Pneumonia Severity Index and CURB-65 score as a Predictor of In-Hospital Mortality in Acute Exacerbation of COPD

Dr. Pankaj Kumar Singh, Dr. Mohit Bhatnagar, Dr. Sandeep Nimba Deore, Dr. Mandeep Joshi, Dr. Tausif Ahmed, Dr. Subhrojyoti Bhowmick, Dr. Shreya Verma

1Junior Consultant, Department of Emergency Medicine, Peerless Hospital and B.K. Roy Research Center, Kolkata, India
2, 3Junior Consultant, Department of General Medicine, Peerless Hospital and B.K. Roy Research Center, Kolkata, India
4Senior Resident, Department of General Medicine, Peerless Hospital and B.K. Roy Research Center, Kolkata, India
5Clinical Director of Department of Quality and Research, Peerless Hospital and B.K. Roy Research Center, Kolkata, India
6DNB General Medicine Trainee, Peerless Hospital and B.K. Roy Research Center, Kolkata, India

Abstract: Aim and Objective: To investigate the role of Pneumonia Severity Index (PSI) and confusion, Urea, Respiratory Rate, Blood Pressures core (CURB-65) in Patients with Acute Exacerbation of Chronic Obstructive Pulmonary Disorder with Reference to Mortality. Methods: In our study a total of 100 patients of COPD with acute exacerbation were included in the study from tertiary care centre, Kolkata for a period of 12 months from December 2015 to November 2016. Results: In our study, overall in hospital mortality was 21%, while mortality in age groups 50-65, 66-80 and >80 were respectively 3.3%, 28.3% and 29.41%. Hence advanced age was associated with significant increase in mortality. The mortality among risk classes of PSI like II, III, IV and V was respectively 0%, 0%, 22.22% and 78.57% respectively. The percentage of mortality increased significantly as the PSI score increases (p value < 0.001). The mortality associated with the low, intermediate and high risk classes of CURB-65 was respectively 4.17%, 14% and 50%. Mortality increased with increase in score demonstrating a significant relation between the two (p value = 0.006). Conclusion: Chronic obstructive pulmonary disease (COPD) is a global public health problem and a significant cause of chronic morbidity and mortality worldwide. Infections are at least 75-80% of acute COPD exacerbations. Our study detected 21% in-hospital mortality. A PSI score of >130 i.e. risk class V as well as CURB-65 score of more than equal to 3 i.e. group 3, were strong predictors of in hospital mortality.

Keywords: Chronic Obstructive Pulmonary Disease; Exacerbation; Mortality; Prognosis

1. Introduction

Episodes of acute exacerbation of chronic obstructive pulmonary disease (AECOPD) are the main causes of disease-related costs, morbidity and mortality.2 AECOPD is also the world’s third leading cause of death. Methods that can accurately classify patients at the terminal stage of the disease are also clinically beneficial.3 A risk marker that represents the real-life clinical condition and determines the risk of death in AECOPD patients is clinically desirable. Such a marker may be used for triage of patients needing hospitalization relative to patients requiring a lower level of health care. An appropriate risk measure can also be used for those in the high-risk community who need more extensive monitoring and treatment. With the exception of the decrease in lung function, several prognostic COPD markers have been reported in previous studies.5-13 In the environment of acute exacerbations, studies have also shown the prognostic importance of COPD, including the incidence of exacerbations, hypercapnia and serum uric acid.13-22 Patients with COPD report an increased prevalence of cancer, cardiovascular disease and depression compared to the general population.23 Prospective studies have looked at COPD comorbidities and death risk.4 The meta-analysis by Aran25 reported that twelve prognostic factors (age, male sex, low body mass index, cardiac failure, chronic renal failure, uncertainty, long-term oxygen therapy, lower limb edema, Phase 4 Global Initiative for Chronic Lung Disease, corpulmonal, acidemia, and elevated plasma troponin levels) were significantly associated with increased short-term mortality, suggesting elevated mortality rates. However, most of the studies that evaluated markers’ predictive function included too many exclusion criteria that do not represent real life, thereby restricting the utility of those markers. Furthermore, most of the variables were validated in only one study without independent validation.25

The most commonly observed scores were CURB65 (confusion, urea > 7 mmol / L, respiratory rate > 30 / min, systolic blood pressure < 90 mm Hg and age > 65 years), and BAP65 (urea, confusion, heart rate, age > 65 years).26-29 The predictive value of the current scores, however, was moderate (area under the curve, 0.7–0.8), indicating that more predictive tools are needed.30

The PSI prediction rule awards points based on age, comorbidity, abnormal physical findings (e.g. pulse 125 / min or systolic blood pressure < 90 mm Hg) and abnormal laboratory findings (e.g. hematocrit < 30 percent, partial blood oxygen pressure < 60 mm Hg or blood glucose level 250 mg / dl (14 mmol/litre)) when presented.31 Yoon K Loke and colleagues conducted a meta-analysis to assess the ability of PSI to correctly predict mortality in pneumonia patients and demonstrated that PSI performed well in identifying pneumonia patients with low risk of death.32 Another system review33 also showed that PSI could predict
the 30 day mortality of CAP, with an area under the sROC curve of 0.8. The PSI score more comprehensively reflects the real-life clinical situation, and is an significant indicator of CAP prognosis. Often shows substantial differences in the clinical presentation of COPD exacerbation and pneumonia. Moreover, many of the variables in the PSI system proved to be prognostic factors for AECOPD. To date, however, no study has measured the PSI score’s prognostic importance regarding the admission of patients with AECOPD. We therefore investigated whether the PSI score could effectively predict in-hospital mortality in AECOPD patients, and compared its usefulness with the mortality prediction CURB65 and BAP65 indexes.

2. Material and Methods

Site of study
Tertiary care centre, Kolkata a multi-specialty tertiary care hospital.

Study population
In this study 100 patients of COPD coming to the emergency department with signs and symptoms of acute exacerbation were included.

Study design
Prospective, Observational and Hospital based study of 100 patients.

Sample size
N (sample size) = \( z^2 \alpha^2 p(1-p)/e^2 \) where p is proportion, e is precision
Here \( \alpha = 5\% \) hence \( z_\alpha = 1.96 \), \( p = 7\% \), \( e = 5\% \). n is coming as 100.

Duration of Study
The study was conducted for a period of 1 year (December2015 - November2016).

Eligibility criteria
Inclusion criteria: All diagnosed cases of COPD presenting to the Emergency Department of tertiary care centre,Kolkata with acute exacerbation with signs and symptoms suggestive of pneumonia were the subjects of present study.

Exclusion criteria: Acute Exacerbation of COPD patients with History of hospital admission in the last 14 days. History of antibiotic ingestion in the last one month. Patient who does not want to be a part of the report.

2.1 Methodology
Demographics, clinical signs and symptoms, co-morbidities and laboratory and radiographic findings of patients coming with Acute Exacerbation of COPD (chronic obstructive pulmonary disorder).

2.2 Statistical Methods
Categorical variables are expressed as Patient number and percentage of patients and compared across groups using Pearson’s Chi Square Independence of Attributes / Fisher's Exact Test as necessary. Continuous variables are expressed as Mean and Standard Deviation and compared as appropriate in the groups using Mann-Whitney U test / Kruskal Wallis Test. Association of duration of hospital stay and other Continuous variables are analyzed using Spearman’s Rank correlation coefficient. For the study the statistical programme SPSS version 20 was used. An alpha level of 5 percent was taken, i.e. if any p value is less than 0.05 it was considered as important.

3. Result and Analysis

Table 1: The relation between age and mortality

| Age       | Total | Death | No | P Value | Significance |
|-----------|-------|-------|----|---------|--------------|
| 50-65     | 29    | 1     | 28 | 0.009   | Significant  |
| 66-80     | 38    | 15    | 23 |         |              |
| >80       | 12    | 5     | 7  |         |              |
| Total     | 50    | 22    | 28 |         |              |

In our study overall mortality was 21%, while mortality in age groups 50-65, 66-80 and >80 were respectively 3.3%, 28.3% and 29.41%. Hence advanced age showed significant increase in mortality (Table 1 and Figure 1).

Table 2: The relation between gender and mortality

| Gender | Total | P Value | Significance |
|--------|-------|---------|--------------|
| Female | 69    | 0.378   | Not Significant |
| Male   | 31    |         |              |

In our study overall mortality was 21%, while mortality in age groups 50-65, 66-80 and >80 were respectively 3.3%, 28.3% and 29.41%. Hence advanced age showed significant increase in mortality (Table 1 and Figure 1).
In our study 2 out of 100 patients were female and mortality for males and females was 50% and 20.41% respectively, the relation between gender and death was not significant (Table 2 and Figure 1).

Table 3: The relation between fever and mortality

|          | No  | Yes  | Total | p Value | Significance |
|----------|-----|------|-------|---------|--------------|
| Death    | 45(76.27) | 34(52.93) | 79(79) | 0.422   | Not Significant |
| No       | 14(23.73)  | 7(17.07)   | 21(21)  |          |               |
| Total    | 59(100)   | 41(100)    | 100(100)|          |               |

Figure 3: The relation between fever and mortality

There were less number of deaths among patients who had fever, p value = 0.422, hence not significant (Table 3 and Figure 3).

Table 4: The relation between cough and mortality

|          | No  | Yes  | Total | p Value | Significance |
|----------|-----|------|-------|---------|--------------|
| Death    | 57(78.08) | 22(31.48) | 79(79) | 0.711    | Not Significant |
| No       | 16(21.92)  | 5(18.52)   | 21(21)  |          |               |
| Total    | 73(100)   | 27(100)    | 100(100)|          |               |

Figure 4: The relation between cough and mortality

The relation between cough and mortality was found to be not significant (p value = 0.711) (Table 4 and Figure 4).

Table 5: The relation between Chest discomfort/Pain and mortality

|          | No  | Yes  | Total | p Value | Significance |
|----------|-----|------|-------|---------|--------------|
| Death    | 77(79.38) | 2(66.67) | 79(79) | 0.511    | Not Significant |
| No       | 20(20.62)  | 1(33.33)   | 21(21)  |          |               |
| Total    | 97(100)   | 3(100)     | 100(100)|          |               |

Figure 5: The relation between Chest discomfort/Pain and mortality

No significant relationship was found between chest pain/discomfort and death (p value=0.511) (Table 5 and Figure 5).

Table 6: The relation between confusion and mortality

|          | No  | Yes  | Total | p Value | Significance |
|----------|-----|------|-------|---------|--------------|
| Death    | 78(78.79) | 1(100) | 79(79) | 0.790    | Not Significant |
| No       | 21(21.21)  | 0(0)    | 21(21)  |          |               |
| Total    | 99(100)   | 1(100)  | 100(100)|          |               |

Figure 6: The relation between confusion and mortality

There were no deaths among patients with confusion, p value=0.790, hence not significant (Table 6 and Figure 6).

Table 7: The relation between risk class and mortality

|          | II  | III  | IV  | V  | Total | p Value | Significance |
|----------|-----|------|-----|----|-------|---------|--------------|
| Death    | 6(100) | 35(100) | 35(77.78) | 3(21.43) | 79(79) | <0.001  | Significant |
| No       | 0(0)  | 0(0)  | 10(22.22) | 11(78.57) | 21(21) |          |               |
| Total    | 6(100) | 35(100) | 45(100)  | 14(100) | 100(100)|         |              |

Volume 9 Issue 11, November 2020

www.ijsr.net
Licensed Under Creative Commons Attribution CC BY
The mortality among risk class of PSI like II, II, IV and V was respectively 0%, 0%, 22.22% and 78.57% respectively. The % of mortality increased significantly as the PSI score increase ($p$ value = <0.001) (Table 7 and Figure 7).

Table 8: The relation between CURB-65 and mortality

| CURB-65 | Low | Intermediate | High | Total | $p$ Value | Significance |
|---------|-----|--------------|------|-------|-----------|--------------|
| Death  | No  | 23(95.83)    | 50(78.13) | 6(50) | 79(79)    | 0.006        | Significant  |
|         | Yes | 1(4.17)      | 14(21.88) | 6(50) | 21(21)    |              |              |
| Total   | 24(100) | 64(100)    | 12(100) | 100(100) |          |              |

Figure 7: The relation between risk class and mortality

Figure 8: The relation between CURB-65 and mortality

The mortality among the low, intermediate and high risk classes of CURB-65 was respectively 4.17%, 14% and 50%, mortality increased as the score increased hence the relationship between these two is significant ($p$ value = 0.006) (Table 8 and Figure 8).

Table 9: The relation between NHR and mortality

| NHR | Total | $p$ Value | Significance |
|-----|-------|-----------|--------------|
| Death | No | 77(78.57) | 2(100) | 0.622   | Not Significant |
|       | Yes | 21(21.43) | 0(0)  |         |              |
| Total | 98(100) | 2(100)   | 100(100) |          |              |

Figure 9: The relation between NHR and mortality

Two patients were admitted from nursing home and rest were from their own home, there was no significant relation between mortality and nursing home residency ($p$ value = 0.622) (Table 9 and Figure 9).

Table 10: Overall the relation between Death and Age, Respiratory rate, Arterial pH, Urea levels, BUN, Blood glucose level, Hematocrit, pO2, PSI score and CURB-65 score

| Death | No | Yes | $p$ Value | Significance |
|-------|----|-----|-----------|--------------|
| Age   | 69.84 ± 9.81 | 76.05 ± 6.4 | 0.004 | Significant |
| Pulse | 100.96 ± 13.79 | 107.19 ± 23.19 | 0.101 | Not Significant |
| SBP   | 139.43 ± 25.11 | 138.57 ± 19.57 | 0.702 | Not Significant |
| DBP   | 77.72 ± 11.2 | 76.67 ± 8.56 | 0.936 | Not Significant |
| RR    | 25.33 ± 3.68 | 27.19 ± 4.2 | 0.035 | Significant |
| Temp  | 99.09 ± 1.31 | 99.13 ± 1.37 | 1.000 | Not Significant |
| Art.pH | 7.38 ± 0.07 | 7.27 ± 0.09 | <0.001 | Significant |
| Urea  | 36.41 ± 13.16 | 52.68 ± 18.89 | <0.001 | Significant |
| BUN   | 17.01 ± 6.15 | 24.62 ± 8.83 | <0.001 | Significant |
| Na    | 133.28 ± 6.01 | 130.9 ± 6.49 | 0.107 | Not Significant |
| Glu   | 137.04 ± 35.76 | 178.81 ± 68.57 | 0.010 | Significant |
| PCV   | 38.29 ± 5.25 | 34.81 ± 4.73 | 0.009 | Significant |
| pO2   | 64.77 ± 11.76 | 54.06 ± 6.03 | <0.001 | Significant |
| PSI   | 91.72 ± 18.31 | 134.33 ± 17.81 | <0.001 | Significant |
| CURB-65 | 1.75 ± 0.65 | 2.29 ± 0.64 | 0.002 | Significant |

Overall the relation between Death and Age, Respiratory rate, Arterial pH, Urea levels, BUN, Blood glucose level, Hematocrit, pO2, PSI score and CURB-65 score was found.
to be significant with association PSI score, pO2, Arterial pH, BUN, Urea level being more significant amongst them (Table 10).

4. Discussion

COPD morbidity and mortality are important and on the rise. By 2020 COPD is expected to become the world's third leading cause of death (only surpassed by heart disease and stroke).

In the study a total of 100 (n = 100) patients were selected from COPD patients coming to the emergency department of tertiary care centre, Kolkata for an observational assessment of the severity of disease with the help of an elaborated history.

Our study prospectively assessed the role of PSI and CURB-65 in AECOPD patients to demonstrate that the PSI and CURB-65 score at hospital admission were predictors for duration of hospital stay, morbidity and mortality.

There were several studies done before to study the role of PSI and CURB-65, In CAP patients.

| Sr. No | Series       | Year | Male | Female |
|-------|--------------|------|------|--------|
| 1.    | Restrepo MI et al. | 2006 | 582  | 162    |
| 2.    | Liapikou A et al. | 2011 | 826  | 553    |
| 3.    | Hu G et al.    | 2015 | 212  | 540    |
| 4.    | Present study  | 2016 | 98   | 2      |

Similar to the study of Hu G et al. where all the patients had underlying COPD, our study also was conducted similarly on patients with baseline COPD. We selected 100 patients. Most of the studies quoted above concentrated only on patients with CAP. The presence of associated COPD was not a regular or defining feature.

In our study 2 out of 100 patients were females, probably due to smaller sample size as compared to other studies. Smoking is not usual among females in the state of West Bengal. 30 (30%) patients belonged to the 50-65 year age group, 53 (53%) patients belonged to the 65-80 year age group and 17 (17%) patients were more than 80 years of age. 2 patients were admitted from the nursing home and the rest of the patients from their own home. 6 (6%) patients belonged to risk class II of PSI, 35 (35%) belonged to class III, while 45 (45%) and 14 (14%) belonged to class IV and V respectively. 24 (24%) were from the low risk group of CURB-65, 64 (64%) and 12 (12%) were from the intermediate and high risk group respectively.

All (100%) patients were having shortness of breath, 41 (41%) were having fever, 27 (27%) had cough, 3 (3%) were having chest pain/discomfort and one (1%) patient presented with confusion. 39 (39%) patients had coexisting renal failure, 14 (14%) had heart failure and 7 (7%) had coexisting liver disease while none of the patients had neoplasm or concurrent cerebrovascular disease. 7 (7%) patients were having pleural effusion.

Comparison between mortalities of different risk classes of PSI and CURB-65

| Series       | Mortality PSI | Mortality CURB-65 |
|--------------|---------------|-------------------|
|              | II | III | IV | V  | Low | Intermediate | High   |
| Hu G et al.  | 0% | 1.3%| 8.7%| 33.1%| 4.2%| 13.3%       | 62.5%  |
| Present study| 0% | 0%  | 22.22%| 78.57%| 4.17%| 21.88%     | 50%    |

In our study, overall in hospital mortality was 21%, while mortality in age groups 50-65, 66-80 and >80 were respectively 3.3%, 28.3% and 29.41%. Hence advanced age was associated with significant increase in mortality. A rather low in-hospital mortality of 9.7% was reported by Hu G et al.

The mortality among risk classes of PSI like II, III, IV and V was respectively 0%, 0%, 22.22% and 78.57% respectively. The percentage of mortality increased significantly as the PSI score increases (p value ≤ 0.001). In the study by Hu G et al. mortalities in PSI risk class II, III, IV and V was 0%, 1.3%, 8.7% and 33.1% respectively.

The mortality associated with the low, intermediate and high risk classes of CURB-65 was respectively 4.17%, 14% and 50%. Mortality increased with increase in score demonstrating a significant relation between the two (p value = 0.006). In the study by Hu G et al. mortalities among low, intermediate and high risk class were 4.2%, 13.3% and 62.5% respectively.

The risk of in hospital mortality was significantly different between the groups and increases with higher PSI as well as a higher CURB-65 score.

A PSI score of >130 i.e. risk class V as well as CURB-65 score of more than equal to 3 i.e. group 3, were strong predictors of in hospital mortality.

Limitations of our study were - We only assessed the role of PSI and CURB-65 score in hospital mortality for AECOPD, We did not study the effect of the PSI and CURB-65 score on the long term mortality of COPD patients.

5. Conclusion

Chronic obstructive pulmonary disease (COPD) is a global public health problem and a significant cause of chronic morbidity and mortality worldwide. At least 75-80% of acute exacerbations of COPD are infectious. In our study a total of 100 patients of COPD with acute exacerbation were included in the study from tertiary care centre, Kolkata for a period of 12 months from December 2015 to November 2016. Our study detected 21% in-hospital mortality. A PSI score of >130 i.e. risk class V as well as CURB-65 score of more than equal to 3 i.e. group 3, were strong predictors of in hospital mortality.
References

[1] Vestbo J, Hurd SS, Agusti AG, Jones PW, Vogelmeier C, Anzueto A, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. American journal of respiratory and critical care medicine. 2013;187(4):347–65. doi: 10.1164/rccm.201204-0596PP PMID: 22878278.

[2] Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet. 2012;380(9859):2095–128. doi: 10.1016/S0140-6736(12)61728-0 PMID: 23245604.

[3] Murray CJ, Lopez AD. Mortality by cause for eight regions of the world: Global Burden of Disease Study. Lancet. 1997;349(9061):1269–76. doi: 10.1016/S0140-6736(96)6041-9 PMID: 9142060.

[4] Edwards L, Perrin K, Wijesinghe M, Weatherall M, Beasley R, Travers J. The value of the CRB65 score in predicting mortality and need for invasive mechanical ventilation in elderly COPD patients presenting with hospital mortality and need for invasive mechanical ventilation. Respiratory medicine. 2011;105(5):740–7. doi: 10.1016/j.rmed.2010.12.020 PMID: 21227672.

[5] Celli BR, Cote CG, Marin JM, Casanova C, Montes de Oca M, Mendez RA, et al. The body-mass index, airflow obstruction, dyspnea, and exercise capacity index in chronic obstructive pulmonary disease. The New England journal of medicine. 2004;350(10):1005–12. doi: 10.1056/NEJMoa021322 PMID: 14999112.

[6] Murphy SA, Haja Mydin H, Fatah S, Antunes G. Predicting end-of-life in patients with an exacerbation of COPD by routine clinical assessment. Respiratory medicine. 2010;104(1):166–74. doi: 10.1016/j.rmed.2010.04.025 PMID: 20537518.

[7] Soler-Cataluna JJ, Martinez-Garcia MA, Sanchez LS, Tordera MP, Sanchez PR. Severe exacerbations and BODE index: two independent risk factors for death in male COPD patients. Respiratory medicine. 2009;103(5):692–9. doi: 10.1016/j.rmed.2008.12.005 PMID: 19131231.

[8] Ashraf Mokhtar Madkour NNA. Predictors of in-hospital mortality and need for invasive mechanical ventilation in elderly COPD patients presenting with acute hypercapnic respiratory failure. Egyptian Journal of Chest Diseases and Tuberculosis. 2013;62(3):393–400. doi: 10.1016/j.ejcjd.2013.07.003

[9] Celli BR, Cote CG, Lareau SC, Meek PM. Predictors of Survival in COPD: more than just the FEV1. Respiratory medicine. 2008;102 Suppl 1:S27–35. doi: 10.1016/S0954-6111(08)70005-2 PMID: 18582794.

[10] Miravitlles M, Izquierdo I, Herrejon A, Torres JV, Baro E, Borja J, et al. COPD severity score as a predictor of failure in exacerbations of COPD. The ESFERA study. Respiratory medicine. 2011;105(5):740–7. doi: 10.1016/j.rmed.2010.12.020 PMID: 21227672.

[11] Esteban C, Quintana JM, Aburto M, Moraza J, Arostegui I, Espana PP, et al. The health, activity, dyspnea, obstruction, age, and hospitalization: prognostic score for stable COPD patients. Respiratory medicine. 2011;105(11):1662–70. doi: 10.1016/j.rmed.2011.05.005 PMID: 21703842.

[12] Fuso L, Incalzi RA, Pistelli R, Muzzolon R, Valente S, Pagliari G, et al. Predicting mortality of patients hospitalized for acutely exacerbated chronic obstructive pulmonary disease. The American journal of medicine. 1995;98(3):272–7. PMID: 7872344.

[13] Groenewegen KH, Schols AM, Wouters EF. Mortality and mortality-related factors after hospitalization for acute exacerbation of COPD. Chest. 2003;124(2):459–67. PMID: 12907529.

[14] Roberts CM, Lowe D, Bucknall CE, Ryland I, Kelly Y, Pearson MG. Clinical audit indicators of outcome following admission to hospital with acute exacerbation of chronic obstructive pulmonary disease. Thorax. 2002;57(2):137–41. PMID: 11828043; PubMed Central PMCID: PMC1746248.

[15] Gunen H, Hacievliyagil SS, Kosar F, Mutlu LC, Gulbas G, Pehlivan E, et al. Factors affecting survival of hospitalised patients with COPD. The European respiratory journal. 2005; 26(2):234–41. doi: 10.1183/09031936.05.00024804 PMID: 16055870.

[16] Ruiz-Gonzalez A, Lacasta D, Ibarz M, Martinez-Alonso M, Falguera M, Porcel JM. C-reactive protein and other predictors of poor outcome in patients hospitalized with exacerbations of chronic obstructive pulmonary disease. Respirology. 2008;13(7):1028–33. doi: 10.1111/j.1440-1841.2008.01403.x PMID: 18945322.

[17] Bartziokas K, Papaioannou AI, Loukides S, Papadopoulos A, Haniotou A, Papiris S, et al. Serum uric acid as a predictor of mortality and future exacerbations of COPD. The European respiratory journal. 2014; 43(1):43–53. doi: 10.1183/09031936.00209212 PMID: 23645404.

[18] Tofan F, Rahimi-Rad MH, Rasm i Y, Rahimirad S. High sensitive C-reactive protein for prediction of adverse outcome in acute exacerbation of chronic obstructive pulmonary disease. Pneumologia. 2012;61(3):160–2. PMID: 23175870.

[19] Fruchter O, Yigla M, Kramer MR. D-dimer as a prognostic biomarker for mortality in chronic obstructive pulmonary disease exacerbation. Am J Med Sci. 2015;349(1):29–35. doi:10.1097/MAJ.0000000000000332

[20] Hoiseth AD, Neukomm A, Karlsson BD, Omland T, Brekke PH, Soyseth V. Elevated high-sensitivity cardiac troponin T is associated with increased mortality after acute exacerbation of chronic obstructive pulmonary disease. Thorax. 2011;66(9):775–81. doi: 10.1136/thx.2010.153122 PMID: 21653926.

[21] Asiimwe AC, Brims JF, Andrews NP, Prytherch DR, Higgins BR, Kilburn SA, et al. Routine laboratory tests can predict in-hospital mortality in acute exacerbations of COPD. Lung. 2011; 189(3):225–35. doi: 10.1007/s00408-011-0354-z PMID: 21244573.

[22] Ko FW, Tam W, Tung AH, Ngai J, Ng SS, Lai K, et al. A longitudinal study of serial BODE indices in predicting mortality and readmissions for COPD. Respiratory medicine. 2011;105(2):266–73. doi: 10.1016/j.rmed.2010.06.022 PMID: 20655186.
Fabbri LM, Luppi F, Beghe B, Rabe KF. Complex chronic comorbidities of COPD. The European respiratory journal. 2008;31(1):204–12. doi: 10.1183/09031936.00114307 PMID: 18166598.

Garcia-Rio F, Rojo B, Casitas R, Lores V, Madero R, Romero D, et al. Prognostic value of the objective measurement of daily physical activity in patients with COPD. Chest. 2012;142(2):338–46. doi: 10.1378/chest.11-2014 PMID: 22281798.

Singanayagam A, Schembri S, Chalmers JD. Predictors of mortality in hospitalized adults with acute exacerbation of chronic obstructive pulmonary disease. Annals of the American Thoracic Society. 2013;10(2):81–9. doi: 10.1513/AnnalsATS.201208-043OC PMID: 23607835.

Shorr AF, Sun X, Johannes RS, Yaitanes A, Tabak YP. Validation of a novel risk score for severity of illness in acute exacerbations of COPD. Chest. 2011;140(5):1177–83. doi: 10.1378/chest.10-3035 PMID: 21527510.

Tabak YP, Sun X, Johannes RS, Gupta V, Shorr AF. Mortality and need for mechanical ventilation in acute exacerbations of chronic obstructive pulmonary disease: development and validation of a simple risk score. Archives of internal medicine. 2009;169(17):1595–602. doi: 10.1001/archinternmed.2009.270 PMID: 19786679.

Chang CL, Sullivan GD, Karalus NC, Mills GD, McLachlan JD, Hancox RJ. Predicting early mortality in acute exacerbation of chronic obstructive pulmonary disease using the CURB65 score. Respirology. 2011;16(1):146–51. doi: 10.1111/j.1440-1843.2010.01866.x PMID: 20920140.

Steer J, Norman EM, Afolabi OA, Gibson GJ, Bourke SC. Dyspnoea severity and pneumonia as predictors of in-hospital mortality and early readmission in acute exacerbations of COPD. Thorax. 2012;67 (2):117–21. doi: 10.1136/thoraxjnl-2011-200332 PMID: 21896712.

Singanayagam A SS, Chalmers JD. Predictors of mortality in hospitalized adults with acute exacerbation of chronic obstructive pulmonary disease. Annals of the American Thoracic Society. 2013 Apr;10(2):81–9. doi:10.1513/AnnalsATS.201208-043OC PMID: 23607835

Fine MJ, Auble TE, Yealy DM, Hanusa BH, Weissfeld LA, Singer DE, et al. A prediction rule to identify low-risk patients with community-acquired pneumonia. The New England journal of medicine. 1997;336(4):243–50. doi: 10.1056/NEJM199701233360402 PMID: 8995086.

Loke YK, Kwok CS, Niruban A, Myint PK. Value of severity scales in predicting mortality from community-acquired pneumonia: systematic review and meta-analysis. Thorax. 2010;65(10):884–90. doi: 10.1136/thx.2009.134072 PMID: 20729235.

Chalmers JD, Singanayagam A, Akram AR, Mandal P, Short PM, Choudhury G, et al. Severity assessment tools for predicting mortality in hospitalized patients with community-acquired pneumonia. Systematic review and meta-analysis. Thorax. 2010;65(10):878–83. doi: 10.1136/thx.2009.133280 PMID:20729231.

Restrepo MI, Mortensen EM, Pugh JA, Anzueto A. COPD is associated with increased mortality in patients with community-acquired pneumonia. European Respiratory Journal. 2006 Aug;1;28(2):346-51.

Liapikou A, Cilloniz C. Severe community-acquired pneumonia: Severity and management. Community Acquir Infect 2015;2:3-7

Hu G, Zhou Y, Wu Y, Yu Y, Liang W, Ran P. The pneumonia severity index as a predictor of in-hospital mortality in acute exacerbation of chronic obstructive pulmonary disease. PloS one. 2015 Jul;17;10(7):e0133160.