Chest Heart Journal
Vol. 46, No. 2, July 2022

ORIGINAL ARTICLE

Prediction of the Need for NIV in Patients with Acute Exacerbation of Chronic Obstructive Pulmonary Disease: A Comparative Study between DECAF and Modified DECAF Score

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Abstract

Background: *Exacerbation of chronic obstructive pulmonary disease (COPD) lead to multiple hospital admissions, longer hospital stays, increased treatment costs as well as increased morbidity and mortality. Currently, no optimal scoring system exists that can predict need for NIV in patients with acute exacerbation of COPD. Accurate prognostic tool can help physicians to select the appropriate level of care and preparedness.*

Objective: *To compare DECAF [(D) dyspnea, (E) eosinopenia, (C) consolidation, (A) acidemia, (F) atrial fibrillation] and modified DECAF score [(D) dyspnea, (E) eosinopenia, (C) consolidation, (A) acidemia, (F) frequency of hospital admission] in predicting the need for NIV in patients with acute exacerbation of chronic obstructive pulmonary disease.*

Materials and Methods: *This cross-sectional study was conducted in the Department of Respiratory Medicine, NIDCH, Mohakhali, Dhaka from April 2021 to May 2022. A total of 91 patients with acute exacerbation of COPD were enrolled in this study. All patients were subjected to complete medical history taking, chest examination, dyspnea assessment by extended modified Medical Research Council Dyspnea(eMRCD), complete blood count, chest radiograph, ECG, and arterial blood gas analysis. Both DECAF and modified DECAF score were calculated and the need for NIV was documented. All collected data were analyzed using appropriate statistical formula and SPSS programme.*

Results: *Out of 91 patients, 20 patients (21.97%) required non-invasive ventilation. The area under the ROC curve of DECAF and modified DECAF score was 0.973 and 0.974 respectively in predicting the need for NIV. The sensitivity, specificity, PPV and NPV of DECAF score were 84.21%, 94.44%, 80.00% and 95.77% respectively at a cut off value of 3. The sensitivity, specificity, PPV and NPV of modified DECAF score were 84.52%, 100%, 100% and 96.51% respectively at a cut off value of 4*

Conclusion: *Both DECAF score and the modified DECAF score are practical and can be calculated easily using simple questions and routine investigations available during the initial admission. Both were good predictors, but modified DECAF was superior in predicting need for NIV in patients with acute exacerbation of COPD*

Keywords: *COPD, DECAF score, modified DECAF score*

[Chest Heart J. 2022; 46(2) : 81-88]

DOI: http://dx.doi.org/10.33316/chab.j.v46i2.2019657

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Submission on: 13 June, 2022 **Accepted for Publication:** 26 June, 2022

Available at http.//www.chabjournal.org

Introduction:

Globally, Chronic obstructive pulmonary disease (COPD) is one of the significant causes of morbidity and mortality, resulting in a substantial and growing economic and social burden[1]. It is currently the third leading cause of death worldwide, causing 3.23 million deaths in 2019, with nearly 90% of deaths under the age of 70 occurring in low and middle income countries[2]. The prevalence of COPD is predicted to increase over the next 40 years and may even result in 5.4 million deaths annually by 2060 due to COPD and allied conditions[3].

GOLD defines Chronic obstructive pulmonary disease (COPD) as a heterogeneous lung condition characterized by chronic respiratory symptoms (dyspnea, cough, sputum production and/or exacerbations) due to abnormalities of the airways (bronchitis, bronchiolitis) and/or alveoli (emphysema) that cause persistent, often progressive, airflow obstruction[4]. Chronic bronchitis, small airway disease, and parenchymal destruction are the main components of chronic obstructive pulmonary disease (emphysema). It is considered in people over the age of 40 who have progressive persistent shortness of breath, chronic and recurrent cough, sputum production, and/or a history of recurrent exposure to risk factors. Spirometry is required to confirm the diagnosis clinically; the presence of post-bronchodilator FEV1/FVC less than 0.70 confirms the diagnosis[5]. COPD is a lung disease that increases the risk of cardiovascular, metabolic, skeletal muscle dysfunction, osteoporosis, depression, anxiety, and lung cancer[6].

Exacerbation of COPD can be defined as the deterioration of symptoms that essentially need management with antibiotics, oral corticosteroids, or both[4]. It generally includes an acute change in one or more of the following cardinal symptoms: (1) Dyspnea increases (2) cough increases in frequency and severity (2) Sputum production increases in volume and/or changes character. Acute Exacerbation can be divided into mild (presence of one out of three cardinal symptoms), moderate (presence of two out of three cardinal symptoms) and severe (presence of three cardinal symptoms)[7]. Exacerbations play an essential role in COPD prognosis, and individuals with recurrent exacerbations have been associated with worse outcomes[8]. Early recovery was found to be a significant factor in determining the long-term prognosis of COPD patients[9].

A robust clinical prediction tool could assist decisions regarding: location of care, early escalation of care, appropriateness for end-of-life care, and suitability for early supported hospital discharge and therefore could help to reduce morbidity and mortality and direct the most efficient use of resources during exacerbation period. In stable COPD, multiple prognostic tools were applied to predict mortality risk, but during the time of exacerbation, limited prognostic scores were found to identify exacerbation at risk of morbidity and mortality. Different scoring systems which were used previously in patients with acute exacerbation of COPD requiring hospital admission, were shown to be suboptimal[10]. The Dyspnea, Eosinopenia, Consolidation, Acidemia and Atrial Fibrillation (DECAF) score is a risk stratification tool initially designed to predict mortality during exacerbations. A modified DECAF score was subsequently designed with the frequency of hospital admissions in the previous year, replacing atrial fibrillation[11].

Our study aims to compare the effectiveness of modified DECAF over DECAF score in predicting the need for NIV in patients with acute exacerbation of COPD to determine which would be a better indicator for Bangladesh.

Materials and methods:

This cross-sectional observational study was conducted in the department of respiratory medicine of National Institute of Diseases of the Chest and Hospital, Mohakhali, Dhaka during the period from April 2021 to May 2022.

Inclusion criteria were:

Patients with diagnosed case of acute exacerbation of COPD admitted into NIDCH.

Exclusion criteria were:

1. COPD patients on domiciliary ventilation
2. Presence of other obstructive lung diseases like Asthma or bronchiectasis
3. Primary reason for admission is other than acute exacerbation of COPD (acute respiratory distress due to other reasons)

4. Patients with active malignancy
5. Patients with multisystem failure

Ninety-One (91) patients were included in the study using purposive sampling method. After informing full information regarding the nature of the study, possible outcome, and importance of follow-up, written consent was obtained. Relevant clinical history was taken through face-to-face interviews. The eMRCD grading and collected data were put on a structured questionnaire. CBC, Chest x-rays, ECG, and arterial blood gas analysis were done to calculate DECAF and Modified DECAF score. Data was collected regarding the need for non-invasive ventilation. All information regarding the clinical features and investigations was recorded in a data collection sheet.

Results:

Out of 91 patients, most patients were above 50 years of age (82.5%) with male predominance (89.0%). Most patients had lower socioeconomic status (72.5%). Of the admitted patients, about 65.9 % were current-smokers and 25.6% were ex-smokers. Severe exacerbations were most common in admitted patients and were noted to be 49 % in the study population. Moderate exacerbations were seen in 40 % and mild exacerbations in 11%. Severity of acute exacerbation of COPD had a significant relationship ($p<0.05$) with both the DECAF and modified DECAF score Among the study population, 49.4 % have co-morbidities. Among those with co-morbidities, HTN was most common at 18.7 %, followed closely by DM (15.3%), then IHD (9.9%) and Pulmonary HTN (5.5%). Both the DECAF and modified DECAF score were not significantly affected by the presence or absence of comorbidities ($p >0.05$).

There were 31 cases (34.06%) who presented with score 0 (eMRCD 0–4), 38 cases (41.76%) with score 1 (eMRCD 5a) and 22 cases (24.18%) presented with score 2 (eMRCD 5b). 15.39% of study patients presented with eosinopenia (<50 cells/mm3), 14.29% with consolidation, 18.68% with acidemia (pH <7.30), 5.50% with Atrial Fibrillation and 58.25% with the history of hospitalization for 2 or more times in last one year due to acute exacerbation of COPD. There was a statistically significant relation($p<0.05$) with the need for non-invasive ventilation and grade of dyspnea (eMRCD), eosinopenia, consolidation, acidemia and frequency of hospital admission (2 or more times in last year), but atrial fibrillation showed no significant relationship ($p>0.05$) with the need for non-invasive ventilation.

Out of 91 patients, 20 patients (21.97%) needed non-invasive ventilation where mean DECAF score was 3.3±0.825 and mean modified DECAF score was 4.5±0.825. The area under the ROC curve of DECAF score and modified DECAF score were 0.973 and 0.976, respectively, predicting need for non-invasive ventilation in patients with acute exacerbation of COPD. The DECAF score had a sensitivity of 85.00%, a specificity of 95.77%, and an accuracy of 93.41 %. In comparison, the modified DECAF score had a sensitivity and accuracy at 85.00% and 94.50%, respectively with a higher specificity at 97.18%.

Table-I

Demographic profile of the study population (n=91)

	Frequency (n)	Percentage
Age (years)		
40-50	16	17.6
51-60	33	36.3
61-70	37	40.6
Above 70 years	5	5.5
Gender		
Male	81	89.0
Female	10	11.0
Socio-economic status*		
Lower	66	72.5
Upper Lower	8	8.8
Middle Lower	13	14.3
Upper Middle	2	2.2
Upper	2	2.2

*Socioeconomic Status Scale-Modified Kuppuswamy Scale,2022

Table-II

Distribution of the study population by smoking status (n=91)

Smoking status	Frequency	Percentage
Current smoker	60	65.9
Ex-smoker	26	28.6
Never smoker	5	5.5
Average pack per year	20.16±5.54	

Table-III

Distribution of the study population by severity of acute exacerbation of COPD (n=91)

Severity of exacerbation	Frequency (n)	Percentage
Mild	10	11
Moderate	36	40
Severe	45	49
Total	91	100.0

Table-IV

Distribution of the study population by co-morbidities (n=91)

Comorbidities	Frequency (n)	Percentage
DM	14	15.3
HTN	17	18.7
IHD	9	9.9
Pulmonary HTN	5	5.5
None	46	50.6
Total	91	100.0

Table-V

Distribution of study population by the components of DECAF and modified DECAF score (n=91)

Components		Score	Frequency (n)	Percentage
Dyspnoea(eMRCD)	eMRCD 0-4	0	31	34.06
	eMRCD 5a	1	38	41.76
	eMRCD 5b	2	22	24.18
Eosinopenia(<50 cells/mm3)	No	0	77	84.61
	Yes	1	14	15.39
Consolidation	No	0	78	85.71
	Yes	1	13	14.29
Acidemia(pH<7.3)	No	0	74	81.32
	Yes	1	17	18.68
Atrial Fibrillation	No	0	86	94.50
	Yes	1	5	5.50
Frequency of Hospitalization	No	0	38	41.75
(2 or more times in last year)	Yes	1	53	58.25

Table-VI

Relationship between need for non-invasive ventilation and each component of DECAF & modified DECAF score among study population (n=91)

Components	Score	Need for Non-invasive Ventilation		Test of significance	p value
		Yes	No		
Dyspnoea(eMRCD)	0	1	30	χ^2=53.8263df 2	<0.00001*
	1	2	36		
	2	17	5		
Eosinopenia(<50 cells/mm3)	0	2	75	χ^2=62.8666df 1	<0.00001*
	1	12	2		
Consolidation	0	9	69	χ^2=35.1796df 1	<0.00001*
	1	11	2		
Acidemia(pH<7.3)	0	4	70	χ^2=63.4455df 1	<0.00001*
	1	16	1		
Atrial Fibrillation	0	19	67	χ^2=0.0121df 1	0.912511 ns
	1	1	4		
Frequency of Hospitalisation	0	1	37	÷2=14.2412df 1	0.000161*
	1	19	34		

p-value reached from Chi-Square test, *significant, ns= not significant

Table-VII

Comparison of DECAF score and modified DECAF score among study population by severity of acute exacerbation of COPD (n=91)

Severity of COPD		N	Mean±SD	Range (min-max)	F value	p-value
DECAF score	Mild	10	.48±.572	0–2	17.302	<0.001*
	Moderate	36	2.10±.968	1–4		
	Severe	45	3.53±.915	2-5		
	Total	91	1.34±1.384	0–5		
Modified	Mild	10	.80±.903	0–3	20.562	<0.001*
DECAF score	Moderate	36	3.10±.968	2–5		
	Severe	45	4.47±.915	3-6		
	Total	91	1.91±1.730	0–6		

p-value reached from ANOVA test, *significant

Table-VIII

Comparison of DECAF score and modified DECAF score among study population by the presence or absence of comorbidities (n=91)

Comorbidities	N	Mean±SD	Range (min-max)	F value	p-value	
DECAF score	DM	14	1.00±1.044	0–3	1.329	0.247^{ns}
	HTN	17	1.53±1.375	0–4		
	IHD	9	1.50±1.604	0–4		
	Pulmonary HTN	5	2.50±1.732	1–4		
	None	46	1.22±1.381	0–5		
	Total	91	1.34±1.384	0–5		
Modified	DM	14	1.67±1.435	0–4	1.114	0.344^{ns}
DECAF score	HTN	17	2.24±1.751	0–5		
	IHD	9	2.00±2.00	0-5		
	Pulmonary HTN	5	3.50±1.732	2–5		
	None	46	1.74±1.744	0–6		
	Total	91	1.91±1.730	0–6		

p-value reached from ANOVA test, ns= not significant

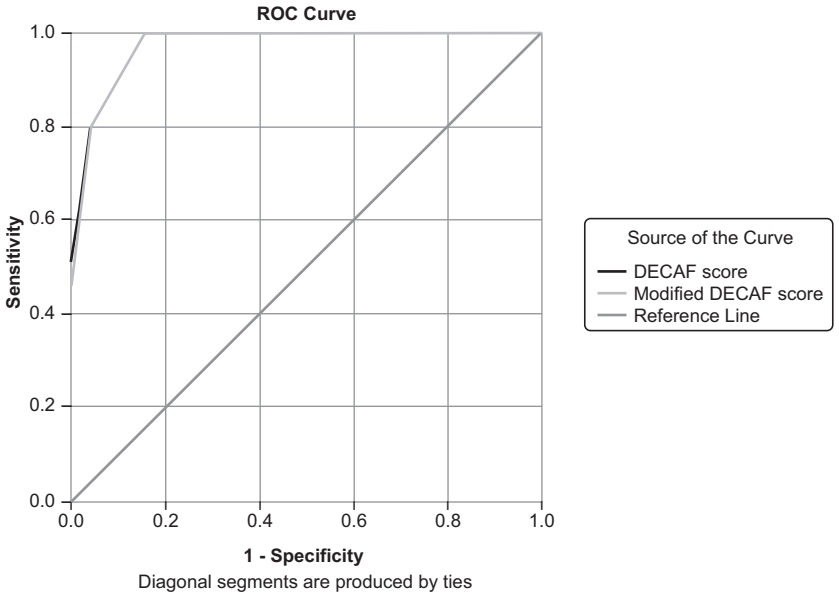

Fig.-1: *ROC curve of DECAF score and modified DECAF score in predicting the need for non-invasive ventilation in patients with acute exacerbation of Chronic Obstructive Pulmonary Disease (n=91)*

Table-IX

Test Result Variable(s)	AUC	Std. error	p-value	95% CI	
				Lower	Upper
DECAF score	.973	.014	<0.0001	.947	1.000
Modified DECAF score	.976	.014	<0.0001	.946	1.000

Table-X

Sensitivity, Specificity, PPV and NPV of DECAF score and modified DECAF score in predicting the need for non-invasive ventilation in patients with acute exacerbation of Chronic Obstructive Pulmonary Disease (n=91)

Test ResultVariable(s)	Cut off value*	Sensitivity	Specificity	PPV	NPV	Accuracy
DECAF score	3	85.00%	95.77%	85.00%	95.77%	93.41%
ModifiedDECAF score	4	85.00%	97.18%	89.45%	95.83%	94.50%

*cut off value reached from Youden Index

Discussion:

The hospital-based cross-sectional study was conducted on 91 patients admitted with AECOPD to determine whether the modified DECAF score was a superior prognostic score over the DECAF. Most patients were within the 50 to 70 age brackets, consistent with increased age being a risk factor for COPD. Gender-wise distribution revealed that 89% of the patients were male, representing an increased smoking prevalence in males. Among the participants, about 65.9 % were current smokers, and 25.6% were ex-smokers signifying the importance of smoking in the development of COPD. These findings reflect those from the study carried out by Islam et al. in 2013, where increasing age, male sex and smoking duration were regarded as independent risk factors for COPD in Bangladesh[12].

The DECAF Score: Dyspnea, Eosinopenia, Consolidation, Acidemia, and atrial Fibrillation was derived by Steer et al. 2012 to predict exacerbators with mortality risk during the hospital stay. DECAF score was primarily the prognostic tool used to stratify patients with AECOPD requiring hospital admission at risk of dying and to predict the outcomes[11]. The DECAF score was applied in patients with acute exacerbation of COPD at Alexandria University Hospital in 2014 by Zidan et al. and confirmed the strong prediction of DECAF score in expecting the in-hospital mortality and suggested the new modified DECAF score replacing atrial fibrillation with frequency of hospital admission in the previous year.

Extended Medical Research Council Dyspnoea (eMRCD) grading was incorporated in both DECAF and modified DECAF score as it includes degree of breathlessness along with functional dependence. Grade 5 of mMRC dyspnoea scale comprises of patients who are dyspneic even at rest. In eMRCD, grade 5 was divided into Grade 5a and 5b. Patients with Grade 5a could manage self-care independently, whereas in Grade 5b required assistance for basic self-care like bathing and dressing[13].

The study group selected had a varying presence of co-morbidities except for an underlying respiratory condition. On analyzing the data, it was seen that their presence or absence had no significant effect on the DECAF or the modified DECAF score, scoring a p-value above 0.05 in both instances (Table-VIII)

There were 31 cases who presented with dyspnea (eMRCD 0–4) with score 0, 38 cases presented with dyspnea (eMRCD 5a) with score 1 and 22 cases presented with dyspnea (eMRCD 5b) with score 2. There were 77 cases whose eosinophil count was >0.05 × 109 /L with score 0 and for 14 cases their eosinophil count was <0.05 × 109 /L with sore 1. There were 78 cases whose chest x-ray did not

show consolidation with score 0 and 13 cases whose chest x-ray showed consolidation with score 1. There were 17 cases in our study with their ABG showing acidemia (pH <7.30) with score 1 while the remaining 74 cases were (pH > 7.30) with score 0. There were 5 cases of atrial fibrillation in ECG with score 1 and remaining 86 cases did not show atrial fibrillation in ECG with score 0. There were 38 cases who had past history with less than 2 times of previous admission in the last year by acute exacerbation of COPD with score 0. There were 53 cases who had past history with more than or equal to 2 times of admission in the last year with score 1.

Incidence of need for non-invasive ventilation was 20 (21.97%). The difference in the components between these two-scoring system is atrial fibrillation in DECAF score and frequency of hospitalization for 2 or more times in the last one year due to acute exacerbation of COPD in modified DECAF score. It was found that atrial fibrillation was not significantly related ($p<0.05$) to the need for non-invasive ventilation, but frequency of hospital admission for 2 or more times in the last year was significantly related to the need for non-invasive ventilation scoring a p-value below 0.05 in all instances. This is in line with the findings of the study carried out by Zidan et al. in 2014 where atrial fibrillation was not significantly related to the need for NIV ($p>0.05$), but there was significant relationship between the frequency of admission with the need for NIV with a p value of < 0.001. Though a study conducted by Malik Sangwan in 2017 reflected significant relationship between mortality and atrial fibrillation ($p<0.05$)[13].

The severity classification of acute exacerbation of COPD was found to be significantly correlated with the DECAF and the modified DECAF score, having a p-value of less than 0.001.

The ROC curve for the DECAF and modified DECAF score for the prediction of the need for non-invasive ventilation were both above the reference line, making them good predictors for suitability. Their sensitivities were same (85.00%) and accuracy were also very similar, with DECAF score at 93.41 % and modified DECAF at 94.50%. The modified DECAF score was more specific at 97.18% compared to the 95.77% DECAF score.

As seen from the study, both the DECAF and modified DECAF Scores are good predictors for the need for non-invasive ventilation in acute exacerbation of COPD, having very similar sensitivities, specificities, and accuracy. But modified DECAF had a slightly higher edge, making it more specific and accurate than the DECAF score. This is in line with the findings of the study carried out by Zidan et al. in 2020, which showed both the scores to be an easy and practical method for predicting mortalities and the need for mechanical ventilation but suggested the use of modified DECAF scores in clinical settings due to its higher specificity[14].

Though the systemic review and meta-analysis carried out by Huang et al. (2020) concluded the DECAF score to have a better prognostic score and stable clinical values, it is important to note that they had mentioned that there was no significant difference between the DECAF and modified DECAF score and further study was needed to compare the two scores[15].

In this study, according to Youden index, the best cut-off value of DECAF score for the prediction of need for non-invasive ventilation was 3 On the other hand, the best cut-off value of modified DECAF score for the prediction of need for non-invasive ventilation was 4.

Conclusion:

In this study, we can see that increasing age, male gender and smoking are at a greater risk of exacerbations of COPD in Bangladesh. The DECAF and modified DECAF score were both found to be practical and helpful bedside prognostic score for the determination of need of non-invasive ventilation. But modified DECAF score has better specificity and accuracy than the DECAF score.

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