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Original Article

Admission Blood Pressure as Predictors of Thirty Days Mortality in Community Acquired Pneumonia in a Tertiary Care Hospital of Bangladesh

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Abstract

Background: *Assessing admission blood pressure (BP) is crucial in predicting mortality community acquired pneumonia.*

Methodology: *This was a prospective longitudinal study at DMCH to explore hemodynamic predictors of the 30-day all-cause mortality, including deaths during hospital stay and after discharge in community-acquired pneumonia. Statistical analyses included the Z-proportion test, multivariate logistic regression, and ROC curve analysis. A p-value of less than 0.05 was considered statistically significant.*

Results: *The study's hospital mortality rate in community-acquired pneumonia was 14%. However, the all-cause mortality rate after 30 days of hospital admission increased to 22.6%. This was significantly associated with systolic blood pressure below 90 mmHg, diastolic pressure of 60 mm Hg or less, pulse of 40 mm Hg or less, and mean arterial pressure below 70 mm Hg (p<0.001). The multivariate logistic regression analysis indicated a significant association between blood pressure parameters and 30-day mortality in community-acquired pneumonia (CAP) patients. Systolic blood pressure (<90 mmHg) was found to be a significant predictor, with an Odds Ratio (OR) of 5.439 (95% CI: 1.565 to 18.895) and a p-value of 0.004. This suggests a significantly higher risk of mortality for subjects with systolic blood pressure below 90 mmHg compared to those with higher readings. However, diastolic blood pressure (<60 mmHg) did not show any significant association, as indicated by an OR of 0.871 (95% CI: 0.336 to 2.256) and a p-value of 0.775. Similarly, pulse pressure (<40 mmHg) did not exhibit any significant relationship with mortality, with an OR of 0.756 (95% CI: 0.090 to 6.377) and a p-value of 0.797. On the other hand, mean arterial pressure (<70 mmHg) emerged as another significant predictor, with an OR of 4.465 (95% CI: 1.280 to 15.579) and a p-value of 0.012. This suggests a significantly higher risk of mortality among subjects with mean arterial pressure below 70 mmHg compared to those with higher values.*

Conclusion: *Low systolic blood pressure (<90 mmHg) and mean arterial pressure (<70 mmHg) are associated with increased mortality risk in CAP patients.*

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Introduction

Pneumonia is one of the leading causes of death and morbidity in developing as well as developed countries. According to an epidemiological study, the incidence rate of community-acquired pneumonia (CAP) is higher in developing countries (ranging from 20% to 30%) compared to developed countries (ranging from 3% to 4%). The incidence rate also varies significantly with age, with the very young and the elderly being at a higher risk.[1,2] Various researchers from different countries recommend different severity measurement tools for CAP. They are the Pneumonia Severity Index, CURB65, and CRB65 score.[3-5]

Hemodynamic status is the core index for all the measurement tools. The pneumonia severity index recommends systolic blood pressure <90 mm Hg as a high-risk feature, and the CURB65 and CRB65 prediction recommends either systolic blood pressure <90 mm Hg or diastolic blood pressure ≤60 mm Hg.

Most of the tools use Admission blood pressure (BP) to assess for severity as well as prediction of mortality.

The Pneumonia Severity Index identifies systolic blood pressure below 90 mm Hg as a significant high-risk factor. Meanwhile, the CURB65 score suggests either systolic blood pressure below 90 mm Hg or diastolic blood pressure below 60 mm Hg as a high-risk indicator. On the other hand, the APACHE II recommends using mean arterial pressure to determine a patient's risk level.

Male gender Malignancy and tachycardia congestive heart failure altered mental status, tachycardia, blood urea nitrogen, hypoxemia, arterial pH, and pleural effusion are poor prognostic factors for mortality, but they vary according to age group. One study found that the mortality rate within 30 days was 15.7%, with 85.3% of deaths occurring in hospitals and 14.7% after discharge.

Mortality rates are higher in older people. The rate also differs in different regions.[10,11]

A previous study found that low diastolic blood pressure is linked to mortality, regardless of systolic blood pressure. As a result, high pulse pressure indicates a negative outcome, according to British et al. and the Public Health Laboratory Service in 1987. Chalmers et al. also performed a study on this topic.

Moreover, it was found that systolic BP is superior to other hemodynamic predictors of 30-day mortality and that mechanical ventilation and inotropic support are needed in community-acquired pneumonia.

A prospective observational study performed by Aziz et al. (2016) showed that mortality was associated with old age (P=0.01) and low diastolic blood pressure (P=0.04).[13] Various severity assessment tools are encouraged daily to predict the morality of pneumonia. Blood pressure is the fundamental index for all measurement tools. Prior research has suggested that a systolic blood pressure reading below 90 mm Hg or a diastolic blood pressure reading of 60 mm Hg or lower may indicate a poor prognosis.[13] A decreased mean arterial pressure can predict mortality in acutely ill patients. However, the available data has been inconsistent in establishing the association between various blood pressure levels and adverse outcomes in cases of CAP.

To our knowledge, no study was carried out to compare blood pressure measurements with outcomes in community-acquired pneumonia in Dhaka Medical College Hospital (DMCH) or any other institution in Bangladesh in the near past. Therefore, the present study is designed to compare blood pressure measurements with outcomes in community-acquired pneumonia. Suppose specific blood pressure parameters are strong predictors of mortality in CAP patients. In that case, it opens avenues for targeted interventions to improve cardiovascular health and systemic perfusion in this population.

Methodology

Study Design and Participant Selection

A prospective observational study was conducted in the Department of Medicine at Dhaka Medical College and Hospital (DMCH) in Bangladesh from September 2022 to August 2023. Adult Patients aged more than 18 years of both sexes who were admitted to the medicine department of Dhaka Medical College Hospital with community-acquired pneumonia were included in the study. Patients with hospital-acquired pneumonia, Patients with active malignancy, immunosuppression, and pulmonary embolism, and patients in whom active treatment was not considered appropriate (palliative care) were excluded from enrolment in the study.

After selecting the subjects, the study's nature, purpose, and benefits were explained to each subject in detail. They were encouraged to participate voluntarily. Prior to the commencement of the study, the participants were provided with a written document containing all the necessary information about the study, including its purpose, procedures, and potential risks and benefits. The participants were given time to read and understand the document and were encouraged to ask any questions. After being provided with all the necessary information, the participants signed a consent form to prove their willingness to participate in the study. This process ensured the participants knew the study and voluntarily agreed to participate. Demographic variables such as age, gender, comorbidity, and smoking status were recorded. Blood pressure measurements, including systolic, diastolic, mean arterial, and pulse pressure, were taken from all patients within four hours of admission to the hospital. These measurements were obtained before any intravenous fluid resuscitation or inotropic support was provided, except for patients who had received paramedic resuscitation before arriving at the hospital. Cut-offs for systolic, diastolic, mean arterial pressure, and pulse pressure were selected from

previous studies. Systolic blood pressure <90 mm Hg, diastolic blood pressure ≤60 mm Hg, mean arterial pressure <70 mm Hg, and pulse pressure >40 mmHg were the most consistently used to define increased risk. All patients received standard treatment for community-acquired pneumonia as per hospital protocol. The attending physician decided on inotropic support. Every patient was followed up to discharge to see if there was any mortality. After discharge, every patient followed after 14 days and after then weekly up to 30 days from hospital discharge. They are requested to attend physically or, in case of death at home or after discharge, from us over the telephone. If he or she did not attend physically, we called them over the telephone and noted information regarding the death of their relatives. If he or she did not attend, then Text messages were sent, and an alternative number was tried; if there was no response for three consecutive days, data was censored. Suppose anyone who disagrees with continuing our follow-up is considered disagreeing to participate in the study. The study's outcome was 30-day mortality, including in the hospital and after discharge. All the information was recorded in a structured data collection sheet.

Data Processing & Analysis

the data was organized and analyzed using IBM SPSS Statistics for Windows, Version 26.0. When presenting continuous variables, we provided the mean value and the standard deviation for data following a normal distribution. We expressed the median value and the interquartile range for skewed distribution data. On the other hand, when dealing with categorical variables, we represent them in terms of their frequencies and corresponding percentages. The Chi-Square test was performed to compare qualitative data between groups. Receiver operator characteristic (ROC) curve analysis was done to calculate the area under the curve (AUC). For interpretation of these values, the following was widely accepted: AUC 0.50–0.59 = no value of test; 0.60–0.69 = poor discriminatory value; 0.70–0.79 = moderate discriminatory value; 0.80–0.89 = good discriminatory value; 0.90–1.00 = excellent discriminatory value. 95% CI was calculated, and p <0.05 was considered the significance level.

Ethical issue

The research was carried out after obtaining ethical clearance from the concerned Department, the Research Review Committee, and the Ethical Review Committee of Dhaka Medical College

Operational definitions

Community-acquired pneumonia (CAP): To diagnose a patient with CAP, three criteria must be met:

1. A board-certified radiologist must confirm the presence of a pulmonary infiltrate on a chest radiograph or CT scan at the time of hospitalization.
2. The patient must exhibit at least one of the following symptoms:
   a) new cough or increased cough or sputum production
   b) fever greater than 37.8°C (100.0°F) or hypothermia less than 35.6°C (96.0°F)
   c) changes in leukocyte count, which may include leukocytosis (greater than a certain number of cells per microliter), left shift (greater than 10% band forms per milliliter), or leukopenia (less than 4,000 cells per microliter).
3. There must be no alternative diagnosis at the time of hospital discharge that justifies the presence of criteria 1 and 2.

These criteria were adapted from previous investigations of community-acquired pneumonia.[14,15]

Blood pressure: it is the lateral pressure blood exerts on the vessel's wall when flowing through it.[16]

Systolic blood pressure: It is the maximum pressure during systole.
Normal: 100 to 120 mmHg

Diastolic pressure: It is the minimum pressure during diastole
Normal: 60 to 90 mmHg

Pulse pressure: It is the difference between systolic and diastolic pressure.
Normal: 30 to 40 mmHg

Mean arterial pressure is calculated as diastolic blood pressure +1/3 of pulse pressure.
Normal: 100mmHg

Result

The majority (43; 28.8%) of the respondents were 55-65 years old mean±SD age was 53.93±11.03 years. Study subjects, 92 (61.2%) were male and 58 (38.8%) were female. Male female ratio was 1.6:1. Shows that 16.3% of patients had diabetes, 6.3% had chronic kidney disease, 6.3% had cardiovascular disease, 23.8% had COPD, and 5% had other chronic pulmonary disease (Table 1).

Table-1. Demographic features of participant

Characteristics	Subgroup	Frequency	Percentage	Mean± SD
Age	35-45	34	22.5	
	45-55	39	26.3	
	55-65	43	28.8	
	≥65	34	22.5	
Sex	Male	92	61.2	
	Female	58	38.8	53.93±11.03
Smoker		88	58.8	
Co morbidities	Diabetes Mellitus	24	16.3	
	Chronic kidney disease	9	6.3	
	Chronic cardiac failure	9	6.3	
	Cardiovascular Disease	39	26.3	
	COPD	36	23.8	
	Other pulmonary disease	8	5.0	

Table-2. *Distribution of the study subjects according to blood pressure (N=150)*

Blood pressure	Frequency	Percentage
Systolic blood pressure		
≤60	43	28.7
61-90	84	56
>90	23	15.3
Mean±SD	75.73±14.48	
Range	61 to 90	
Diastolic blood pressure		
≤40	15	10.0
41-60	128	85.3
≥61	7	4.7
Mean±SD	56.03±6.89	
Range	49 to 62	
Pulse pressure		
<30	134	89.3
31-40	11	7.3
41-60	5	3.3
61-80	0	0
>80	0	0
IQR (Q_3-Q_1)	23	
Range	8 to 31	
Mean arterial pressure		
≤50	17	11.3
50-69	95	63.3
≥70	38	25.3
Mean±SD	62.61±8.47	
Range	54 to 71	

Data were expressed as frequency, percentage and mean±SD

The study showed that the mean systolic blood pressure was 75.73 ± 14.48 mmHg, diastolic pressure was 56.03 ± 6.89 mmHg, and mean arterial pressure was 62.61 ± 8.47 mmHg. Among all the patients who participated in this study, 56% had systolic pressure ranging from 61-90 mmHg, 85.3% of patients had diastolic pressure ranging from 41-60 mmHg, 89.3% of patients had pulse pressure of less than 30 mmHg and 63.3% of patients had mean pressure ranging from 50-69 mmHg (Table 2).

A 30-day mortality was significantly ($p<0.001$) associated with systolic blood pressure <90 mmHg, diastolic pressure ≤60 mm Hg, pulse pressure ≤40 mmHg and mean arterial pressure <70 mmHg (Table 3).

Table-3. Association of blood pressure with 30-day mortality (n=34)

Blood pressure	30-day mortality		P
	Frequency	Percentage	value
Systolic blood pressure			
<90 mmHg	31	91.2%	<0.001[s]
≤90 mmHg	3	8.8%	
Diastolic blood pressure			
≤60 mm Hg	34	100%	<0.001[s]
>60 mm Hg	0	0%	
Pulse pressure			
≥40 mmHg	34	100%	<0.001[s]
>40 mmHg	0	0%	
Mean pressure			
<70 mm Hg	31	91.2%	<0.001[s]
≥70 mm Hg	3	8.8%	

Data were expressed as frequency and percentage. p value was obtained from Z proportion test.

Subjects with a systolic blood pressure less than 90 mmHg had a significantly higher odds of 30-day mortality, with an odds ratio of 5.439 (p = 0.004). There was no statistically significant association between diastolic blood pressure less than 60 mmHg and 30-day mortality, as indicated by an odds ratio of 0.871 (p = 0.775). Similarly, there was no statistically significant association between pulse pressure less than 40 mmHg and 30-day mortality, with an odds ratio of 0.756 (p = 0.797). Subjects with mean pressure less than 70 mmHg had a significantly higher odds of 30-day mortality, with an odds ratio of 4.465 (p = 0.012) (Table 4).

It seems that systolic blood pressure less than 90 mmHg and mean pressure less than 70 mmHg are associated with increased odds of 30-day mortality, while diastolic blood pressure and pulse pressure do not show significant associations with this outcome in this study.

Table-4. Multivariate logistic regression analysis of 30-day outcome and blood pressure of the study subjects (N=150)

Outcome	OR	95% CI	p value
30-day mortality			
Systolic blood pressure <90 mmHg	5.439	1.565 to 18.895	0.004[s]
Diastolic blood pressure <60 mmHg	0.871	0.336 to 2.256	0.775[ns]
Pulse pressure <40 mmHg	0.756	0.090 to 6.377	0.797[ns]
Mean pressure <70 mmHg	4.465	1.280 to 15.579	0.012[s]

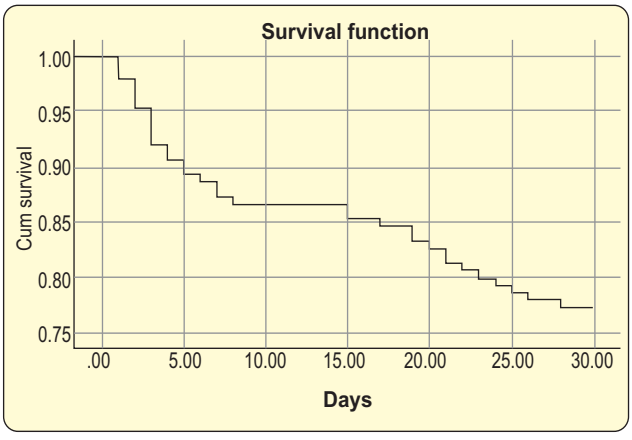

Figure 1. Kaplan–Meier survival curve showing 30-day mortality (N=150)

Kaplan–Meier survival curve showing 30-day mortality. Here survival function rate was 73.3% and rate of censored was 22.7% (Figure 1).

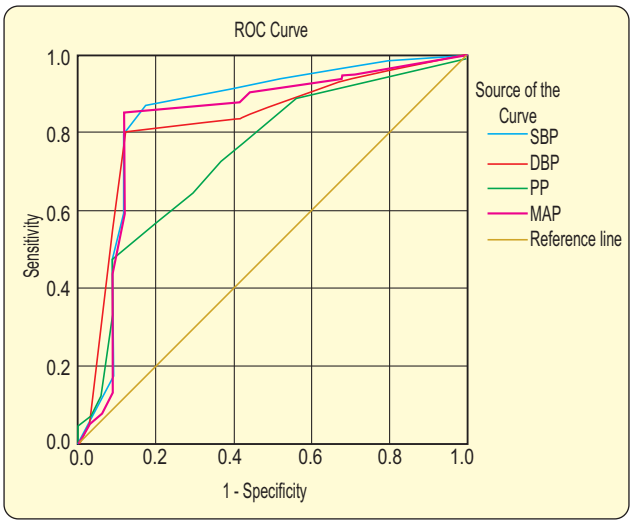

Figure 2. Receiver Operating Characteristic (ROC) showing different blood pressure and prediction of 30-day mortality (N=150)

ROC curve analysis showed area under curve for systolic blood pressure was 0.852, diastolic blood pressure was 0.826, pulse pressure was 0.746 and mean arterial pressure was 0.835. In this study systolic pressure, diastolic pressure and mean arterial pressure had good discriminatory values and pulse pressure had moderate discriminatory value for prediction of 30-day mortality (Figure 2).

Discussion

Hypertension is a risk factor for the worst prognosis of pneumonia (17). There is a causal relationship between blood pressure(18). Hypertension can lead to endothelial dysfunction, which may increase the risk of infection. In murine models, dysregulation of nitric oxide release and signaling during pulmonary inflammation has been shown to cause more severe lung injury.[19]

However, during acute pneumonia, hypotension plays a critical role in developing worse consequences. Various researchers from different countries have found a significant association between hypotension and increased mortality and examining prognosis in patients with community-acquired (Chalmers et al., 2008) 12. The present study was conducted in the Department of Medicine, Dhaka Medical College Hospital, Dhaka, to see the association of blood pressure measurements with outcomes in community-acquired pneumonia. This study included one hundred fifty patients with Community-acquired pneumonia (CAP). After admission, 14% of patients died during a hospital stay, and the remaining were alive during discharge. However, At 30 days of follow-up, a total of 22.6% of patients died. This was like the previous study conducted in the USA, where

mortality during hospitalization was 6.5%, and at 30 days, it was 23.4% (17). An observational study based on the extensive database from the German nationwide performance measurement program in healthcare quality found hospital Mortality was (14.0%)(18), higher than the previous study. Chalmers et al. (2008) stated that the 30-day mortality rate was 9.6%.

Low blood pressure can be life-threatening and associated with poor outcomes of pneumonia. When blood pressure is too low, the heart cannot pump enough blood to organs, which can cause them to stop working.

In the current study, 30-day mortality was significantly ($p<0.001$) associated with systolic blood pressure <90 mmHg, diastolic pressure d"60 mm Hg, pulse pressure <40 mmHg, and mean arterial pressure <70 mm Hg.

Chalmers et al. (2008) revealed a significant association between low systolic, diastolic, mean arterial, and pulse pressure and the 30-day mortality rate. However, an increased pulse pressure >40 mm Hg was not associated with increased 30-day mortality.

Our study showed systolic blood pressure <90 mmHg and mean pressure <70 mmHg was 5.439 (CI: 1.565 to 18.895) times and 4.465 (CI: 1.280 to 15.579) times more risk for the development of 30-day mortality and 2.958 (CI: 1.007 to 8.691). The study found that both systolic and mean arterial blood pressure were identified as independent risk factors ($p<0.05$) associated with the development of 30-day mortality. These findings were similar to Chalmers et al. (2008).

In this study, systolic pressure (AUC: 0.852), diastolic pressure (AUC:0.826), and mean arterial pressure (AUC: 0.835) had good discriminatory values, and pulse pressure (AUC: 0.746) had moderate discriminatory value for prediction of 30-day mortality. A study was carried out by Chalmers et al. (2008) and found the area under the curve for systolic blood pressure was 0.707, diastolic blood pressure was 0.590, pulse pressure was 0.640, and mean arterial pressure was 0.600. They demonstrated that systolic pressure had moderate discriminatory value and pulse and mean arterial pressure had some discriminatory value for prediction of 30-day mortality.

Limitations

Although optimal care had been tried by the researcher in every step of the study, but there were some limitations:

- Study was conducted in a single hospital. So, the study population might not represent the whole community
- The sample was taken purposively. So, there may be chance of bias which can influence the results
- The study and follow-up period were short in comparison to other studies.
- Small sample size
- Limited resources and facilities

Conclusion

systolic blood pressure and mean arterial pressure are superior to other blood pressure parameters in predicting the 30 days mortality in community acquired pneumonia.

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