

ORIGINAL ARTICLE

Usefulness of the PEARL Score to Predict 90-Day Post Discharge Outcome after Hospitalization among the Patients of Acute Exacerbation of COPD

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Abstract

Background: Acute exacerbation of chronic obstructive pulmonary disease (AECOPD) frequently leads to hospital admissions, with approximately one third of patients requiring readmission within 90 days. Early identification of this group of patients by a useful prognostic tool may ensure more aggressive treatment and lead to improved prognosis and reduced mortality.

Objective: To determine the usefulness of The PEARL score to predict 90-day post discharge outcome after hospitalization among the patients with AECOPD.

Materials & Methods: This prospective observational study was conducted in NIDCH, Mohakhali, Dhaka from May 2022 to September 2023. A total of 91 patients admitted with AECOPD, discharged after treatment were enrolled in this study. PEARL score & BODE index were calculated before discharge. On day 90 of discharge, they were followed up to assess & correlate the previously calculated score with the 90-day post discharge outcome as defined by need for readmission. Cut-off values of the PEARL score and BODE index were determined. The Statistical Package for Social Science (SPSS) v.23 was used for statistical analysis.

Results: Out of 91 patients admitted with AECOPD, 34 patients needed readmission within 90-day post discharge period. Mean PEARL score (5.5 ± 1.5 vs 3.2 ± 1.6) was significantly higher among the readmission group than non-readmission group in comparison to BODE index (5.4 ± 1.4 vs 4.5 ± 1.1). Receiver operating characteristic (ROC) curves showed PEARL score and BODE index cut-off values of ≥ 4.5 and ≥ 5.5 . Sensitivity and specificity of BODE index were 50.0% and 82.5%. While the sensitivity and specificity of PEARL score were 73.5% and 77.2%. The accuracy of BODE index and PEARL score were 70.3% and 75.8%. Cohen's Kappa test determined Kappa value of 0.462 which reflected moderate agreement between BODE index and PEARL score.

Conclusion: The PEARL score is a valuable tool calculated by history taking and routinely available investigation, can predict the need for 90-day post discharge readmission in patients admitted with AECOPD.

Keywords: AECOPD, PEARL score, BODE index

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Introduction

Chronic Obstructive Pulmonary Disease (COPD) is now one of the top three causes of death worldwide and 90% of these deaths occur in low and middle-income countries (LMICs)¹. Global burden will rise in future due to increasing exposure to risk factors and aging of the population¹. Though it is treatable and avoidable, the prevalence is rising, mostly in third world countries².

Acute exacerbation of COPD (AECOPD) is one of the most common causes for hospitalization and about one-third of patients need readmission within 90 days³. COPD is a grossly under diagnosed public health problem in Bangladeshi adults aged 40 years or older. Illiteracy, smoking & biomass fuel burning are modifiable risk factors of COPD⁴. COPD is highly prevalent among Bangladeshi adults with an estimated prevalence of 12.5%⁵. Clinicians are not up to the mark to find out the patients who are at risk of readmission⁶.

Chronic Obstructive Pulmonary disease is a heterogenous lung condition characterized by chronic respiratory symptoms (dyspnea, cough, sputum production) due to abnormalities of the airways (bronchitis, bronchiolitis) and/or alveoli (emphysema) that causes persistent, often progressive airflow obstruction. COPD primarily consists of chronic bronchitis, small airway disease and parenchymal destruction (emphysema)¹. COPD should be considered in any patient, usually age more than 40 years, who has dyspnea, chronic cough or sputum production, history of recurrent lower respiratory tract infections and/or a history of exposure to risk factors for the disease.

Forced spirometry showing the presence of a post-bronchodilator FEV₁/FVC ratio < 0.7 is required to establish the diagnosis of COPD¹. Significant pathology such as chronic inflammation, increased inflammatory cells, and structural changes resulting in injury and lung repair are observed in COPD. COPD exacerbations are defined as an event characterized by increased dyspnea and/or cough & sputum that worsen over <14 days, often associated with increased local & systemic inflammation caused by airway infection pollution or other insults to the lung⁷. Exacerbations of COPD are important events in the management of COPD as they negatively impact health status, rates of hospitalization, readmission and progressive decline of lung function⁸.

There is a lack of accuracy among physicians to

identify particular risk factors for patients getting readmitted⁶. Care after discharge is directed by clinical judgement alone, which is not up to the mark⁹.

Different scores have been designed to predict readmission or death in patients with COPD like BODE index, ADO index, PEARL score¹⁰. BODE index has shown potential to predict the future exacerbation in COPD patients of India¹¹. Baseline BODE index could predict both survival and readmission for COPD¹². PEARL score also has shown potential to predict readmission⁹, but it has shown c-statistics of 0.703¹⁰ and 0.70⁹. So, these findings need to be validated by further studies.

At present there is no gold standard scoring to predict readmission in COPD patients. Hence, a simple and accurate prognostic tool is required to identify these risk factors, that would benefit the patients from additional management and care, which will lead to improved prognosis and reduced mortality¹⁰.

The aim of this study was to establish the usefulness of the PEARL score to predict the post discharge outcome after hospitalization among the patients of AECOPD in comparison to BODE index, that could have a significant impact on clinical decision making.

Materials and methods

This prospective observational study was conducted in the department of Respiratory Medicine of National Institute of Diseases of the Chest and Hospital, Mohakhali, Dhaka from May 2022 to September 2023.

Inclusion criteria:

1. Patients admitted to NIDCH with acute exacerbation of COPD who were discharged after treatment.
2. Patients willing to participate in the study.

Exclusion criteria:

1. Medical history or clinical signs of asthma, asthma COPD overlap.
2. Inability to perform spirometry or six-minute walk test or both.
3. Recent myocardial infarction, unstable angina, decompensated heart failure.
4. Patients having uncontrolled co-morbidities that could likely cause death within 2 years.
5. Patients having active malignancy.

Purposive sampling method was applied in this study. Ethical approval was taken from the Ethical Review Committee of NIDCH. A total of 91 acute exacerbation of COPD patients who were admitted to NIDCH, Mohakhali, Dhaka & discharged after management were enrolled fulfilling the inclusion and exclusion criteria. Informed written consent was obtained from all the patients and their attendants after proper explanation about the study protocol. Enrolled patients were evaluated in detail, including present and past clinical history, physical examination. Both PEARL score & BODE index of the individual patient were calculated. They were followed up physically or over telephone 90 days after discharge to assess & correlate the previously calculated scores with the 90-day post discharge outcome as defined by need for readmission. Sensitivity, specificity, positive and negative predictive values, accuracy of the PEARL score and BODE index were determined. Cut-off values of the PEARL score and BODE index for prediction of the requirement of readmission were also determined by plotting on ROC curves. As none of these scores is gold standard, agreement between the scores was assessed by Cohen's Kappa test.

Results

Out of 91 patients, majority (38.5%) belonged to age group 61-70 years and the mean age was 62.2 ± 8.5 years. Male patients were predominant (96.7%), male to female ratio was 29.3:1. Majority 31(34.1%) patients were cultivator. Fifty patients had normal BMI, 4 were underweight, the mean BMI was 22.0 ± 2.2 kg/m². Majority (68.1%) patients were current smokers, 28.6% were ex-smokers and 3.3% were never-smoker. Exposure to biomass fuel was found in 3 patients. NIV was required in 24 patients (26.4%) during index admission. Majority (38.5%) needed admissions ≥ 2 times in past year. The mean duration of hospital stay during index admission was 6.6 ± 2.0 days. Right heart failure was found in 21(23.1%) and left heart failure in only 2(2.2%) patients. Moderate airflow obstruction- was found in 36 patients, severe in 46 and very severe in 9 patients. The mean FEV₁ was 45.0 ± 10.2 . More than half (50.5%) had intermediate-risk, 41.8% had high-risk and only 7 patients had low-risk of PEARL score. Mean PEARL score was 4.0 ± 1.9 with range from 0.0 to 8.0. Forty-one patients (45.0%) had BODE index quartile-3 (5-6), 44.0% had quartile-2 (3-4) and 11.0% had quartile-4 (7-10). The mean BODE index was 4.9 ± 1.3 with range from 3 to 8.

Among 91 patients 34 needed readmission representing 37.4% of study population, the mean

time elapsed for readmission was 50.8 ± 19.1 days. One patient died which is 1.1% of total study population. Mean PEARL score (5.5 ± 1.5 vs 3.2 ± 1.6) was significantly higher among readmission group than non-readmission group of patients in comparison to BODE index (5.4 ± 1.4 vs 4.5 ± 1.1). Mean duration of hospital stay was significantly longer in high risk of PEARL score than low & intermediate risk of PEARL score group (7.8 ± 2.0 and 5.8 ± 1.5 days). Based on the ROC curves, PEARL score had better area under curve (0.837) than BODE index (0.679). ROC curve gave the PEARL score a cut-off value of ≥ 4.5 & BODE index cut-off value of ≥ 5.5 . BODE index showed Sensitivity of 50.0%, specificity 82.5%, accuracy 70.3%, positive predictive value 63.0% and negative predictive value 73.4%. The PEARL score showed sensitivity of 73.5%, specificity 77.2%, accuracy 75.8%, positive predictive value 65.8% and negative predictive value 83.0%.

Observed agreement was 74.7%. Kappa value was 0.462. This measure of agreement is statistically significant with moderate agreement between BODE index and PEARL score.

Table I
Distribution of the study population by demographic profile (n=91)

Demographic profile	Number of patients	Percentage
Age (years)		
41-50	13	14.3
51-60	31	34.1
61-70	35	38.5
71-80	10	11.0
>80	2	2.2
Mean $\pm$ SD	62.2	± 8.5
Range (min-max)	43.0	-85.0
Sex		
Male	88	96.7
Female	3	3.3
Occupational status		
Cultivator	31	34.1
Businessman	18	19.8
Unemployed	14	15.4
Day laborer	6	6.6
Service holder	6	6.6
Housewife	3	3.3
Tobacco industry worker	2	2.2
Brick field worker	4	4.4
Others	7	7.7

Table II*Distribution of the study population according to clinical information (n=91)*

Clinical information	Number of patients	Percentage
H/O Chronic cough	81	89.0
H/O Chronic sputum production	73	80.2
Need for NIV (During index admission)	24	26.4
History of previous admissions		
≥2 times in past year	35	38.5
<2 time in past year	32	35.2
No admission in past year	24	26.4
Mean duration of hospital-stay (days)	6.6	±2.0
Range (min-max)	3.0	-11.0

Table-III*Distribution of the study population according to clinical parameters (n=91)*

Clinical parameters	Number of patients	Percentage
eMRCD score		
1-3	2	2.2
4	14	15.4
5a	22	24.2
5b	53	58.2
Right heart failure		
Yes	21	23.1
No	70	76.9
Left heart failure		
Yes	2	2.2
No	89	97.8
Severity of airflow obstruction(FEV ₁ % predicted)		
Moderate (50% to <80% predicted)	36	39.6
Severe (30% to <50% predicted)	46	50.5
Very severe (<30% predicted)	9	9.9
Mean±SD	45.0	±10.2
6 min walk distance (meters)		
150-249	6	6.6
250-349	46	50.6
≥350	39	42.9

Table-IV*Distribution of the study population according to outcome at 90-day after discharge (n=91)*

Outcome at 90-day after discharge	Number of patients	Percentage
Need for readmission		
Yes	34	37.4
No	57	62.6
Time elapsed for readmission (Days)	50.8	±19.1
Range (min-max)	15.0	-81.0
Death		
Yes	1	1.1
No	90	98.9

Table-V*Relation between PEARL score and BODE index with 90-day post discharge outcome (n=91)*

	No need for readmission (n=57) Mean $\pm$ SD	Need for readmission (n=34) Mean $\pm$ SD	t value	df	P value
PEARL score	3.2 $\pm$ 1.6	5.5 $\pm$ 1.5	6.665	89	0.001 ^s
Range (min-max)	0.0-6.0	2.0-8.0			
BODE index	4.5 $\pm$ 1.1	5.4 $\pm$ 1.4	3.250	89	0.002 ^s
Range (min-max)	3.0-7.0	3.0-8.0			

s= significant

P value reached from unpaired t-test

Table-VI*Receiver operating characteristic (ROC) curve of BODE index and PEARL score for prediction of need for readmission*

	Cut-off value	Sensitivity	Specificity	Area under the ROC curve	95% Confidence interval (CI)	
					Lower bound	Upper bound
BODE index	≥ 5.5	50.0	82.5	0.679	0.561	0.797
PEARL score	≥ 4.5	73.5	77.2	0.837	0.756	0.919

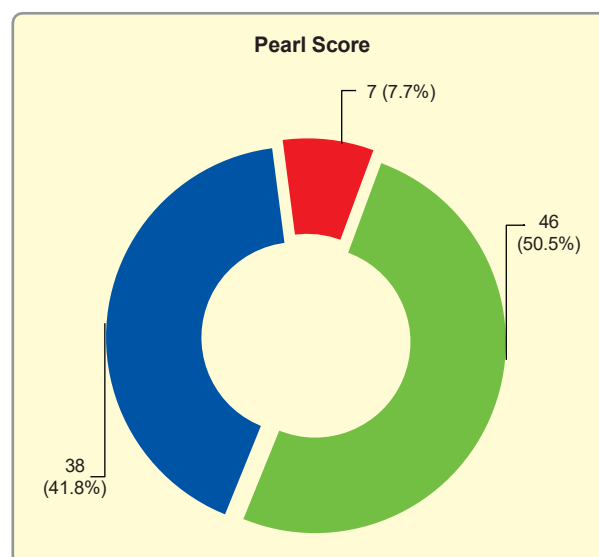
Table-VII*Association between BODE index and PEARL score evaluated by need for readmission (n=91)*

BODE index	PEARL score			
	≥ 4.5 n=38	%	<4.5 n=53	%
≥ 5.5 (n=27)	21	55.3	6	11.3
<5.5 (n=64)	17	44.7	47	88.7

s=significant

Measures of agreement Kappa Value 0.462, p value 0.001^sKappa value matches with moderate agreement.
Observed agreement = 74.7%

Kappa	Interpretation
< 0	Poor agreement
0.0 – 0.20	Slight agreement
0.21 – 0.40	Fair agreement
0.41 – 0.60	Moderate agreement
0.61 – 0.80	Substantial agreement
0.81 – 1.00	Almost perfect agreement

**Figure 1:** Distribution of the study population according to PEARL score (n=91)

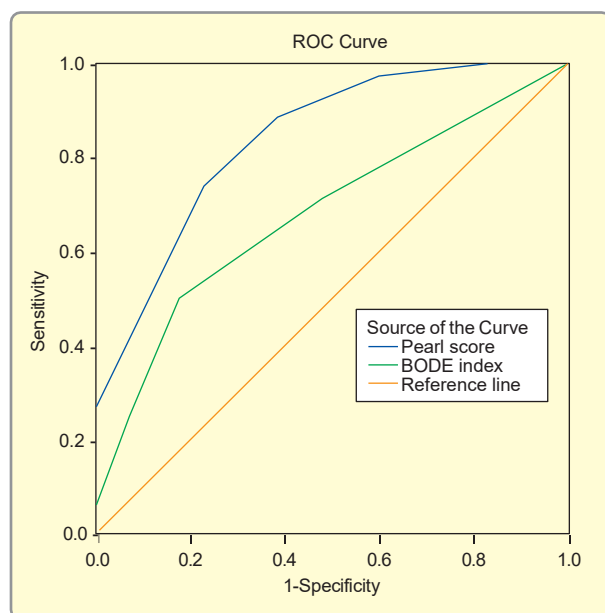


Figure 2: Receiver operating characteristic (ROC) curves of BODE index and PEARL score.

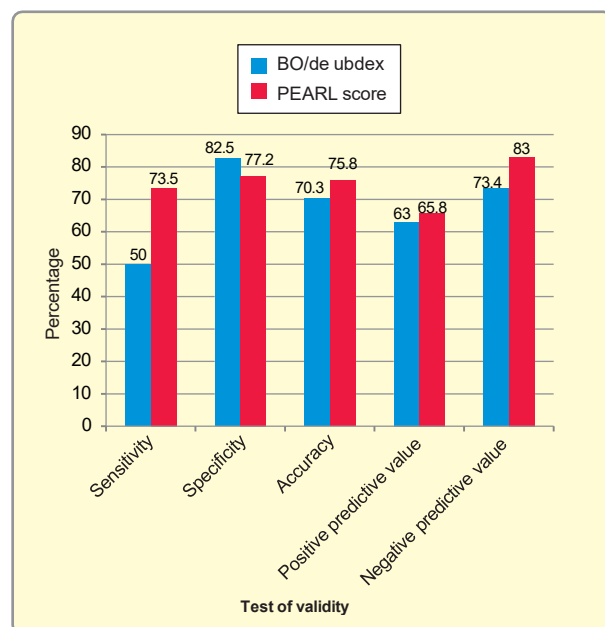


Figure 3: Bar diagram showing sensitivity, specificity, accuracy, positive and negative predictive values of the PEARL score and BODE index for prediction of need for readmission

Discussion

This prospective observational study was carried out with an aim to determine the usefulness of the PEARL score to predict 90-day post discharge outcome (need for re-admission) after

hospitalization among patients with AECOPD. A total of 91 patients admitted to NIDCH, Mohakhali, Dhaka with AECOPD and discharged after treatment who fulfilled the inclusion and exclusion criteria during the period from May 2022 to September 2023 were included in this study. The present study findings were discussed and compared with previously published relevant studies.

In our study, majority 35 (38.5%) patients belonged to age group of 61-70 years, the mean age was 62.2 ± 8.5 years. In a study conducted by Joshi et al. (2021) reported that the mean age of the patients was 70.54 ± 10.85 years with range from 45 to 98 years¹³. A study done by Soler-Cataluña et al. (2019) found the mean age was 71 ± 9 years¹⁴. Another study done by Praveen et al. (2009) found the mean age was 65.55 ± 7.21 years¹¹. So, most of the patients were from older age group which was almost similar to this study.

Regarding clinical information, this study observed that NIV was needed in 24 (26.4%) during index admission. Majority 35 (38.5%) had history of previous admissions two or more times in past year. The mean duration of hospital stay was 6.6 ± 2.0 days. Chen and Chen (2021) reported that, 70.60% patients did not need readmission¹⁵. C. Echeverria et al. (2017) found need for NIV in 17.8% patients and mean length of hospital stay was 6 (4-11) days in their derivation cohort¹⁰. These findings were also consistent with my study.

This study observed that, majority 53 (58.2%) patients had eMRCd score 5b. Moderate airflow obstruction- was found in 36 (39.6%), severe in 46 (50.5%) and very severe in 9 (9.9%) patients. The mean FEV_1 was 45.0 ± 10.2 . It was also found that 46 (50.6%) patients had 6 min walk distance 250-349 m. Chen and Chen (2021) had observed that mMRC grade 2 was found in 43.87% and grade 3 in 29.72%¹⁵. The mean $FEV_1\%$ predicted $55.33 \pm 17.82\%$. Another study also done by Ko et al. (2011) showed the mean $FEV_1\%$ predicted $51.7 \pm 21.6\%$, mean 6 min walk distance was 262.3 ± 99.0 m¹². These findings were almost similar to this study.

Our study observed that, majority of the patients had intermediate risk of PEARL score 50.5%, while 41.8% had high risk and 7.7% had low risk of PEARL score. The mean PEARL score was 4.0 ± 1.9 .

In a study conducted by Joshi et al. (2021) obtained that the intermediate risk PEARL group had the highest number of patients (43.1%) followed by low-risk PEARL group with 40% of patients while high risk PEARL group had the least number of patients (17.6%)¹³. Kishor et al. (2020) also showed that the mean PEARL score 3.140 ± 2.094 ¹⁰. There was minimum variation in mean PEARL score and distribution within risk groups among the studies.

Regarding outcome at 90-day after discharge, need for readmission was found in 34(37.4%), the mean time elapsed before readmission was 50.8 ± 19.1 days. Only one (1.1%) patient died within 90 days of follow up. In a study conducted by Kishor et al. (2020) reported that of the 100 patients, 51(51%) patients were not admitted, 29(29%) patients were readmitted and 20(20%) patients died¹⁰. Percentage of readmitted and not readmitted patients are almost similar to this study but number of deaths is less than other relevant studies.

In this present study it is observed that, mean PEARL score (5.5 ± 1.5 vs 3.2 ± 1.6) was significantly higher in those who needed readmission compared to BODE index (5.4 ± 1.4 vs 4.5 ± 1.1) ($p < 0.05$). Kishor et al. (2020) described that the mean value of PEARL score in not admitted, readmitted, dead patients were 1.569 ± 0.7281 , 4.034 ± 1.592 , and 5.850 ± 1.461 respectively¹⁰. The mean value of BODE index was 6.294 ± 1.238 , 7.759 ± 0.9876 , 8.300 ± 0.6569 respectively. It was evident that higher PEARL score was associated with increased probability of readmission.

This study observed that need for NIV was significantly higher in high risk of PEARL score than intermediate PEARL score (42.1% vs 17.4%). Similarly, a study conducted by Joshi et al. (2021) demonstrated that need for NIV was found in 15.0% in low-risk group, 15.9% in intermediate group and 44.4% in high-risk group, which is consistent with our study.

ROC curve was constructed using BODE index showing sensitivity of 50.0%, specificity 82.5% with a cut-off value of $e^{-5.5}$ and AUROC of 0.679. Kishor et al. (2020) described that the area under the curve (AUC) curve was 0.500 in BODE index. De Torres et al. (2014) also showed the BODE Index has the best predictive capacity of all of the single explored

parameters with an AUC of 0.71 (95% CI 0.67 to 0.76, $p < 0.001$). The abovementioned study findings were almost similar to this study.

Based on the ROC curves PEARL score had better area under curve (0.837). The ROC curve measured PEARL score cut off value of $e^{-4.5}$, sensitivity of 73.5% and specificity of 77.2%. Echevarria et al. (2017) reported that the AUROC for the PEARL score for 90-day readmission/death without readmission was: derivation=0.73(95% CI 0.70 to 0.77); internal validation=0.68 (95% CI 0.64 to 0.72) and external validation=0.70 (95% CI 0.66 to 0.73). Kishor et al. (2020) obtained that the AUROC was 0.6250 for PEARL score. PEARL score was better at predicting readmission or death in patients with AECOPD. These findings were also consistent with our study.

Conclusion

This study demonstrates that the PEARL score is a simple and valuable tool that uses routinely available and non-invasive investigation in risk stratification and prediction of 90-day post discharge outcome in patients admitted with acute exacerbation of COPD. The PEARL score is found to be a better predictor than BODE index. Hence, the PEARL score has the potential to reduce the burden of exacerbation, improve patient outcome and contribute to improved quality of life in this group of patients.

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