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ORIGINAL RESEARCH ARTICLE

Application of DECAF and BAP-65 to Predict the In-Hospital Mortality of Acute Exacerbation of COPD in SRMSIMS

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ABSTRACT

Introduction: Hospitalisation due to acute exacerbations of COPD (AECOPD) is common, and subsequent mortality high. The dyspnoea, eosinopenia, consolidation, acidemia and atrial fibrillation (DECAF) and BAP 65 score was derived for accurate prediction of mortality and risk stratification to inform patient care. We aimed to validate these scores and to compare them in predicting hospital mortality in AECOPD.

Material and Methods: 106 patients of AECOPD, admitted during 6 months period were scored at admission using all two scores and their ability to predict in-hospital mortality were analyzed.

Results: On receiver-operator characteristic curve analysis, the area under the curve for prediction of in-hospital mortality was 0.791 and 0.885, respectively, for DECAF and BAP-65 scores. Thus, among the two scoring systems, BAP-65 had a maximum area under curve while DECAF had a minimum area under the curve. Sensitivity and specificity values for prediction of in-hospital mortality were 83.3 and 54.3% for DECAF and 83.3 and 84.0% for BAP-65. Thus, BAP-65 was the better predictor with adequate sensitivity and specificity for the in-hospital mortality.

Conclusion: BAP-65 was most effective in the prediction of in-hospital mortality.

Keywords: BAP 65, COPD, DECAF.

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INTRODUCTION

COPD is the fourth leading cause of death in the world (WHO, 2000).[1] The natural history of COPD is punctuated by exacerbations, which have major implications on the patient and healthcare system.[2] According to the 2019 GOLD Report,[3] exacerbations can be termed as-acute worsening of respiratory symptoms requiring additional treatment. Exacerbations are indicators of COPD severity. Infection of the tracheobronchial tree and air pollution (e.g., tobacco smoke, occupational exposures, ozone) are the most common identifiable causes of COPD exacerbations. One-third of exacerbations have no identifiable cause.[4] Exacerbations seem to affect pulmonary functions, particularly forced expiratory volume in one second (FEV1). Exacerbations have been reported to be more frequent in those with regular sputum production, and regular sputum production was reported to be associated with an accelerated decline in FEV1[5] and with death.[6] Exacerbations are a major cause of hospitalization and mortality among COPD patients. The multivariate analysis showed that moderate-to-severe AECOPD, age older than 75 years, severe COPD, abnormal blood gas values, and complications during hospital stay were independently related to mortality.[7] Autopsy results suggest that common contributing causes of early death in patients hospitalized with severe COPD exacerbation are concomitant complications including cardiac failure, pneumonia, and tropical pulmonary eosinophilia. Respiratory failure due to a progression of COPD was less common than these.[8] Mortality rates one year after hospital discharge for patients requiring mechanical ventilation for respiratory failure have been reported to be as high as 59%, and the risk factors include hypercapnia, hypoxemia, low BMI, older age, cardiac diseases, comorbidities, severity of illness, low serum albumin level, long-term use of oral corticosteroids, and functional status.[9]

In the past few decades, some specific scoring systems specifically developed for AECOPD patients have been developed. BAP-65 was developed by Tabak *et al.* (2009).[10] This score utilizes four variables - blood urea nitrogen, acute mental status changes, pulse rate, and age as the predictors. For each variable, 1-point is awarded, and the total score could reach a maximum of 4. The authors have found the associated mortality risk for different scores as 0.5, 1.4, 3.7, 12.7 and 26.2% respectively for scores 0, 1, 2, 3 and 4. DECAF is a relatively newer scoring system that was proposed by Steer *et al.* (2012)[11] came up with a simple scoring system based on the DECAF score. For all the variables, except for dyspnoea, 1-point each is awarded. For dyspnoea, the score can range from 0 to 2,

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depending on the MRC score for dyspnoea. The scores were categorized to describe the risk of mortality. Scores in range 0 to 3 have been categorized to have low risk, 3 to 4 have intermediate risk and 5 to 6 have high risk.

A few studies to date have evaluated existing severity scores derived for alternative use such as CURB-65[11,12] or attempted to derive new scores such as BAP-65,[10,13] but the predictive value of these scores is modest. There is a need to identify robust predictors of mortality for use in clinical practice. Recently, Steer *et al.*[11] came up with a simple scoring system based on the DECAF score to for prediction of exacerbations of chronic obstructive pulmonary disease. They showed it has a high predictive value and claimed it to be better than other scoring systems such as APACHE II, BAP-65, and CURB-65, especially for the prediction of mortality. Although some recent studies have also found it to be a robust predictor of mortality,[14-16] however, as such, there is still doubt regarding the existence of a golden score as another recent study has found BAP-65 score to be better than DECAF score for prediction of in-hospital mortality.[17-18]

The present study was done to evaluate the use of the BAP-6 and DECAF scoring systems to assess the severity of the acute exacerbation of COPD and to compare these scoring systems in predicting the in-hospital mortality rate and 30-day mortality rate.

MATERIAL AND METHODS

Study Design

Prospective observational study.

The study was conducted in the Department of Respiratory Medicine, SRMS IMS, Bareilly. The subjects of the study group were from among the patients attending the outpatients' department and those admitted. For our study, the patients selected were diagnosed as a case of AECOPD on clinical and radiological grounds.

Patients with clinical and radiological evidence of AECOPD were studied on various grounds to assess the severity and mortality of AECOPD. A total of 106 patients were enrolled in this study.

Study Period

The study was conducted by over a period of one and a half year, i.e., 1st November 2015 to 30th April 2017.

Inclusion Criteria

- Age > 40 years.
- Presentation to the hospital from the community with a primary diagnosis of COPD on the clinical and radiological ground.
- Symptom(s) of exacerbation (increasing breathlessness) in a patient with known (confirmed by spirometry) COPD.
- Symptom(s) of exacerbation (e.g., increasing breathlessness) in a patient aged > 40 years with a history of cigarette smoking in which the diagnosis of COPD can be confirmed by spirometry during or after the hospitalizations.

Exclusion Criteria

- Age < 40 years.
- Hospitalization primarily for a reason other than COPD, e.g., pulmonary embolism, congestive cardiac failure, acute myocardial infraction.
- Airways disease primarily due to a cause other than COPD (severe asthma, bronchiectasis, allergic broncho-pulmonary aspergillosis).
- Interstitial lung disease.

RESULTS

The majority of the patients included in the study were aged ≥ 65 years (51.9%), followed by 55 to 64 years (31.1%); only 17.0% of patients were aged 40 to 54 years. Out of 106 patients, 75 (70.8%) patients were male, and the rest 29.2%) were females. Out of 106 patients, 83 (78.3%) had a habit of smoking, and 23 (22.7%) patients were non-smokers. All the patients were suffering from cough with expectoration. Breathlessness was observed in all the 106 patients. Breathlessness was observed among 50 (47.2%) patients even at rest, among 19 (17.9%) on exertion and 37 (34.9%) patients during daily activity. Chest pain was reported by only 39.6% of patients. Weight loss was observed in only 4 (3.8%) patients. Fever was observed in 60 (56.6%) of patients (Table 1).

The DECAF score ranged between 1 to 5 (median 2.50), and the mean DECAF score was 2.55 ± 1.30. BAP65 score ranged between 0 to 4 (median 2.00) and mean BAP65 score was 1.99 ± 0.85 (Table 2).

Based on the direction of assessment, DECAF and BAP65 score was evaluated for prediction of mortality among cases of COPD with acute exacerbation at a cut-off with a higher value indicating a positive result. The area under the curve was 0.791 and 0.885 (indicating a projected accuracy of 79.1 and 88.5%) for DECAF and BAP65, respectively. Cut-off DECAF scores under high sensitivity, high specificity and balanced considerations were > 1.50 (i.e., 2 or above), > 4.50 (i.e., 5 or above) and > 2.50 (i.e., 3 or above) having projected sensitivity and specificity of 91.7 and 67%, 58.3 and 98.9%, and 83.3 and 54.3%, respectively (Table 3).

Cut-off BAP scores under high sensitivity, high specificity and balanced considerations were >1.50 (*i.e.* 2 or above), > 3.50 (*i.e.,* 4 or above) and > 2.50 95 (*i.e.,* 3 or above) having projected sensitivity and specificity of

Table 1: Demographic profile of study population (n = 106)

	No. of patients	*Percentage*
Age		
40-54 years	18	17.0
55-64 years	33	31.1
≥65 years	55	51.9
Sex		
Male	75	70.8
Female	31	29.2
Chief complaints		
Cough with expectoration	106	100
<1 years	24	22.6
1–5 years	33	31.1
>5 years	49	46.2
Breathlessness	106	100
On exertion	19	17.9
On daily activity	37	34.9
At rest	50	47.2
Chest pain	42	39.6
Fever	60	56.6
Weight loss	4	3.8
Personal habits and biomass fuel exposure		
Smoking	83	78.3
<10	34	32.1
10–20	45	42.5
>20	4	3.8
Tobacco	13	12.3
Alcohol	40	37.7
Biomass fuel exposure	*29*	*27.4*
<10 years	0	0.0
10-20 years	7	6.6
>20 years	22	20.8

100% and 30.9%, 33.3% and 98.9%, and 83.3% and 84.0% respectively (Table 4).

Mean DECAF score was maximum in severe exacerbation (3.50 + 0.97) followed by mild (1.78 + 0.83) and moderate (1.76 + 0.99), respectively. On evaluating the data statistically, the difference among different stages was found to be significant ($p < 0.001$) with severe exacerbation having significantly higher DECAF scores as compared to mild and moderate exacerbation (Table 5).

Mean BAP-65 score was maximum in Severe exacerbation (2.38 + 0.84) followed by moderate exacerbation (1.69 + 0.74) and mild exacerbation (1.56+0.74), respectively. On evaluating the data statistically, the difference among different severity of exacerbation was found to be significant ($p < 0.001$) with Severe exacerbation having significantly higher BAP-65 scores as compared to mild and moderate (Table 5).

DISCUSSION

Acute exacerbations are concerning complications of COPD which often result in poor outcome. Chronic obstructive pulmonary disease affects the pulmonary functions of the patients which are affected adversely in the event of acute exacerbations, however, a reassessment of these pulmonary functions is not possible among the patients owing to their critical health status and hence there is search for promising markers to study the health status of patients in order to formulate appropriate treatment strategies and to predict the outcome. Prognostic research in exacerbations requiring hospitalization has been limited, and there appears to be

Table 2: Distribution of cases according to GOLD severity of COPD exacerbation

S.N.	*Severity*	*No. of patients*	*Percentage*
1.	Mild	9	8.5
2.	Moderate	49	46.2
3.	Severe	48	45.3

Scoring system	*No. of patients*	*Min.*	*Max.*	*Median*	*Mean*	*S.D.*
DECAF	106	1	5	2.50	2.55	1.30
BAP65	106	0	4	2.00	1.99	0.85

Table 3: Association of scores with In- hospital outcome and outcome after 30 days of discharge (Mann Whitney U test)

		In hospital mortality	*In hospital survival*	*Mortality after 30 days of discharge*	*Survival after 30 days of discharge*
DECAF	N	12	94	8	86
	Md (Range)	4.00 (1-5)	2.00 (1-5)	3.50 (2-4)	2.00 (1-5)
	Mn	3.83	2.38	3.38	2.29
	SD	1.34	1.20	0.74	1.20
		Z = 3.369; p = 0.001		Z = 2.470; p = 0.014	
BAP65	N	12	94	8	86
	Md (Range)	3.00 (2-4)	2.00 (0-5)	2.00 (2-3)	2.00 (0-4)
	Mn	3.17	1.84	2.13	1.81
	SD	0.72	0.74	0.35	0.76
		Z = 4.670; p < 0.001		Z = 1.315; p = 0.189	

Table 4: Cut-off values for prediction of in-hospital mortality in AECOPD cases under different considerations

Scoring system and cut-off consideration	*Cut-off value*	*Projected sensitivity*	*Projected specificity*
DECAF			
High sensitive but low specific	>1.50	91.7%	67.0%
High specific but low sensitive	>4.50	58.3	98.9%
Balanced sensitive and Specific	>2.50	83.3%	54.3%
BAP-65			
High sensitive but low specific	>1.50	100.0%	30.9%
High specific but low sensitive	>3.50	33.3%	98.9%
Balanced sensitive and Specific	>2.50	83.3%	84.0%

little common ground between predictors of mortality in stable disease and during AECOPD[19] In the recent years scoring systems like DECAF and BAP-65 have been widely proposed and validated in different settings with differential utilities for different scoring systems. Keeping in view the need for a predictive scoring system that can help in management and prediction of outcome among hospitalized patients of AECOPD, the present study was carried out with two scoring systems – DECAF and BAP-65 under consideration. The primary outcome was in-hospital mortality while 30-day after discharge mortality was considered the secondary outcome.

In present study, majority of patients were >65 years of age (51.9%) were predominantly males (70.8%). Compared to this Zidan *et al.*[20] reported the mean age of their patients as 46.46 years, thus giving a relatively younger age profile. The age profile of patients in present study was similar to that reported by Yousif *et al.* and Thambi *et al*.[21,22] Predominance of males has also been reported in other studies too.[21,22] One of the reasons for higher prevalence of males in traditional societies like India could be the fact that smoking is one of the most common risk factors for COPD which is considered to be a habit mostly acquired by males. This assumption of ours was substantiated with the finding as habit of smoking was revealed by 78.3% of patients, thus covering almost all the males. In India, smoking and biomass fuel exposure continue to be the major COPD etiologies for females who otherwise do not smoke. In present study, out of 31 women enrolled, 29 had history of biomass fuel exposure, thus highlighting this classical relationship of gender-specific COPD etiologies.

In present study, cough with expectoration and breathlessness were the universal presenting complaints in accordance with the AECOPD patients' profile who generally get admitted to hospital owing to uncontrolled cough, expectoration and breathlessness. Apart from this a total of 60 (56.6%) patients had fever too. The presence of fever in majority of patients could be indicative of a probable infectious etiology or acute systemic inflammatory response among these patients.

In present study, according to GOLD severity, moderate and severe exacerbation patients dominated with 91.5% of total patient population. There were 9 (8.5%) patients with mild exacerbation. In present study, in-hospital mortality rate was 11.3%. The in-hospital mortality rate has been shown to vary substantially ranging from less than 10% to 60% depending on the severity level of the population studied.[23] Compared to present study a relatively lower in-hospital mortality rate was reported by Son *et al.*[24] who reported an in-hospital mortality rate of 4.2% only. However, Zidan *et al.*[20] in their study reported mortality rate similar to our study (11%). In contrast Yousif *et al.*[21] reported mortality rate of 7.58% which is lesser than that reported in present study while Nafae *et al.*[14] reported it as 12.5% which is slightly higher than the present study. Thambi *et al.* reported a much higher mortality rate (25%) in their study.[22] A much lesser mortality rate has been reported in the study of Tabak *et al.*[10] who reported mortality rate of 1.8 and 1.9% in their derivation and validation cohorts. The differences in mortality patterns in different setups might be owing to difference in infrastructure facilities at different settings. While developing countries generally have a high mortality rate,[17,18,21,24] however, it is generally under control in developed countries having better infrastructure for diagnosis, treatment, and management of AECOPD patients.

In present study, both in-hospital as well as 30-day after discharge mortality showed a significant association with COPD stage. This finding is in agreement with the observations of Flattet *et al.*[17] who also found that COPD stage is significantly associated with higher risk of

Table 5: Association between GOLD severity of COPD exacerbation and different scoring systems

	DECAF		*BAP-65*	
COPD Severity	*Mean*	*SD*	*Mean*	*SD*
1. Mild (n = 9)	1.78	0.83	1.56	0.53
2. Moderate (n = 49)	1.76	0.99	1.69	0.74
3. Severe (n = 48)	3.5	0.97	2.38	0.84
Statistical significance (Kruskal-Wallis test)	H = 47.76; p< 0.001		H = 17.54; p< 0.001	

in-hospital mortality. No doubt higher COPD stage is an indicator of decreased pulmonary function and increased risk of co-morbidities, however, despite their association with a higher risk of mortality, their predictive role for in-hospital and 30-day after discharge mortality is debatable owing to a low sensitivity associated with it. In present study, though all the mortalities took place in moderate/severe, but if severe exacerbation is taken as an indicator of mortality then despite having a 100% sensitivity, it will have a specificity of 9.6% only, and hence adaptation of COPD exacerbation severity as a predictor for in-hospital mortality can be ruled out.

In present study, both the scoring systems showed a significant association with in-hospital mortality. On receiver-operator characteristic curve analysis, the area under curve for prediction of in-hospital mortality was 0.791 and 0.885, respectively for DECAF and BAP-65 scores, respectively. Thus, among the scoring systems BAP-65 had maximumarea under curve while DECAF had minimum area under curve. Compared to this Thambi *et al*.[22] in their study AUROC values of 0.729 for DECAF. Son *et al*[24] reported AUROC value of DECAF as 0.72. Zidan *et al*.[20] in their study reported AUROC for DECAF as 0.848. Yousif *et al*.[21] reported AUROC for DECAF and BAP as 0.828 and 0.861, thus showing BAP-65 to be a better predictor of in-hospital mortality as in our study. Tabak *et al*.[10] in their derivative and validation cohorts of BAP-65 found AUROC values for in-hospital mortality as 0.72 and 0.71 respectively. Shorr *et al*.[13] found AUROC for in-hospital mortality or MV need as 0.79 for BAP-65. Steer *et al*.[11] in their study reported AUROC values for DECAF and BAP-65 as 0.86 and 0.68, respectively. These wide differences in AUROC in different studies suggest that universal applicability of a single scale is not possible, however, most of the studies showed AUROC values to be > 0.70 for all the predictive scales thus showing that all the scales were useful under different circumstances. AUROC > 0.70 is considered to have a reasonable predictive value 130. In present study, we observed that AUROC values were > 0.7 for all the scoring systems, thus indicating that primarily all the scoring systems were useful, however, BAP-65 emerged as the most efficacious for in-hospital mortality as observed in present study. However, contrary to results observed for in-hospital mortality, the present study did not find a significant association of BAP-65 with 30-day after discharge mortality and found only DECAF to hold a significant association with 30-day after discharge mortality. These observations are in agreement with the observations of Steer *et al*.[11] who also found DECAF to be a stronger predictor than BAP-65 for estimation of 30-day mortality. In another study, Ramnarain and Brands[15] observed DECAF to hold higher AUROC as compared to BAP-65 for 30-day mortality. However, Lubis *et al*.[19] though found both DECAF and BAP-65 scores to be 100% sensitive for 30-day mortality, however, they found BAP scores to be more specific (39%) as compared to DECAF score (16%). But, Echevarria *et al*.[16] in their study, found DECAF to be better as compared to BAP-65 in prediction of 30-day mortality, a finding much close to that observed in present study.

In present study, a significant association between COPD severity grading and all the scoring systems in question was observed. It was seen that severe exacerbation patients had significantly higher DECAF and BAP-65 scores as compared to mild and moderate patients, thus implying that with increasing severity of COPD, the airway obstructions lead to impairment of normal physiological functions which eventually lead to poorer clinical condition.

CONCLUSION

The findings in the present study thus show that different predictive scoring systems are useful in the prediction of outcome among AECOPD patients, which might be helpful in guiding the management and treatment of these patients. Although discriminant value of different scores for different outcomes showed a variability yet considering the fact that these scoring systems are easy tocalculate and do not require any additional investigation other than the routine investigations performed among AECOPD patients and there was not much qualitative difference in predictive values. It can be suggested that any of these scoring systems should be used for patient management depending upon the suitability of different scoring systems in different environment. In the present study, we found that BAP-65 and DECAF can be used successfully for prediction of in-hospital mortality and 30-day after discharge mortality. Further studies to substantiate these findings are recommended in a larger sample.

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