

The Predictors of Mortality Rate in Hypertensive COVID-19 Patients based on Electrocardiogram, Chest X-Ray and Laboratory Abnormalities

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Abstract

The probability of in-hospital death was significantly higher in patients with hypertension, hence increasing the risk for severe clinical presentations of COVID-19. This retrospective cohort study included 406 patients with hypertension and confirmed COVID-19 in referral hospitals in East Java between March 2020 to April 2021. Clinical finding, electrocardiograph (ECG), laboratory and chest x-ray (CXR) findings are examined to predict mortality of the hypertensive COVID-19 patients. The median patient age was 57 years with range 49 - 64 years old, predominantly men 58.4%. The final model associated with an increase of mortality in hypertensive COVID-19 patients include cardiomegaly ($p = 0.036$), sinus tachycardia ($p = 0.001$), ST-segment abnormalities ($p = 0.036$), right bundle branch block ($p = 0.008$), left bundle branch block ($p = 0.046$), left ventricle hypertrophy ($p = 0.023$), and creatinine ($p = 0.000$) which were found to be significant predictors of mortality in hypertensive COVID-19 patients after the multivariable regression analysis. We concluded that three different examinations (CXR, ECG, and Laboratory findings) increase the mortality risk in hypertensive COVID-19 patients.

Keywords : Covid-19; hypertension; electrocardiogram; chest x-ray; creatinine

1. Introduction

(The Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) was identified in Wuhan, China, in December 2019, with the World Health Organization (WHO) declaring it a pandemic by March 11, 2020. As of May 11, 2022, Indonesia reported over 6 million COVID-19 cases and 156,000 deaths, ranking 17th globally in case numbers (Marwah, 2022). Comorbidities, additional diseases accompanying the primary ailment, significantly impact COVID-19 outcomes. A meta-analysis by Huang (2020) linked diabetes to higher mortality, severity, and Acute Respiratory Distress Syndrome (ARDS) occurrence. The Faculty of Medicine, University of Indonesia found higher mortality in COVID-19 patients with comorbidities like hypertension, obesity, and blood coagulation issues, leading to low blood oxygen levels, inflammation, and lung damage.

Hypertension and diabetes are prevalent comorbidities in COVID-19 cases, their pathophysiology contributing to severe outcomes (Mehraeen, 2020). Upon hospital admission, 20–51% of patients reported comorbidities, increasing ARDS risk by 75%. COVID-19, compared to influenza and other coronaviruses, is more likely to cause respiratory failure and death, particularly in susceptible groups (Becker, 2021). The probability of in-hospital death is significantly higher in patients with diabetes and hypertension, with hypertension increasing the risk by 2.7 times (Munawaroh, 2021). In Indonesia, 13.2% of COVID-19 deaths had hypertension, and 11.6% had diabetes (Karya, 2021). The risk for individuals with hypertension to die is 1.37 times higher due to increased ACE2 receptors (Drew and Adisasmita, 2021).

The COVID-19 pandemic contributes to hypertension development, mainly due to psychological impacts, emphasizing the need for monitoring high-risk individuals (Rifiana, 2020). Indonesia has the highest mortality rate in Asia, with comorbidities as the leading cause of death. Mortality percentages for COVID-19 patients with hypertension, diabetes, and heart disease are 50.5%, 34.5%, and 19.6%, respectively (Kemkes, 2021).

To reduce mortality in hypertensive COVID-19 patients, a proposed study aims to investigate ECG and CXR abnormalities and characteristics related to abnormal laboratory results. Supporting examinations, including ECG, CXR, and laboratory tests, play a crucial role in diagnosing and assessing COVID-19 complications. This comprehensive approach seeks to enhance understanding and improve outcomes for individuals at high risk of severe complications due to COVID-19 and hypertension.

2. Methods

This study employs an analytical observational design, focusing on analyzing the relationship between variables. Researchers will solely observe and measure variables without administering any treatment to the research subjects. In line with the paper's scope, a retrospective method is utilized for data collection. Retrospective research involves the observation of past events, aiming to identify factors associated with causation. This method is deemed appropriate as the study requires pre-existing data.

The population for this research comprises the data of COVID-19 patients in referral hospitals in East Java during the period from September 2020 to September 2021. The sample for this study encompasses all medical record data that meet the inclusion criteria. Inclusion criteria involve data on COVID-19 patients with hypertension in referral hospitals in East Java between September 2020 and September 2021, with complete medical record variables. A total sampling approach is adopted, meaning that samples will be taken from the entire accessible population, ensuring a comprehensive representation.

The primary dependent variable in this study is the mortality rate in COVID-19 patients with hypertension upon admission to referral hospitals in East Java from September 2020 to September 2021. The independent variables include results from electrocardiograms, chest X-rays, and laboratory tests in COVID-19 patients with hypertension that may impact the mortality rate.

To determine the mortality rate in COVID-19 patients, researchers will review patient medical records, classifying outcomes as either "Alive" or "Dead." The history of hypertension will be established by examining the medical record for a history of hypertension, categorized as "Yes" or "No." Chest X-rays will be conducted through electromagnetic wave radiation to reveal thoracic images, with outcomes categorized as "Cardiomegaly." Electrocardiograms will be examined for various abnormalities, including sinus tachycardia, ST abnormalities, T-wave abnormalities, right/left axis deviation, atrial fibrillation, right/left bundle branch block, QT prolongation, left ventricular hypertrophy, and left atrial enlargement. Laboratory tests will utilize a blood sample to check creatinine and C-reactive protein levels.

The data will be statistically processed at a 5% significance level using the chi-square test in SPSS Statistics 25. To maintain confidentiality, personally identifiable information will be excluded from data processing and analysis, ensuring the privacy of the sample. The benefits of the study include an enhanced

understanding of the relationship between abnormalities in electrocardiograms, chest X-Rays, laboratory tests, and mortality in COVID-19 patients. These insights are expected to contribute to new research prospects and improve the prognosis of COVID-19 patients.

3. Result

3.1. Subject Characteristics

The retrospective cohort study used medical record data of COVID-19 patients from several referral hospitals in East Java within the period of September 2020 to September 2021 with total of 3893 confirmed COVID-19 and researcher took data of COVID-19 patients who had comorbid hypertension with 406 data satisfying our inclusion and exclusion criteria.

The inclusion criteria are hospital admitted patients who have hypertension with complete and readable medical records of Chest X-Ray, Electrocardiogram and Laboratory examination. Patients with incomplete or unreadable data are excluded from the study. Clinical characteristics including Chest X-Ray, Electrocardiogram, and Laboratory examination were obtained from the medical records with a total sampling method.

3.2. Analysis Result

The amount of 76,1% (309 subjects) found to be alive upon hospital discharge, and the remaining proportion of 23,9% (97 subjects) were dead. The demographic distribution of the subject is as follows: 58,4% (237 subjects) are male and 41,6% (169 subjects) are female. The median subjects's age is 57 years old, with the youngest at 49 years old and the oldest at 64 years old.

Table 1. ECG, CXR, and laboratory Characteristics and Univariate Analysis

Variables	Mortality status		P value
	Alive (309, 76,1%)	Dead (97, 23,9%)	
Chest X-Ray characteristics and univariate analysis			
Cardiomegaly (n,%)	71 (64.5%)	39 (35.5%)	0.001
Electrocardiogram characteristics and univariate analysis			
Sinus Tachicardia (n,%)	50 (58.1%)	36 (41.9%)	0.000
ST Abnormalities (n,%)	98 (65.8%)	51 (34.2%)	0.000

T Wave Abnormalities (n,%)	45 (63.4%)	26 (36.6%)	0.006
Right Axis Deviation (n,%)	7 (58.3%)	5 (41.7%)	0.143
Left Axis Deviation (n,%)	24 (57.1%)	18 (42.9%)	0.002
Atrial Fibrillation (n,%)	7 (63.6%)	4 (36.4%)	0.325
RBBB (n,%)	9 (40.9%)	13 (59.1%)	0.000
LBBB (n,%)	3 (37.5%)	5 (62.5%)	0.010
QT Prolongation (n,%)	21 (75.0%)	7 (25.0%)	0.887
LVH (n,%)	35 (53.8%)	30 (46.2%)	0.000
LAE (n,%)	18 (75.0%)	6 (25.0%)	0.896
Laboratorium characteristics and univariate analysis			
Creatinine (n%)	72 (60.0%)	48 (40%)	0.000

Abbreviations : RBBB, right bundle branch block ; LBBB, left bundle branch block ; LVH, left ventricle hypertrophy ; LAE, left atrial enlargement

From Table 1, the relationship between ECG, CXR, and laboratory examination findings with the clinical outcome in the subjects was analysed using chi-square. From the ECG, CXR, and Laboratory characteristics in Table 1, four variables with p -value ≥ 0.25 (atrial fibrillation, QT prolongation, left atrial enlargement) will be excluded from multivariate analysis. While the ten variables with p -value < 0.25 (cardiomegaly, sinus tachycardia, ST abnormalities, T wave abnormalities, right axis deviation, left axis deviation, RBBB, LBBB, LVH, creatinine) were analysed using backward logistic regression.

Table 2. Logistic Regression

Step 5	B	Wald	Sig	Exp (B)
Cardiomegaly	- 0.595	4.374	0.036	0.55
Sinus tachycardia	- 0.999	11.880	0.001	0.37
ST abnormalities	- 0.563	4.397	0.036	0.57
RBBB	- 1.331	7.096	0.008	0.26

LBBB	- 1.698	3.971	0.046	0.18
LVH	- 0.759	5.162	0.023	0.47
Creatinine	- 1.044	15.317	0.000	0.35
Constant	4.503	18.119	0.000	90.26

Following the logistic regression shown in Table 2, can be seen seven significant variables were obtained ($p < 0.05$) which are “cardiomegaly” (odds ratio [OR]=0.55; $p=0.036$), “sinus tachycardia” (odds ratio [OR]=0.37; $p=0.001$), “ST abnormalities” (odds ratio [OR]=0.57; $p=0.036$), “RBBB” (odds ratio [OR]=0.26; $p=0.008$), “LBBB” (odds ratio [OR]=0.18; $p=0.046$), “LVH” (odds ratio [OR]=0.47; $p=0.023$), “creatinine” (odds ratio [OR]=0.35; $p=0.000$).

Moreover, based on the B value of each variable, a logistic model can be formed:

$$Y = - (4.5 - 0.6 [\text{Cardiomegaly}] - 1.0 [\text{Sinus tachycardia}] - 0.56 [\text{ST abnormalities}] - 1.33 [\text{RBBB}] - 1.7 [\text{LBBB}] - 0.76 [\text{LVH}] - 1.04 [\text{Creatinine}])$$

3.3. Discussion

The study investigates the relationship between prognostic factors and mortality in COVID-19 patients with hypertension, considering various parameters such as electrocardiogram (ECG), chest X-ray, and laboratory tests. This research, based on data from 406 patients in East Java from September 2020 to September 2021, identifies significant predictors and their associations with the mortality rate.

Several comorbidities, including hypertension, play a crucial role in the mortality rate of COVID-19 patients. According to Alfhad et al. (2020), hypertension is implicated in the highest death rate globally due to complications in various organs. In COVID-19 patients, hypertension is a prevalent comorbidity (15%), significantly increasing the mortality rate (Gunawan et al., 2020). Yin et al. (2021) reported a 3.5 times higher potential for death in COVID-19 patients with hypertension, reinforcing its impact on outcomes.

The study collected 13 prognostic mortality factors for COVID-19 patients with hypertension, focusing on ECG, chest X-ray, and laboratory creatinine tests. Logistic Regression revealed that seven abnormal ECG prognostic factors had a substantial connection to the mortality rate: cardiomegaly, sinus tachycardia, ST abnormalities, RBBB, LBBB, LVH, and creatinine.

In the realm of ECG, sinus tachycardia emerged as a common finding in COVID-19 patients, significantly correlating with mortality. It is indicative of increased cardiovascular risk, aligning with the European guidelines on hypertension (Palatini et al., 2017). Additionally, ST abnormalities were found to be associated with mortality, contrary to some studies (Arocutipia et al., 2021), highlighting the complex relationship between COVID-19, hypertension, and ECG manifestations.

While T-wave abnormalities had a less significant relationship with mortality, left and right axis deviations were observed. Left axis deviation is commonly found in hypertensive patients and may be attributed to left ventricular hypertrophy (Seko et al., 2021). Atrial fibrillation did not significantly correlate with mortality, contradicting expectations based on its association with hypertension and increased risks (Aronow, 2017).

Bundle branch blocks (RBBB and LBBB) were both significantly associated with mortality. RBBB, considered an electrocardiographic sign of right ventricular strain in COVID-19 patients (Zuin et al., 2021),

and LBBB, frequently linked to hypertension and ischemic heart disease (Bang et al., 2022), were identified as important predictors.

QT prolongation, a known complication associated with increased mortality risk in various clinical scenarios, did not exhibit a significant relationship with mortality in hypertensive COVID-19 patients (Vicentini et al., 2020).

Moving to chest X-ray findings, cardiomegaly was significantly associated with mortality. The hypertensive COVID-19 patients with cardiomegaly exhibited higher cardiovascular pressures, emphasizing the relationship between high blood pressure and cardiomegaly (Daines et al., 2021).

Laboratory tests, specifically elevated creatinine levels, showed a significant association with mortality. Hypertension's role in chronic kidney disease and its impact on creatinine levels (Phan et al., 2014) highlight the importance of monitoring renal function in COVID-19 patients with hypertension.

4. Conclusion

We concluded that cardiomegaly, sinus tachycardia, ST segment abnormalities, left ventricle hypertrophy, right bundle branch block, left bundle branch block, and creatinine abnormal levels may be used to predict mortality rate in hypertensive COVID-19 patients. Therefore, ECG, CXR, and laboratory examination is important for hypertensive COVID-19 patients to determine prognosis

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