Original Article

Mortality in Patients with Acute Exacerbation of Chronic Obstructive Pulmonary Disease with Lower and Higher Decaf Scores

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Abstract

Introduction: To determine the diagnostic accuracy of the DECAF score in predicting mortality in patients with acute exacerbation of chronic obstructive pulmonary disease having a DECAF score < 4 and ≥ 4 within 7 days of hospital admission keeping actual mortality as the gold standard.

Materials and Methods: In this cross-sectional validation study, 146 Patients with COPD were selected from emergency and OPD of Fauji Foundation Hospital Rawalpindi presenting with signs and symptoms of acute exacerbation of COPD from 15th May 2017 to 15th Nov. 2017. The procedure began after taking the informed consent of the patients. Clinical features were documented and investigations were sent. The expense of all the tests was borne by the hospital administration and not the patient. A specially designed Performa was used for data collection.

Results: Mean age (years) in the study is 64.90+0.93. Patients with DECAF score of 1, 2 and 3 are (2.7+26+35.6 =64.3) are 64 %. The cases with a DECAF score of 4 are 26.7% and the cases with a DECAF score of 5 and 6 are 8.9%. DECAF score versus mortality with different age groups and duration of smoking gave reasonably high values of sensitivity and, specificity. Also, the PPV and NPV values are appropriate. The minimum diagnostic accuracy is 71.23% indicating that this test is appropriate for predicting the true status of the cases.

Conclusion: The study concludes that the DECAF score is a useful predictor of mortality in patients admitted with acute exacerbation of COPD. Patients admitted to the hospital with a high DECAF score of ≥ 4 should be admitted to the intensive care unit because they may require invasive ventilation due to respiratory failure and high mortality.

Keywords: Chronic obstructive pulmonary disease, acute exacerbation of COPD, DECAF score, Diagnostic accuracy.

Introduction

Chronic obstructive pulmonary disease (COPD) is among one of the major causes of morbidity and mortality worldwide.[4,5] COPD has a significant economic and social burden on the communities.[2] It is more common in males and older people. The prevalence of COPD varies from 0.2%-37%.[2] About 3 million people died of COPD in 2012 comprising 6% of all deaths worldwide.[5] It is expected that COPD will be the third leading cause of death worldwide by 2020.[2]

COPD has a progressive course of disease that is worsened by exacerbations that affect the quality of life and increases both short and long-term mortality.[3] Acute exacerbations in this illness are responsible for 1 in 8 hospital admissions and about 4.4 to 7.7% of in-hospital deaths.[4]

In the case of stable COPD, BODE Index (Body mass index(B), Airflow Obstruction(O), Dyspnea(D), and Exercise capacity index(E)) has been validated as a satisfactory tool for predicting mortality. However, in the case of acute exacerbations, to date, few tools are available that predict mortality in hospitalized patients. By identifying the risk factors for mortality, the level of care can be modified and decisions about early hospital discharge can be made avoiding wastage of resources[1].

One of the few tools explored in the recent past in patients with exacerbations is the DECAF (Dyspnea, Eosinopenia, Consolidation, Academia, Atrial Fibrillation) score. In some recent studies, it is found that a 0 score has in-hospital mortality of 0.5%, a score of 1 has 2.1%, a score of 2 has 8.4%, a score of 3 has 24%, a score of 4 has 45.6% and a score of 5 has 70% in-hospital mortality[1] The sensitivity of score 1 is 0.99 which is highest among the DECAF scores followed by a DECAF score of 2 which has sensitivity 0.93, a score of 4 has a sensitivity of 42% and a score of 5 has the lowest sensitivity that is 0.15. Similarly, the specificity for the DECAF score of 5 is 0.99 which is the highest followed by a score of 4 which has a specificity of 0.96 and the score of 1 has a specificity of 0.24.[6]

The DECAF score is a new tool that needs further exploration in terms of reliability and validity.[7] The DECAF Score shows promise for the risk stratification of patients hospitalized with Acute exacerbation of COPD (AECOPD).[8] Studies in the past suggest DECAF score is a better predictor of mortality than CURB-65 (Confusion Urea nitrogen, Respiratory rate, Blood pressure, 65 years of age and older), COPD, and Asthma Physiology Score predictive tools.[9] The death rates for each grade of the DECAF Score suggest the following risk categories: DECAF 0-1 ('low risk'; in-hospital mortality 1.4%); DECAF 2 ('moderate risk'; mortality 8.4%); and DECAF 3-6 ('high risk'; mortality 34.6%).[10] About more than half of the patients hospitalized with AECOPD can be classified as low risk of both in-hospital and 30-day mortality and might therefore potentially be suitable for early discharge.[1] Use of the DECAF Score will help patients as current evidence suggests approximately 25% of patients hospitalized with AECOPD are considered eligible for early discharge.[11]

In this study, we calculated diagnostic accuracy of DECAF scores < 4 and ≥ 4 within 7 days of hospital admission in patients with acute exacerbation of chronic obstructive pulmonary disease keeping actual mortality as the gold standard. It could do risk stratification at admission and modify our management according to the score. This score is feasible at the bedside because the parameters of the DECAF score are usually measured on routine admissions.

It will enhance the knowledge of medical practitioners and policymakers for planning to take proper measures for referring the patients and predicting mortality.

Materials and Methods

A cross-sectional validation study was conducted at the chest Department, Fauji Foundation Hospital Rawalpindi. The duration of the study was 6 months from 15th May 2017 to 15th Nov 2017. Consecutive (non-probability) sampling was used for purpose of data collection.

A total of 146 patients enrolled with acute exacerbation of COPD were taken using the WHO| sample size calculator. The confidence interval used was 95%, sensitivity=42%, specificity=93%, prevalence=45.6%, absolute precision for sensitivity=10%, absolute precision for specificity=4%, It came out n=146 i.e. patients. Inclusion criteria were Patients 40-90 years of age, both male and female, Tobacco smokers, and patients admitted to the hospital with acute exacerbation of the chronic obstructive pulmonary disease. Exclusion criteria were diagnosed patients with respiratory diseases other than COPD, Asthmatic, Allergic rhinitis, Malignant disease, Severe pulmonary tuberculosis, Heart failure, Domiciliary oxygen, Pulmonary hypertension, Obstructive sleep apnea after approval from the ethical committee and informed consent. Patients

meeting the inclusion criteria were evaluated in detail using history, general and systemic examination, and parameters like hospital number, age, gender, eosinophil count, ABGs for pH, was noted and ECG, a chest x-ray was done. These patients were then followed during admission for mortality during 7 days of admission. The variables measured were age, mortality, hypertension, duration of smoking, diabetes, DECAF score, and CVA(Cerebro Vascular Accident).

Data analysis was done on SPSS version 22.0. Descriptive statistics were calculated for qualitative and quantitative variables. For qualitative variables like gender, CVA (Cerebro Vascular Accident), mortality, hypertension, frequency, and percentage (%) were used and for quantitative data like age mean ±SD were calculated.

2x2 tables were constructed to calculate sensitivity, specificity, positive predictive value, and negative predictive value.

ROC curve was drawn between mortality and DECAF score being mortality the binary variable and DECAF score the test variable. The sensitivity and specificity are obtained from the ROC curve along with the cut point.

The DECAF score is split into two groups. The first group is (DECAF score is < 4) and the second group is (DECAF score ≥ 4). The test developed is DECAF groups versus mortality. The different measures such as TP(True Positive), TN(True Negative), FP(False Positive), FN(False Negative), Sensitivity, specificity, Positive Predictive Value (PPV), Negative predictive value (NPV) and Diagnostic accuracy (DA) have been calculated for effect modifiers, age, and duration of smoking, considering mortality as the gold standard. The cross table in our case is

Test	*Reality*		*Total*
	Died	*Alive*	
≥4	A(TP)	B(FP)	A+B
<4	C(FN)	D(TN)	C+D
Total	A+C	B+D	A+B+C+D

The DECAF score as a test under different effect modifiers

The DECAF score as a test has been considered under the following different situations by making cross tables and relevant statistics.

i. **DECAF groups versus mortality**
ii. **Age groups versus DECAF groups versus mortality**
iii. **Smoking groups versus DECAF groups versus mortality**

Results

Among 146 patients in the study, the age ranged between 40 and 93 years with a mean and standard error of 64.93±0.937. The duration of smoking was between 2 and 50 with a mean and standard error of 27.84±0.935. The minimum smoking period of two years may be attributed to their previous history of wood burning. The BMI ranged from 16 to 39 with a mean and standard error of 23.54±0.336 and the DECAF score was between 1 and 6 with a mean and standard error of 3.15±0.08603. Statistics of numerical variables are presented in Table 1(a). The frequency distribution of qualitative/categorical variables is in Table 1(b).

It is apparent from Table 1(b) that all the cases under study are female. Table 1(b) also indicates that most of the patients i.e. 77% have hypertension, only 37% have diabetes and only 7% of the cases have CVA.

The patients with DECAF scores of 1, 2, and 3 (2.7+26+35.6 =64.3) are 64%. The cases with a DECAF score of 4 are 26.7% and the cases with a DECAF score of 5 and 6 are 8.9%. Also about mortality, it is clear that 93% are still alive and only 7% have died.

Table 2(a) gives the results of the DECAF score versus mortality. From Table 2(a), it can be seen that there is no mortality with a DECAF score of 1, 2, and 3. With a DECAF score of 4, there are 39 patients and 3 died i.e. 7.6% died whereas with a DECAF score of 5 there are 10 patients and 5 died i.e. 50% died and the number of patients died with a DECAF score of 6 is 66.7%. There are (10+3=13) patients with a DECAF score of 5 and 6; out of 13, 7 died i.e. (53.8%) died. It can be concluded that the increase in DECAF score increases mortality.

Table 2(b) gives the frequency and % cases suffering from any component of the DECAF score. In all the cases mMMRC was present. 36% had Eosinopenia, 45.89% had Consolidation, 22.60% had Acidemia and only 13.69% had Atrial Fibrillation. It is concluded that all cases had mMMRC and in most cases, Consolidation and Eosinopenia were also present.

The Roc curve: Figure 1 shows the coordinates of the ROC curve and the ROC curve of DECAF score versus mortality, respectively. The total area under the curve for the test variable DECAF score is 0.933 with p=0.00< 0.05, the 95% interval ranging from 0.875 to 0.992, indicating that it is a good fit.

The values of sensitivity and specificity are high around point 4.0(the cut point). The sensitivity is 0.85 and the specificity is about 0.89. Both sensitivity and specificity are reasonably high indicating the DECAF score is a good predictor of mortality.

Diagnostic accuracy of DECAF taking mortality as the gold standard

Table 3 shows the results of DECAF groups versus mortality as the gold standard and Tables 4 and 5 show the results of DECAF versus mortality, considering stratification with respect to age groups and duration of smoking groups respectively.

i. **DECAF groups versus mortality as the gold standard**

In Table 3, the Pearson Chi-Square= 19.46 (p-value= 000) indicates that DECAF score and mortality are associated.

Table 3 also shows that the test has 100% sensitivity, which means that all the persons with a positive result are truly positive so the test can detect all the truly positive as truly positive.

The specificity is 69.12%, meaning thereby that 94 out of 136 with negative results are truly negative so the test detects % truly negative as negative.

The positive predictive value is 19.23%, which means that that the persons who test positive, only 19.23 of them have yes (dead) in our case i.e. 10 out of 52.

The negative predictive value is 100%, which means all those that test negative do not have the mortality (alive) i.e. 94 out of 94 test negative and are alive.

Overall the diagnostic accuracy of the test is 71.23% which is 104 out of 146 are correctly classified. The diagnostic accuracy is reasonably high so the test is good.

ii. **Age groups versus DECAF groups versus mortality**

In Table 4a, the Pearson Chi-Square=.086 (p-value= .769) indicates that age groups and mortality are not associated i.e both groups are not different with respect to age.

Table 4a also shows that within the age groups of 40-60 years and 61-95 years, the sensitivity is the same and 100 %, which means for both groups sensitivity is the same and very high.

The specificity for age group 40-60 is 82.97% and for age group 61-95 is 69.11%. It is clear that it is different for both groups and the age group 40-60 has higher specificity.

The PPV for the age group 40-60 is 17.07% whereas it is 19.42% for the age group 61-95. It is almost the same for both groups.

The NPV for both groups is100% which is very high and is the same. The overall DA is 71.23% which is reasonably good. It can be concluded that both groups are not different with respect to age.

iii. **Smoking groups versus DECAF groups versus mortality**

In Table 4b, the Pearson Chi-Square= 2.183 (p-value= 0.140) indicates that the duration of smoking and mortality are not associated at 10% but are associated at 15% level are significant. The significance level may be increased because of the practical nature of the problem.

Table 4b also shows that within the two groups of smoking periods <20 years and >20 years, the sensitivity is the same and is 100%. The specificity for <20 years and >20 years is 77.27% and 65.21% respectively. It is clear that it is different for both groups and it is higher for group <20 years.

The PPV for <20 years and >20 years is 17.07% and 19.42% respectively. It is almost the same for both groups. The NPV for both groups is100% which is the same and very high.

Table 1: a) Summary statistics of variables and frequency distribution of categorical variables and b) DECAF Score and c) mortality, respectively.

1(a): Summary statistics of numerical variables

Variable	Mean± SE
Age	64.93±.937
Duration_smoking	27.84±.935
BMI	23.54±.336
DECAF_score	3.15±.086

1(b): Frequency distribution of the categorical variables

Variable	Frequency	Percentage	Cumulative%
Gender			
Female	146	100.0	100.0
Hypertension			
No	33	22.6	22.6
Yes	113	77.4	100.0
Diabetes			
No	92	63.0	63.0
Yes	54	37.0	100
CVA			
No	136	93.2	93.2
Yes	10	6.8	100.0

1(c): Frequency distribution of DECAF Score and mortality

DECAF-Score			
Score	Frequency	Percentage	Cumulative %
1.00	4	2.7	2.7
2.00	38	26.0	28.8
3.00	52	35.6	64.4
4.00	39	26.7	91.1
5.00	10	6.8	97.9
6.00	3	2.1	100.0
Total	146	100	

Mortality			
Alive	136	93.2	93.2
Dead	10	6.8	100
Total	146	100.0	

Table 2: a) DECAF score versus mortality and b) Distribution of the studied cases according to DECAF score

a) DECAF-score versus mortality.

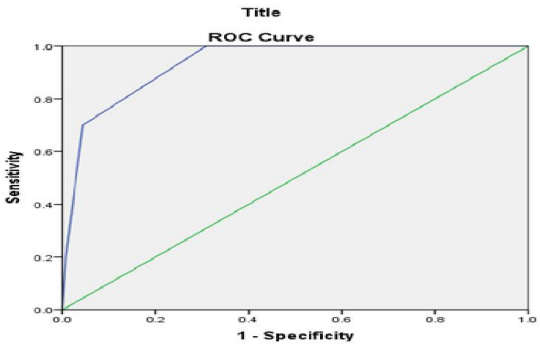
		Mortality		Total	Alive % within mortality	Died % within mortality	Alive % within DECAF	Died % within DECAF	Alive % of Total	Died % of Total
		alive	Dead							
DECAF-score	1.00	4	0	4	2.7	0.0	100	0.0	2.7	0.0
	2.00	38	0	38	26.0	0.0	100	0.0	26.0	0.0
	3.00	52	0	52	35.6	0.0	100	0.0	35.6	0.0
	4.00	36	3	39	26.7	30	92.3	7.7	24.7	2.1
	5.00	5	5	10	3.7	50.0	50.0	50.0	3.4	3.4
	6.00	1	2	3	0.7	20	33.3	66.7	0.7	1.4
Total		136	10	146	100	00	93.2	6.8	93.2	6.8

b) Distribution of the studied cases according to DECAF

DECAF Score	Frequency (%)
mMMRC	146 (100%)
Eosinopenia	53 (36.3)
Consolidation	67 (45.89)
Acidemia	33 (22.60)
Atrial Fibrillation	20 (13.69)
Median	3
Score:Min.Max.	1-6

a) The Coordinates of ROC curve

Test Result Variable(s)		
Positive if Greater than or equal to cut point	Sensitivity	1 - Specificity
.0000	1.000	1.000
1.5000	1.000	.971
2.5000	1.000	.691
3.5000	1.000	.309
4.5000	.700	.044
5.5000	.200	.007
7.0000	.000	.000



b) ROC curve of DECAF score versus Mortality.

Figure 1: a) The coordinates of the ROC curve and b) ROC curve of DECAF score versus Mortality

Table 3: DECAF groups versus mortality

			Mortality Yes (Dead)	No (Alive)	Total	Statistics
DECAF Group	≥ 4	Count	10	42	52	
		% within mortality	100.0%	30.9.0%	35.6%	Sn=100%
	< 4	Count	0	94	94	Sp=69.12
		% within mortality	%0	69.1%	64.4%	PPV=19.23
Total		Count	10	136	146	NPV=100.0
		% within mortality	100.0%	100.0%	100.0%	DA=71.23

Table 4: a) Age Groups * DECAF Score groups* mortality and b) Duration of Smoking *DECAF Score * mortality.

a) Age Groups * DECAF Score groups* mortality.

Age Groups				Mortality		Total	Statistics%
				Yes	No		
40-60	DECAF Score	≥ 4	Count	3	8	11	Sn=100
			% within mortality	100%	17%	22%	Sp=82.97
		< 4	Count	0	39	39	PPV=27.27
			% within mortality	0%	83%	78%	NPV=100
	Total		Count	3	47	50	DA=84
61-95	DECAF Score	≥ 4	Count	7	34	41	Sn=100
			% within mortality	100%	8.2%	42.7%	Sp=61.79
		< 4	Count	0	55	55	PPV=17.1
			% within mortality	0%	61.8%	57.3%	NPV=100
	Total		Count	7	89	96	DA=64.58
Total	DECAF Score	≥ 4	Count	10	42	52	Sn=100
			% within mortality	100%	30.9%	35.6%	Sp=69.12
		< 4	Count	0	94	94	PPV=19.23
			% within mortality	0%	69.1%	64.4%	NPV=100
	Total		Count	10	136	146	DA=71.23

b) Duration of Smoking *DECAF Score * mortality.

Dur-Smok Groups				mortality		Total	statistics
				yes	No		
<20 years	DECAF Score	≥ 4	Count	1	10	11	Sn=100
			% within mortality	100.0%	22.7%	24.4%	Sp=77.27
		<4	Count	0	34	34	PPV=9.10
			% within mortality	0.0%	77.3%	75.6%	NPV=100
	Total		Count	1	44	45	DA=77.77
>20 years	DECAF Score	≥ 4	Count	9	32	41	Sn=100
			% within mortality	100.0%	34.8%	40.6%	Sp=65.21
		< 4	Count	0	60	60	PPV=21.95
			% within mortality	0.0%	65.2%	59.4%	NPV=100
	Total		Count	9	92	101	DA=68.32
Total	DECAF Score	≥ 4	Count	10	42	52	Sn=100
			% within mortality	100.0%	30.9%	35.6%	Sp=69.12
		< 4	Count	0	94	94	PPV=19.23
			% within mortality	0.0%	69.1%	64.4%	NPV=100
	Total		Count	10	136	146	DA=71.23
			% within mortality	100.0%	100.0%	100.0%	

Discussion

COPD is a common preventable lung disease mainly caused by smoking.[2] It is characterized by progressive airflow limitation.[2] Its slowly progressive course is interrupted by repeated exacerbations. Acute exacerbation of COPD is a life-threatening event with high mortality among these patients' ranging from 4-30%[7] and causes a rapid decline in FEV1 as compared to stable disease.[4] Every exacerbation in COPD increases the risk of further attack.[4] Patient admitted with acute exacerbation is 25 times more likely to be readmitted with acute exacerbation after their 10th hospitalization with COPD.[4] Mortality peaks during the first week of exacerbation.[12]

DECAF is a relatively new score, with few well-designed trials showing its reliability in predicting mortality. An effort has been made to study the DECAF score and other related factors to predict mortality in acute exacerbation of COPD. In our study, the mean age±standard error (years) in the study was 64.93±0.937. The mean age of the patients was 73.1 (SD 10.0) in a study done by Steer J and Gibson J1. In

another study mean (SD) age was 73.1 (10.3) years.[13] All the cases in the study were females because Fauji Foundation hospital is a tertiary care hospital for families of retired army officers and most of the patients visiting Fauji Foundation hospital were females. This may be a source of bias in our study. In our study mean duration of smoking was 27.84±0.935. Another study conducted by Liu and Pleasants showed smoking duration ranged from 19.2% (1–9 years) to 36.2%.[14] In this study mean BMI was 23.54±0.336 which was similar to a study by Sami (23.23±4.42 Kg/m2).[15]

In this study, the DECAF score was between 1 and 6 with a mean of 3.1507±0.08603. With DECAF scores of 1, 2 and 3 mortality was zero. With the DECAF score of 4, 5, and 6, mortality was 8%, 50%, and 66.7% respectively. The DECAF score split into two groups (<4 and >=4) showed that no patient died in the group with (DECAF score <4) and 19.23% died with the (DECAF score >=4) In a study conducted in 2016, it is found that 1 score has a mortality of 1.5%, a score of 2 has 5.4%, a score of 3 has 15.3%, a score of 4 has 31%, a score of 5 has 40.5% and a score of 6 has 50% in-hospital mortality.[4] Our results are similar to the study when the DECAF score is high (5,6) and are different at lower values of the DECAF score. The results of another study conducted in 2012 agreed with our results for higher values of DECAF score but different for lower values, particularly at 4.[16]

John steer shows that a DECAF score of 0-1 had a mortality of 41.4%, a DECAF score of 2 showed a mortality of 48.4% and a DECAF score of 3-6 showed a mortality of 34.6%.[2] In a study by Echevarria the median DECAF score was 2 with 28.3% having radiographic consolidation and 18.9% having acidaemia.[4] Another study included 257 patients who showed respiratory failure in 27.9% with respiratory acidosis (pH <7.35 and paCO2 >6kPa) during a hospital stay.[1]

There were a few limitations in this study. The patients included in our study were exclusively females as Fauji Foundation hospital is meant for families of x-serviceman. We have checked mortality only within 7 days of hospital admission. All the hospital-based parameters have to be included in the study which cannot help to warn the patients at home to seek urgent medical help.

The study has many future implications for further research. A comparison of both male and female patients needs to be performed in future studies. Further research is required to quantify the impact of the DECAF score on clinical practice, for example, in the identification of patients for early discharge. A study can be performed to assess the mortality of patients beyond 7 days and up to 30 days after an exacerbation.

Conclusion

DECAF score is a useful predictor of mortality in patients admitted with acute exacerbation of COPD. Patients admitted in-hospital with a high DECAF score of more than 3 (≥4) should be managed in the intensive care unit due to the possible need for ventilation and the risk of respiratory failure.

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