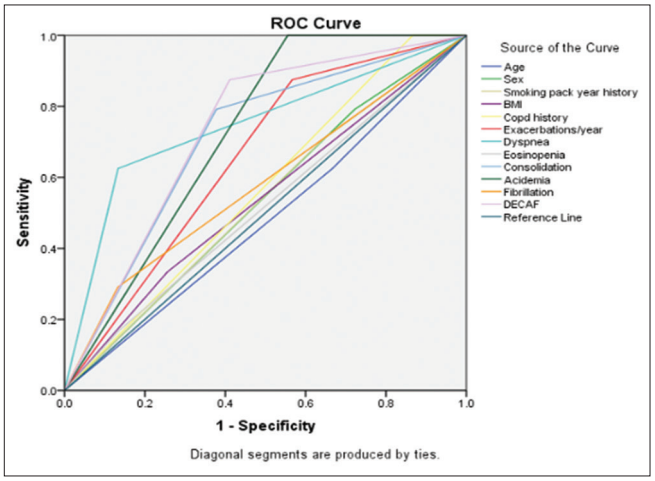

Figure 1: Receiver operating characteristic curve

DECAF is successful in predicting inhospital mortality in patients hospitalized with an acute exacerbation of COPD.

On assessment of individual parameters of the DECAF score to successfully predict inhospital morality independently, it was observed that Extended Medical Research Council Dysnpoea Score (eMRCD) score of 5a/b, consolidation on the chest X-ray, and acidemia on arterial blood gas analysis were all very strong independent predictors of mortality with a statistically significant $P < 0.01$. Eosinopenia and atrial fibrillation were not associated with higher mortality. This observation was similar to that by Zidan *et al.*[8] who did not find fibrillation and eosinopenia to be independent predictors of mortality, whereas studies conducted by Steer *et al.*,[7] Nafae *et al.*,[9] and Echevarria *et al.*[6] found all five parameters of the DECAF score as strong independent predictors of mortality.

Analysis of association between the length of hospital stay (LOS) and the DECAF score was another main objective of this study. A study by Yadavilli *et al.*[10] in 75 patients observed that the LOS was associated with an increase in the DECAF score. LOS was highest in those with DECAF scores of 3 or more (16.7 days) and lowest in those with scores of 0–1 (12 days). In the present study, it was observed that the length of stay also increased with the DECAF score, thereby confirming the findings of Yadavilli *et al.*[10] The length of stay for scores of 0–1 was 6.42 days, for a score of 2 was 7.47 days, and for scores of 3 or more was 9.64 days, thereby demonstrating an increasing trend with each score of DECAF. This was statistically significant with $P < 0.05$.

There was no statistically significant impact of the age groups, gender, BMI, smoking history, or past history of COPD on the mortality among the patients. However, a previous history of exacerbations and their number in the previous 1 year had a statistically significant impact on the mortality in patients with AECOPD with $P = 0.0011$ which was consistent with the results obtained by Zidan *et al.*[8] Schmidt *et al.*[11] found similar results in a large cohort of 16,647 eligible patients with prevalent COPD, of whom 6664 (40%) developed an AECOPD where one or more exacerbations in the previous year were not associated with 30-day mortality but were associated with an increased 31–365-day mortality.

Multiple logistic regression analysis of mortality results showed that age, previous history of COPD, dyspnea, consolidation, acidemia, and the DECAF score had a significant association with the mortality in patients with AECOPD ($P < 0.05$). Odds ratio (95% confidence interval) is significant in and increases with the BMI, smoking PYH, acidemia, fibrillation, dyspnea, and consolidation. These findings were similar to the results obtained from studies conducted by Steer *et al*.,[7] Nafae *et al*.,[9] and Echevarria *et al*.[6]

The ROC curve analysis was done for all variables independently and the DECAF score as a whole in predicting inhospital mortality, and a significant association was observed in exacerbations/year, dyspnea, consolidation, acidemia, and the DECAF score which was statistically significant ($P < 0.001$), thereby proving that the DECAF is an important and significant predictor of mortality in AECOPD.

Limitations of the study

The samples were selected from a single center. The sample size of 228 is not adequate enough to highlight the importance of the DECAF score. There was a disproportionate distribution of the gender in the study population, therefore unable to establish a definite relationship.

CONCLUSION

The DECAF score is a simple yet robust predictor of mortality in patients hospitalized with an exacerbation of COPD. It has the potential to help clinicians predict prognosis more accurately by identifying low-risk patients potentially suitable for home-based care or early hospital discharge and high-risk patients who require escalated palliation and a high level of care to improve the outcome in this common condition.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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