



Comparison of Scoring Systems for Mortality Prediction in Acute Exacerbation of Chronic Obstructive Pulmonary Disease

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ABSTRACT

Acute exacerbation of chronic obstructive pulmonary disease (AECOPD) is a frequent cause of emergency admission. A scoring system is invaluable in predicting mortality and guiding therapeutic interventions.

Aims: *Comparison of DECAF, BAP-65, CURB-65, CAPS, APACHE II risk scores in predicting in hospital mortality in AECOPD.*

Methods: *150 patients of AECOPD, admitted during ten month period were scored at admission using all 5 scores and their ability to predict in-hospital mortality was analysed. The cut off value of scores that best predicted mortality was identified. Individual parameters that correlated best with mortality were also documented.*

Results: *DECAF score ≥ 2 , with an AUROC of 0.729, correlated best with mortality. APACHE 2 score ≥ 18 could predict in hospital mortality with an AUROC of 0.700, CURB-65 ≥ 2 predicted mortality with an AUROC of 0.709. Parameters that were most closely associated with mortality were Altered Mentation, Respiratory rate $> 30/\text{min}$, Hyponatremia ($S.Na^+ < 130\text{mEq/L}$, Hypoalbuminemia ($< 3.5\text{g/dL}$).*

Conclusion: *DECAF score (≥ 2) best correlates with in hospital mortality. Individual parameters of Altered Mentation ($GCS < 15$), Respiratory rate $> 30/\text{min}$, Baseline dyspnoea of eMRC 5b, Elevated WBC count (> 40000), Hyponatremia ($S.Na^+ < 130\text{mEq/L}$, Hypoalbuminemia ($< 3.5\text{g/dL}$) correlates best with mortality.*

Keywords: *acute exacerbation, COPD, DECAF, CAPS, APACHE II, CURB 65, BAP.*

INTRODUCTION

Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) is defined as "An acute worsening of respiratory symptoms that result in additional therapy"¹. Patients in exacerbation face the immediate risks of respiratory failure and death and in the long-term it results in impaired lung function, poor prognosis and increased risk of mortality. Most

patients with AECOPD visiting Emergencies have severe exacerbation and need hospitalization, may require Intensive care and mechanical ventilation if respiratory failure is present. In such situations, assessing the severity of Exacerbation is mandatory to guide decisions regarding degree of care (home, hospital ward or intensive care unit) as well as intensity of, treatment, initiation of mechanical ventilation and follow-up.²

A large number of scores have been developed for AECOPD like DECAF³, modified DECAF, CAPS⁴. Scores like CURB-65⁵ which was originally developed for pneumonia has also been used in AECOPD, and general ICU scoring systems like APACHEII⁶ has been used to predict mortality. Many studies comparing these systems have also been done on various populations with different results^{2,7,8}.

In order to recommend a score for use in the Emergency room, a comparison of the performance of these scores in the present setting had to be done. We selected five scoring systems-DECAF, CAPS, BAP, CURB-65, APACHE II which were based on routinely measured parameters, and compared their performance in predicting in hospital mortality.

AIM

To compare performance of five risk scores (DECAF, BAP, CURB-65, COPD and Asthma Physiology Score (CAPS), Acute Physiology and Chronic Health Evaluation II (APACHE II)) in AECOPD and to find the score that best predicts in hospital mortality.

MATERIALS AND METHODS

A hospital based prospective study was conducted in The Department of Respiratory medicine for ten month period.

Study population was a consecutive sample of 150 patients admitted with AECOPD during the study period.

Inclusion criteria- Previously diagnosed COPD, Age >40, Admitted with primary diagnosis of AECOPD

Exclusion criteria- Other primary cause of present admission, Myocardial Infarction(MI), Chronic Kidney Disease(CKD), Acute Kidney Injury(AKI) & Malignancy, unwilling to participate, Left/ Referred without completing treatment Informed consent taken. Detailed history including age, sex, smoking, and assessment of stable state dyspnea grade over the preceding 3 months based on the extended Medical Research

Council Dyspnea Score (eMRCD), clinical examination including assessment of mental state conscious level and signs of severity of exacerbation (cyanosis, use of accessory inspiratory muscles, paradoxical abdominal movement, asterixis, neurological impairment, lower limb edema), chest radiological examination, ECG, arterial blood gases analysis, measurement of blood urea nitrogen (BUN), complete blood count (CBC). Severity scores for AECOPD were calculated for each patient and the individual parameters used in calculating the scores were also recorded.

DECAF has 5 variables (Baseline dyspnoea eMRCD 5a or 5b, Eosinopenia ($< 0.05 \times 10^3/\mu\text{L}$), Consolidation, Acidemia (PH<7.3), Atrial Fibrillation), a maximum score of 6. BAP score uses 4 variables (Elevated BUN, Altered Mental Status, Pulse Rate>109/min, Age>65) maximum score of 4; CURB65 uses 5 variables Confusion, Blood Urea>45mg/dL, Respiratory Rate>=30, SBP<90 or DBP<60, Age>65) and is scored out of 5. CAPS uses 7 variables scored differentially according to their value (Heart Rate, Mean Arterial Pressure, PH, Sodium, Urea, Creatinine, Albumin, WBC count) maximum score of 100. APACHE II is scored out of a maximum of 71 based on 12 physiologic variables, age, and chronic health.

Patients were admitted and managed according to their condition and current hospital protocols, prognosis was recorded, as either recovery and discharge or death.

STATISTICAL ANALYSIS

Data was analysed with Spss v24. Receiver operator curves(ROC) analysis performed. Area under ROC(AUROC) indicates the accuracy of a diagnostic score. AUROC of >0.7 indicates fair accuracy. The scoring system with the largest AUROC was selected. A cut off score with highest sensitivity and specificity selected.

Relationship between 17 individual parameters (which were used to derive the scores) and mortality analysed with chi square test.

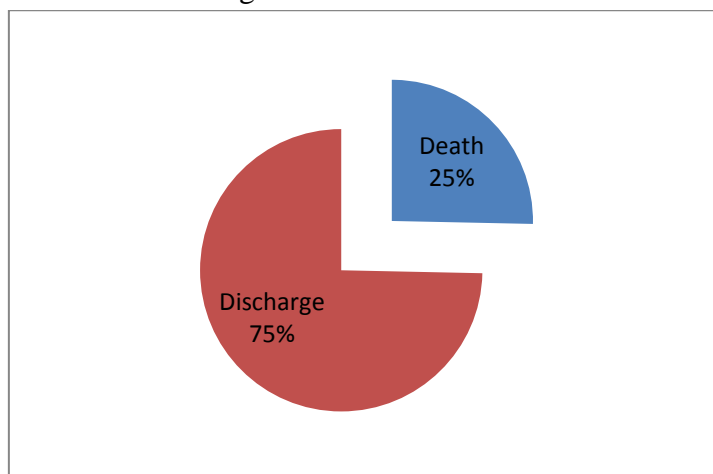
Parameters which were associated with mortality at a significance level of 0.01 identified.

RESULTS

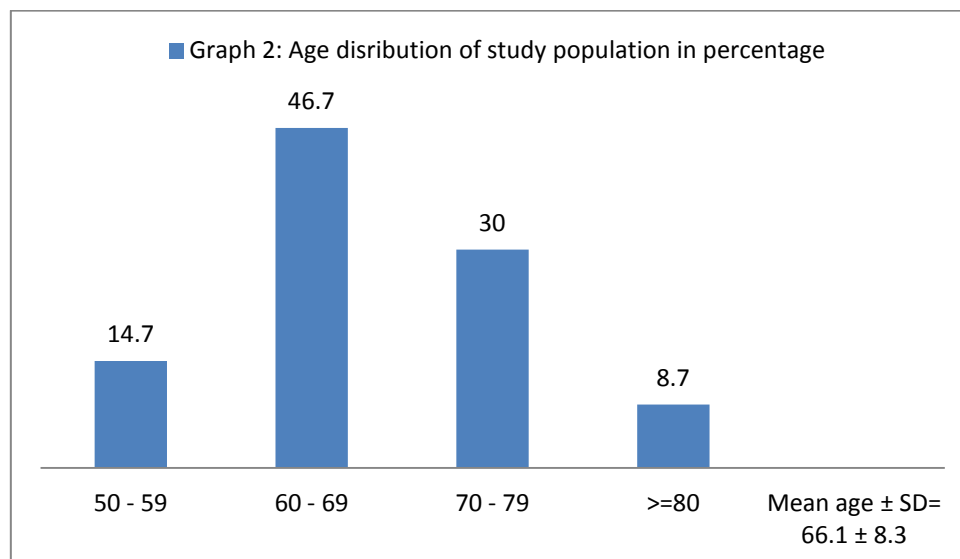
The study population consisted of 150 consecutive patients. 128 (85.3%) were males and 22 (14.7%) females. 130 out of 150 were current or ex smokers, which included 125 out of the 128 males and 5 out of the 22 females. Average age of study group was 66.1 (SD8.3).

95 patients required admission to a critical care unit, 62 patients had acidemia with an average PH

of 7.18 (SD=0.12). 41 of these patients needed invasive mechanical ventilation and they remained on ventilator for an average of 4.71 days (SD=2.8). Average hospital stay was 4.8 days (SD=1.88) for those admitted in ward, 6.4 days (SD=2.5) for those admitted to ICU. 38 of the 150 patients died in hospital, resulting in a 25% mortality, 6 of these patients were initially admitted to ward.



Graph 1: Mortality in study population



Graph 2: Age distribution of study population

Various individual parameters and their correlation with in hospital mortality was analysed with χ^2 test. The parameters that were found to be significant at 0.01 level were Altered Mentation (GCS<15), Respiratory rate>30/min, Baseline

dyspnoea of eMRCd 5b, Elevated WBC count (>40000), Hyponatremia (S.Na+ <130mEq/L, Hypoalbuminemia(<3.5g/dL) at the time of admission.

Table 1: Comparison of various parameters based on outcome

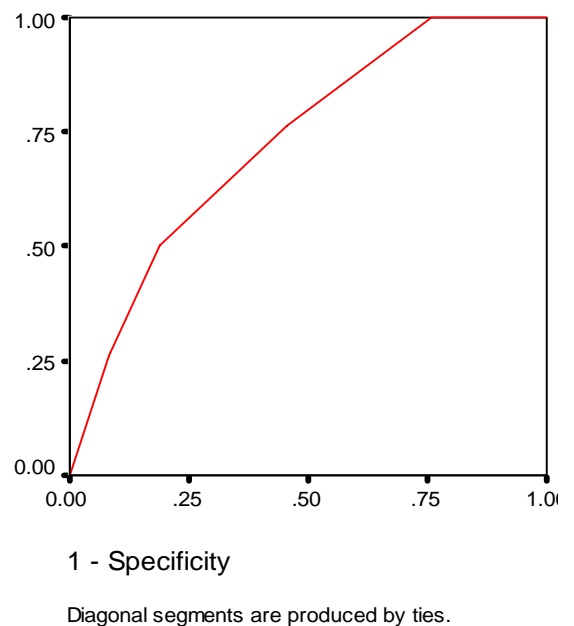
	Parameters	Outcome						χ^2	P
		Death		Discharge					
		Count	Percent	Count	Percent				
1	Eosinopenia (< 0.05*10 ³ /μL)	23	33.8	45	66.2	4.74*	0.029		
2	Consolidation	12	32.4	25	67.6	1.31	0.253		
3	Acidemia (PH<7.3)	20	32.3	42	67.7	2.68	0.102		
4	Atrial Fibrillation	0	0.0	9	100.0	3.25	0.071		
5	Exacerbations(>2/yr)	25	24.0	79	76.0	0.3	0.584		
6	Elevated BUN	18	33.3	36	66.7	2.85	0.091		
7	Altered Mentation	17	44.7	21	55.3	10.13**	0.001		
8	Tachycardia (>109/min)	22	34.4	42	65.6	4.82*	0.028		
9	AGE>65	25	26.6	69	73.4	0.21	0.645		
10	RR>30/min	29	49.2	30	50.8	29.17**	0.000		
11	Hypotension (BP<90/60mm)	3	50.0	3	50.0	2.01	0.156		
12	Hyponatremia (<130 mEq/L)	38	33.3	76	66.7	16.07**	0.000		
13	Hypoalbuminemia(<3,5g/dL)	16	50.0	16	50.0	13.08**	0.000		
14	WBC count	<14000	17	19.5	70	80.5	20.34**	0.000	
		(14000 - 19999)	3	11.1	24	88.9			
		(20000 - 39999)	15	45.5	18	54.5			
		(>40000)	3	100.0	0	0.0			
15	Baseline Dyspnoea	Nil	13	14.6	76	85.4	31.64**	0.000	
		eMRCDD Grade	5a	9	23.1	30			76.9
			5b	6	72.7	6			27.3
		Mean	SD	N	Mean	SD	N	χ^2	p
16	Mean arterial pressure (mm of Hg)	91.1	14.4	38	94.7	14.6	112	1.33	0.187
17	Urea (mg/dL)	43.9	25.8	38	33.7	22.5	112	2.32*	0.022
18	Creatinine(mg/dL)	2.0	1.5	38	1.3	0.9	112	3.26**	0.001

** significant with p<0.001

Predictive power of different scoring systems for in hospital mortality

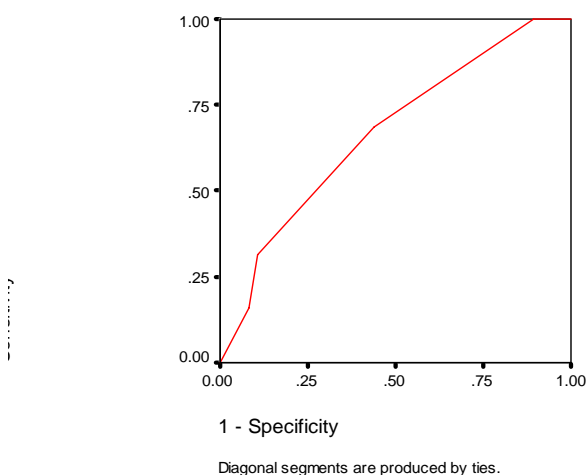
Area under (ROC) curve is a summary measure of the accuracy of a quantitative diagnostic test. Two or more diagnostic tests can be compared by the difference in AUC. An AUROC of >0.70 indicates a fairly accurate test. The largest area under ROC was 0.729 for DECAF, followed by CURB-65 with 0.709 and APACHE 2 which had 0.700. CAPS score had an AUROC of 0.680 and BAP score had 0.668, which indicated they had poor accuracy in this setting. Comparing the AUROC of DECAF with CURB-65 & APACHE-2, the differences were not statistically significant.

Graph 3: ROC curve for DECAF



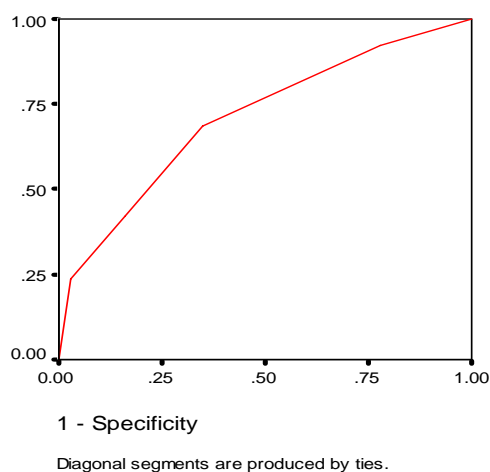
Area Under the curve = 0.729

Graph 4: ROC curve for BAP



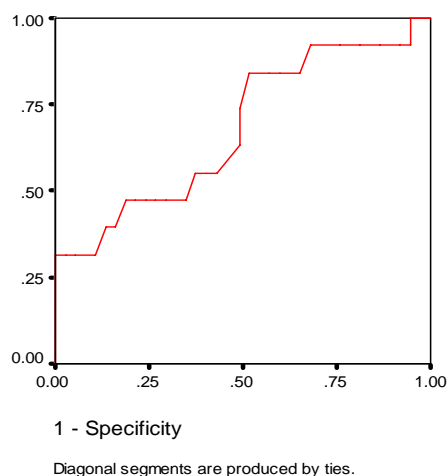
Area Under the curve = 0.668

Graph 5: ROC curve for CURB65



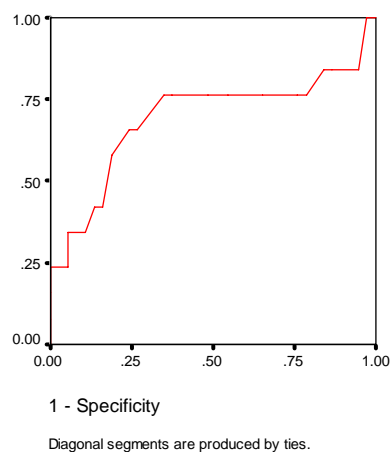
Area Under the curve = 0.709

Graph 6: ROC curve for prediction of CAPS



Area Under the curve = 0.680

Graph 7: ROC curve for prediction of APACHE II



Area Under the curve = 0.700

Graph 8: Difference In Area Under ROC

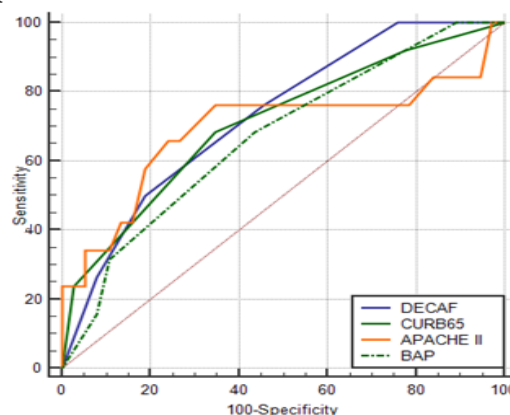


Table 2: AUROC Of Scoring Systems

Variable	AUC	SE ^a	95% CI ^b
DECAF	0.729	0.0431	0.651 to 0.799
BAP	0.668	0.0469	0.587 to 0.743
CURB65	0.709	0.0489	0.630 to 0.780
CAPS	0.680	0.0531	0.599 to 0.754
APACHE-II	0.700	0.0601	0.612 to 0.765

^a DeLong et al., 1988

^b Binomial exact

Table 3: Comparison of AUROC

SCORE	CUT OFF	AUROC	VS DECAF P=
DECAF	>=2	<u>0.729</u>	
CURB-65	>=2	0.709	0.74
APACHE 2	>=18	0.700	0.63
CAPS	>=31	0.680	0.46
BAP	>=3	0.668	0.28

DECAF SCORE

A decision threshold of DECAF score >2 was found to have a sensitivity of 50% and specificity of 81%, Accuracy of 73.3%

Table 4: Sensitivity and specificity for different points of decaf

Positive if Greater Than or Equal To	Sensitivity	Specificity
-1.00	1.00	0.00
0.50	1.00	0.24
1.50	0.76	0.54
2.50	0.50	0.81
3.50	0.26	0.92
5.00	0.00	1.00

Table 5: Statistical parameters of DECAF

Sensitivity	50.0
Specificity	81.3
False Negative	50.0
False positive	18.8
Positive Predictive value	47.5
Negative Predictive value	82.7
Positive Likelihood ratio	2.7
Negative Likelihood ratio	0.6
Accuracy	73.3

DISCUSSION

Despite improvements in care, death during hospitalization for AECOPD is a challenging issue⁷. AECOPD being both common and often fatal, accurate prognostication of patients hospitalized with an exacerbation is important and difficult³.

In our study population of 150 cases of AECOPD, 38 (25%) patients had a fatal outcome. This mortality rate matches with published figures; as it was published that in-hospital mortality of 4–30% has been reported in patients with AECOPD requiring hospitalization^[3,7,10.]

Our study showed statistically significant relation of mortality with eosinopenia, changes in mentation, tachypnea, hyponatremia and hypoalbuminemia. There is also a statistically significant relation between higher grades of baseline dyspnea, higher Serum creatinine and mortality. Using DECAF 40 patients had score more than 2 and 110 had scores less than or equal to 2. Out of 40 i.e., score >2, 19(47.5 %) died. In patients with less scores only 17% died. Using BAP score

there were 75 patients each with scores less than or equal to 1 and more than 1. In group with higher score there is higher mortality(34.66%) compared to scores with low value(16%) Using CURB -65 Score there are total 65 patients with scores more than 1. In that 40% died. In the less score group only 14.11% died.

Nafae et al.⁷ carried out a study on 200 AECOPD patients, they illustrated that the DECAF score showed an excellent discrimination for in-hospital mortality (AUROC =0.83). Furthermore, the DECAF Score performed significantly better in the prediction of in-hospital mortality than the Acute Physiology and Chronic Health Evaluation (APACHE) II prognostic index (AUROC = 0.68, DECAF vs. APACHE II, p =0.03) and the COPD and Asthma Physiology Score (CAPS) (AUROC = 0.65, p =0.01); which have been proposed as useful predictive systems in AECOPD. They also found that the DECAF score was a significantly stronger predictor of in-hospital mortality than CURB-65 for a subgroup of patients with radiological consolidation (AUROC = 0.87 vs. 0.65, p= 0.02). Comparing the AUROC of DECAF with CURB-65 & APACHE-2 in our study, the differences were not statistically significant. The largest area under ROC was 0.729 for DECAF, followed by CURB-65 with 0.709 and APACHE 2 which had 0.700. CAPS score had an AUROC of 0.680 and BAP score had 0.668, which indicated they had poor accuracy in this setting. CURB 65 system which was initially developed for risk stratification in CAP, was compared with DECAF in this study and was found to be inferior to DECAF in prediction of in-hospital mortality for both patients with (AUROC 0.77 vs. 0.66, p=0.003, n=299) and without (AUROC =0.87 vs. 0.72, p=0.002, n=621) consolidation. In the current study AUROC for DECAF with consolidation=0.620, CURB with consolidation=0.740 (p=0.5). AUROC for DECAF without consolidation =0.752, CURB=0.693 (p=0.234). Although AUROC for CURB with consolidation is higher than DECAF, the difference is not statistically significant.

Zidan et al.¹¹ tried to replace the atrial fibrillation item in the DECAF score (which has no significant value ($p=0.618$)) to mortality by the frequency of admission (which has a significant relation to the mortality ($p<0.001$)), and they called the new score Modified DECAF score (dyspnea, eosinopenia, consolidation, respiratory acidosis and frequency of admission). There were significant values ($p<0.001$) between the modified DECAF score and mortality due to AECOPD. They concluded that the Modified DECAF score is more sensitive and more specific in predicting in-hospital mortality in acute exacerbation of COPD than the DECAF score with no significant difference between the two scores.¹¹

The BAP-65 score developed by Shorr et al.¹² depends on age, altered mental status, pulse and one laboratory marker which is the BUN. They found that it had AUROC =0.77 and it correlated well with multiple clinical outcomes ranging from in-hospital mortality and need for mechanical ventilation to length of stay and cost. They claimed that the BAP-65 score also identified subjects unlikely to need mechanical ventilation.¹² In our study BAP score had an AUROC of 0.682, or poor accuracy.

The APACHE II is a severity of disease classification system, which uses 12 routine physiological variables and its increasing values from 0 to 71 signifies increasing risk of mortality¹³. Different studies showed varying AUROC for APACHE II in AECOPD. The CAPS derivation study by Wildman et al, showed AUROC of 0.663¹⁴, The DECAF derivation study by Steer, Gibson et al showed an AUROC of 0.73³, our study showed an AUROC of 0.700, which was not significantly different from DECAF.

The CAPS score developed by Wildman et al in 2006 using eight variables, was found to have an AUROC of 0.718 in the derivation study; validation study showed similar results and discrimination was also found to be better than APACHE II. In the current study CAPS score had an AUROC of 0.680, which implied poor

accuracy and was behind DECAF, CURB 65 and APACHE II.

The DECAF score was derived by Steer, Gibon et al in 2012 from a study population of 960, it underwent internal bootstrap validation and was found to have an AUROC of 0.86 (95% CI 0.82 to 0.89) in the prediction of in-hospital mortality. In the current study it had an AUROC of 0.729 and was the highest among all scores tested. At a decision threshold of DECAF score >2 it could predict mortality with a sensitivity of 50% and specificity of 81%.

CONCLUSION

It is recommended to use a scoring system for AECOPD in assessing mortality in the emergency setting and for guiding further treatment decisions. According to current study DECAF score (≥ 2) best correlates with in hospital mortality. Individual parameters that correlated best with mortality are Altered Mentation (GCS <15), Respiratory rate >30 /min, Baseline dyspnoea of eMRC 5b, Elevated WBC count (>40000), Hyponatremia (S.Na $^+$ <130 mEq/L, Hypoalbuminemia (<3.5 g/dL) at the time of admission. Other general scoring systems like CURB 65 and APACHE II can also predict mortality in AECOPD with an accuracy which is lesser than DECAF but without a statistically significant difference.

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LIMITATIONS: Single centre study.

ETHICAL APPROVAL

The study was approved by the Institutional Ethical Committee.

Source of Support: Nil

Conflict of Interest: None Declared.

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