



Predictors of Cardiac Arrest in Patients with Acute Myocardial Infarction in Singkawang City

Suhendra^{1*}); Teguh Wahyu Sardjono²; Laily Yuliatun³; Kelana Kusuma Dharma⁴

^{1*)2,3}Nursing Program Faculty of Medicine Universitas Brawijaya, Indonesia

⁴Health Polytechnic of the Ministry of Health, Pontianak

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ABSTRACT

The current nursing literature has not devoted adequate attention to studying cardiac arrest in hospitals, especially in patients with acute myocardial infarction. Identifying predictors of cardiac arrest in patients with acute myocardial infarction is needed to determine appropriate nursing strategies to prevent cardiac arrest. This study aims to determine the predictor factors of cardiac arrest in patients with acute myocardial infarction. This study used a retrospective cohort design with a population of 181 people who were treated with a diagnosis of STEMI and NSTEMI during 2017-2020. Data analysis used chi-square test, Spearman rank and logistic regression. Spearman rank analysis test, age $p=0.045$, $r=0.149$; systolic pressure $p=0.002$, $r=-0.228$; diastolic pressure $p=0.020$, $r=-0.173$; Heart rate $p=0.064$, $r=0.138$; the number of comorbid diseases $p=0.322$, $r=0.074$ and Killip class $p=0.000$, $r=0.431$. Chi square analysis test, gender $p=0.487$, OR=1.322; ECG picture $p=0.885$, OR=1.060; troponin enzyme levels $p=0.951$, OR=1.025; and length of stay $p=0.000$, OR=0.181. The predictor factors for cardiac arrest in patients with acute myocardial infarction were Killip class, length of stay, systolic pressure and heart rate. The most dominant factor in influencing cardiac arrest in patients with acute myocardial infarction is the Killip class.

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Kata kunci:

Faktor predictor
Infark miokard
Henti jantung

*) corresponding author

Nursing Program Faculty of Medicine
Universitas Brawijaya, Indonesia
Jl. Veteran Malang East Java Indonesia Phone
Number: +62 822 5520 7598

Email: suhendra_psmk@student.ub.ac.id

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ABSTRAK

Literatur keperawatan saat ini belum mencurahkan perhatian yang memadai dalam mempelajari henti jantung di rumah sakit khususnya pada pasien infark miokard akut. Mengidentifikasi factor predictor henti jantung pasien infark miokard akut diperlukan untuk menentukan strategi keperawatan yang tepat dalam mencegah kejadian henti jantung. Penelitian ini bertujuan untuk mengetahui factor prediktor kejadian henti jantung pada pasien infark miokard akut. Penelitian ini menggunakan desain cohort retrospective dengan populasi sebanyak 181 orang yang dirawat dengan diagnosis STEMI dan NSTEMI selama 2017-2020. Analisis data menggunakan uji chi-square, spearman rank dan regresi logistik. Uji analisis spearman rank, usia $p=0.045$, $r=0.149$; tekanan sistolik $p=0.002$, $r=-0.228$; tekanan diastolik $p=0.020$, $r=-0.173$; Heart rate $p=0.064$, $r=0.138$; jumlah penyakit komorbid $p=0.322$, $r=0.074$ dan kelas Killip $p=0.000$, $r=0.431$. Uji analisis chi square, jenis kelamin $p=0.487$, OR=1.322; gambaran EKG $p=0.885$, OR=1.060; kadar enzim troponin $p=0.951$, OR=1.025; dan lama rawat $p=0.000$, OR=0.181. Factor predictor kejadian henti jantung pada pasien infark miokard akut adalah kelas Killip, lama rawat, tekanan sistolik dan heart rate. Factor paling dominan dalam mempengaruhi henti jantung pada pasien infark miokard akut adalah kelas Killip.

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INTRODUCTION

The increasing number of cardiovascular diseases is the leading cause of death worldwide as many as 17.1 million. This figure is expected to continue to increase to 23.4 million deaths in 2030. The same is true in Indonesia. Acute Myocardial Infarction (AMI) is an ischemic disease with the highest case fatality rate (CFR) of 13.48%, followed by heart failure and other heart diseases, which are 13.42% and 13.37%, respectively (Saktiningtyastuti & Astuti, 2017).

Acute Myocardial Infarction (AMI) is the most severe form of Acute Coronary Syndrome (ACS) and often occurs with cardiac events leading to increased mortality (B̄arcan et al., 2016). AMI patients have a heart risk 4-6 times greater than other heart diseases (Zaman & Kovoor, 2014). AMI is characterized by chest pain caused by heart damage with complications of cardiac arrest due to ventricular fibrillation (VF) or ventricular tachycardia (VT) without a pulse (Widiyaningsih & Kusyati, 2019).

Acute myocardial infarction with ST segment elevation (STEMI) with various complications is the most severe form of acute coronary syndrome (Dharmawan et al., 2019). Most AMI patients experience cardiac arrest as the first manifestation of an acute event. It is likely that the patient will not be admitted to the hospital immediately after the onset of symptoms. In many cases, cardiac arrest in acute coronary events can be successfully resuscitated if specialized care is given in a timely manner. Survival after an acute event is highly dependent on restoration of coronary flow in the infarcted artery (B̄arcan et al., 2016). However, acute myocardial infarction patients who experience cardiac arrest remain at a low hospital survival rate. In-hospital mortality in cardiac patients is substantially higher than in non-cardiac arrest patients (Kontos et al., 2019).

Death can occur quickly if AMI is not treated immediately. First aid in overcoming pain and blockage does not absolutely lead to a better heart condition because AMI still poses a risk of death in the first 6 months after the attack even though the patient has passed the critical period during the first attack (Emaliyawati et al., 2017). Recurrent infarction, heart failure, cardiogenic shock, hemorrhagic stroke, and cardiac arrest are the most common complications. Therefore, the main key to managing AMI is risk factor control, diagnosis and management in accordance with guidelines (Dharmawan et al., 2019).

To date, there are several risk stratification scores for STEMI patients, including Thrombolysis in Myocardial Infarction (TIMI) scores, Global Registry of Acute Coronary Event (GRACE) scores, Platelet glyco-protein IIb/IIIa in unstable angina: Receptor Suppression Using Integrilin scores (PURSUIT), Rapid Revascularization on Instability in Coronary disease (FRISC) score, HEART score, and CHADS2 score. However, this score is more appropriate for predicting mortality and morbidity during follow-up. Ways to predict the incidence of in-hospital cardiac arrest in acute myocardial infarction are still not available (Han et al., 2017).

Cardiac arrest in patients with AMI is associated with a variety of causative factors. So far, identifying patients at risk for cardiac arrest is a factor that greatly influences survival rates. Nurses can have a significant impact in preventing and minimizing the risk of cardiac arrest in acute myocardial infarction (Attin et al., 2016). Nursing strategies need to be adjusted to the factors associated with predictors of cardiac arrest in acute myocardial infarction. It is intended that nurses who work in an interdisciplinary team can plan appropriate nursing resources, continuous ECG monitoring and close observation in preventing cardiac arrest in AMI

patients. This is an effort to help reduce deaths from AMI and improve patient prognosis (Cui et al., 2018). Based on this background, the researcher wanted to know the factors that could be predictors of the incidence of cardiac arrest in patients with myocardial infarction who underwent hospitalization. The purpose of this study was to determine the relationship between various predictor factors and their effects on the incidence of cardiac arrest in patients with acute myocardial infarction.

METHOD

Participant characteristics and research design

The characteristics of the participants in this study were patients who were treated at the Regional Hospital in Singkawang City with a diagnosis of acute myocardial infarction. The research design used correlational analytic with a retrospective cohort approach.

Sampling procedures

The research data were obtained from the medical records of patients treated with a diagnosis of acute myocardial infarction from 2017-2020. The sampling technique used was total sampling. The research was carried out from March 2021-April 2021 at the RSUD dr. Abdul Aziz Singkawang which is a type B hospital under the Health and family planning department of the city of Singkawang.

Sample size, power, and precision

The population in this study were all patients who were treated with a diagnosis of acute myocardial infarction during 2017-2020 totaling 181 people.

Measures and covariates

All required data are recorded in a research sheet containing research information, namely patient demographic data including age and gender, patient supporting examination data including ECG and troponin enzyme levels, patient vital sign data including systolic blood pressure, diastolic blood pressure and heart rate, disease history data which includes comorbid diseases and length of stay as well as data on killip class. The research data was then processed to determine the relationship of all factors with the incidence of cardiac arrest using the SPSS 22 program.

Data analysis

Bivariate analysis was performed using the Spearman rank test to determine the relationship between age, systolic pressure, diastolic, heart rate, number of comorbid diseases and Killip class with the incidence of cardiac arrest. The chi-square test was used to determine the relationship between sex, ECG features, troponin enzymes, and length of stay with cardiac arrest. Meanwhile, multivariate analysis used logistic regression test. All variables were considered significant at the $p < 0.05$ level.

RESULTS AND DISCUSSION

Of the total 181 patients enrolled in the study, 31 (17.1%) experienced cardiac arrest. based on demographic data, the most common age groups experiencing cardiac arrest were the late elderly (7.7%) and male sex (9.9%). Based on vital signs, most cardiac arrests occurred at systolic pressure <120 MmHg (7.7%), diastolic <80 MmHg (8.3%) and heart rate 41-

90 times/minute (9.9%). Based on Killip class, most cardiac arrests occurred in Killip 4 class (6.6%).

Bivariate analysis showed that the factors associated with the incidence of cardiac arrest in patients with acute myocardial infarction were 1) age, $r = 0.149$, $p = 0.045$; 2) systolic pressure, $r = -0.228$, $p = 0.002$; 3) diastolic pressure, $r = -0.173$, $p = 0.020$; 4) length of stay $OR = 0.181$ 95% CI 0.077 – 0.423, $p = 0.000$; and 5) killip class $r = 0.431$, $p = 0.000$. (table 1).

Table 1
The incidence of cardiac arrest in patients with acute myocardial infarction based on the characteristics of the respondents

Characteristics of Respondents		Number of Respondents	Cardiac Arrest		Result	
			Yes	No		
Age	Adults (26 - 45 years)	21	1	20	p: 0.045*	r: 0.14*
	Early Elderly (46 – 55 years old)	44	5	39		
	Late Elderly (56 – 65 years)	66	14	52		
	Seniors (65 years and over)	50	11	39		
Sex	Man	115	18	97	p: 0.48**	OR : 1.32** (0.601 – 2.907)
	Woman	66	13	53		
Systolic	< 120 MmHg	49	14	35	p : 0.002*	r : -0.22*
	120 - 139 MmHg	39	10	29		
	140 - 159 MmHg	54	3	51		
	≥ 160 MmHg	39	4	35		
Diastolic	< 80 MmHg	65	15	50	p: 0.020*	r : -0.17*
	80 – 89 MmHg	37	9	28		
	90 – 109 MmHg	66	6	60		
	≥ 110 MmHg	13	1	12		
Heart Rate	≤ 40 x/ min	2	0	2	p: 0.06*	r: 0.13*
	41 - 90 x/ min	118	18	100		
	91 - 130 x/ min	53	9	44		
	≥ 131x/ min	8	4	4		
ECG picture	STEMI	113	19	94	p: 0.88**	OR: 1.06** (0.479 – 2.347)
	NSTEMI	68	12	56		
Troponin enzyme levels (cTn)	Reactive	106	18	88	p: 0.95**	OR: 1.02** (0.468 – 2.245)
	Non-Reactive	75	13	62		
Number of comorbid diseases	no commorbid diseases	10	2	8	p: 0.32*	r : 0.07*
	1 comorbid disease	46	5	41		
	>1 comorbid disease	125	24	101		
Length of stay	<5 days	68	22	46	p: 0.000**	OR : 0.18** (0.077 – 0.423)
	>5 days	113	9	104		
Killip Class	Killip 1	90	4	84	p : 0.000**	r : 0.43**
	Killip 2	46	6	40		
	Killip 3	23	9	14		
	Killip 4	22	12	10		

* Spearman analysis test, ** chi square analysis test

Based on the results of the bivariate analysis test, the variables that meet the requirements to be included in the multivariate analysis are age, systolic blood pressure, diastolic blood pressure, heart rate, length of stay and Killip class because it has a p-value <0.25. In this study, logistic regression analysis was performed using the backward method. (Table 2).

Distribution of Cardiac Arrest Events on each variable

Age

Based on the total number of patients, cardiac arrest was more common in the late elderly (56-65 years) and male.

However, the percentage of cardiac arrests mostly occurred in the elderly age group (>65 years) which was 22% and the female sex was 19.69%. Age is associated with increased mortality in acute myocardial infarction. Increasing age contributes dramatically to mortality. The incidence of AMI will increase fivefold at the age of 40-60 years (Muhibbah et al., 2019) and most acute myocardial infarction patients are in the 56-65 year age range (Faridah et al., 2016), but about 80% of deaths from disease heart disease occurs in people aged 65 years or older (Huma et al., 2012). A person's susceptibility to atherosclerosis will increase with age. Another study stated that most acute myocardial infarctions at the age of 45 years and over were caused by stress factors, obesity and hypertension that trigger left ventricular work so

that it causes an imbalance in oxygen supply (Putri et al., 2018). Increasing age is in line with the increase in the incidence of cardiac arrest in patients with acute myocardial

infarction and is often associated with a poor prognosis after cardiac arrest (Andersen et al., 2019).

Table 2
Test Results of Logistic Regression Analysis Predictor Factors for Cardiac Arrest in Patients with Acute Myocardial Infarction in Singkawang City

	Variable	Coefficient (B)	P-value	OR (CI 95 %)
Step 1	Age	0.386	0.146	1.471 (0.874 – 2.476)
	Systolic	-0.495	0.144	0.610 (0.314 – 1.185)
	Diastolic	0.014	0.970	1.014 (0.495 – 2.076)
	Length of Stay	-1.843	0.001	0.158 (0.056 – 0.451)
	Killip Class	1.084	0.000	2.955 (1.839 – 4.750)
	Heart Rate	0.706	0.095	2.025 (0.885 – 4/632)
	Constant	-2.990	0.090	0.050
Step 2	Age	0.386	0.147	1.471 (0.874 – 2.746)
	Systolic	-0.486	0.043	0.615 (0.385 – 0.984)
	Length of Stay	-1.842	0.001	0.158 (0.056 – 0.451)
	Killip Class	1.084	0.000	2.955 (1.839 – 4.750)
	Heart rate	0.707	0.093	2.028 (0.889 – 4.626)
	Constant	-2.987	0.090	0.050
Step 3	Systolic	-0.498	0.036	0.608 (0.382 – 0.968)
	Length of Stay	-1.833	0.001	0.160 (0.057 – 0.449)
	Killip Class	1.104	0.000	3.017 (1.883 – 4.833)
	Heart Rate	0.709	0.092	2.032 (0.890 – 4.638)
	Constant	-1.897	0.222	0.150

Sex

In this study, the incidence of acute myocardial infarction was more common in men with a ratio of 63.5%: 36.5%. This is similar to previous studies which stated that the majority of patients with acute myocardial infarction were male, namely 67.02% (Muhammad & Ardianto, 2015). Other studies also show that men have a greater percentage of experiencing acute myocardial infarction, namely 80% compared to women as much as 20% or with a ratio of 4:1 (Susilo, 2015). However, the percentage of cardiac arrests was mostly female, namely 19.69%. Women suffering from acute myocardial infarction are more prone to cardiac arrest than men. Women are more likely to experience AMI at an older age than men. AMI that occurs at a younger age is associated with a substantial risk of death in women compared to men, especially in women aged <60 years (Canto J et al., 2012). There was no significant difference between gender and the incidence of cardiac arrest. However, women tend to have an increased risk of cardiovascular death which is associated with levels of depression, stress, psychological and anxiety (Takahashi et al., 2018). This finding was reinforced in previous studies that gender differences do play an important role in the pathophysiology of AMI, but coronary plaque rupture and acute thrombosis formation are common in both men and women. The difference is that in women, AMI often occurs at an older age but has a higher mortality than men (Yang et al., 2019).

Sistolic Blood Pressure

The majority of respondents who experienced acute myocardial infarction had systolic pressure in the range of 140-159 MmHg, namely 54 people (29.8%) and diastolic pressure in the range of 90-109 MmHg, namely 66 people (36.5%). However, cardiac arrest was more common in diastolic pressure <120 MmHg as many as 14 respondents

(7.7%) and diastolic <80 MmHg in 15 people (8.3%). Myocardial infarction and sudden cardiac death occur in patients with a systolic pressure in the range of 120 mmHg. The cardiovascular impact in high-risk patients was effectively reduced at a systolic pressure of 140 mmHg. low diastolic blood pressure during treatment leading to increased coronary events occurring in patients with pre-existing disease. Thus, the higher a person's systolic and diastolic pressure, the lower the risk of sudden cardiac death (Weber et al., 2013).

Diastolic Blood Pressure

Most of the cardiac arrests occurred in patients with acute myocardial infarction who had a heart rate of 40-90 beats/minute with more than one comorbidity with a total of 18 people and 24 people, respectively. Although the number of comorbid diseases does not guarantee that someone diagnosed with acute myocardial infarction will not experience cardiac arrest, statistically there is a decrease in the number of cardiac arrests along with a decrease in the number of comorbid diseases. A decrease in heart rate before cardiac arrest can be caused by an imbalance between the sympathetic and parasympathetic nervous systems. It has been reported that the chronotropic response to vagal stimulation develops gradually as sympathetic stimulation precedes stimulation. High heart rate that does not decrease further may be caused by sympathetic nervous system activity that dominates parasympathetic activity (Attin et al., 2015). This study shows that there is a relationship between diastolic blood pressure and the incidence of cardiac arrest in patients with acute myocardial infarction in a negative direction. This can be seen based on the value of the correlation coefficient which shows a negative value and the results of the study which show that the higher the diastolic pressure, the incidence of cardiac arrest seems to decrease. No unfavorable effect was found for diastolic pressure <60 mmHg after adjusting for confounding variables. This implies

that diastolic pressure <60 mmHg does not increase patient risk when cofactors are included in the analysis (Sobieraj et al., 2019). However, diastolic hypertension independently predicted an adverse outcome, although systolic hypertension had a greater effect. In relation to the incidence of infarction, high diastolic blood pressure increases the risk of infarction up to 6.2 times greater than normal diastolic pressure (Flint et al., 2019). An increase in blood pressure in ACS patients in the first 24 hours can occur because of a history of hypertension or the stress response to an ACS attack (Halimuddin, 2016).

Heart Rate

Most of the respondents with acute myocardial infarction in this study had a heart rate of 40-90 beats/minute, namely 118 people (65.2%). Of this number, as many as 18 respondents experienced cardiac arrest. This number is the highest of all heart rate categories. The second largest number was followed by respondents with a heart rate of 91-130 times/minute, as many as 53 people (29.3%) and 9 people with cardiac arrest. According to Attin et al (2015), the decrease in heart rate before cardiac arrest may be due to an imbalance between the sympathetic and parasympathetic nervous systems. It has been reported that the chronotropic response to vagal stimulation develops gradually as sympathetic stimulation precedes stimulation. High heart rate that does not decrease further may be due to sympathetic nervous system activity that dominates parasympathetic activity. Heart rate turbulence proved to be a strong independent predictor of cardiac arrest in acute myocardial infarction patients. However, the heart rate variable is influenced by other factors such as age, gender and drug history so that comparisons cannot be made on the entire AMI population. In addition, the limitation of research on heart rate is the short recording period so that it does not provide a real picture of the overall heart rate turbulence (Abdelghani et al., 2016).

Length of stay and Killip class

Based on the results of this study, the majority of patients with acute myocardial infarction were treated for more than 5 days and the highest number were patients with Killip class 1, but cardiac arrest occurred more in respondents who were treated for <5 days and Killip class 4. Cardiac arrest that occurred later during hospitalization showed failure of hemodynamic stabilization (McManus et al. 2012). Most cardiac arrests in hospital occur after 3 days of hospitalization. Patients who experience cardiac arrest after 3 days of hospitalization have a lower survival at discharge and patients who survive have a lower neurological status and a longer length of stay than during cardiac arrest (Qazi et al. 2017). The Killip classification is an important predictor of the risk of death in patients with acute myocardial infarction including cardiac arrest during hospitalization. The higher the Killip classification, the higher the risk of cardiac arrest (Yang et al., 2019). In this study, most of the respondents who experienced cardiac arrest were respondents with class Killip 4 totaling 12 people. This is in line with previous research which stated that the killip classification is a short-term predictor of post-treatment outcomes for ACS patients with cardiac rehabilitation programs as an indicator of cardiorespiratory function ($p = 0.01$). This study found that ACS patients hospitalized with Killip II were at high risk for poor cardiorespiratory function outcomes after treatment (Alhamid et al., 2021)

Number of Comorbid Diseases

In this study, the majority of acute myocardial infarction patients who experienced cardiac arrest occurred in respondents with more than one comorbid disease. Although the number of comorbid diseases does not guarantee that someone diagnosed with acute myocardial infarction will not experience cardiac arrest, statistically there is a decrease in the number of cardiac arrests along with a decrease in the number of comorbid diseases. That is, the fewer the number of comorbid diseases, the smaller the risk of a person experiencing cardiac arrest. This is in line with previous studies that Acute Myocardial Infarction patients with multiple comorbidities tend to experience a higher mortality rate during hospitalization so that to improve the short-term prognosis an effective strategy is needed in managing AMI patients with multiple comorbidities (Nguyen et al., 2014). This study showed that there was no relationship between the number of comorbid diseases and the incidence of cardiac arrest in patients with acute myocardial infarction. This is different from previous studies which stated that there was a strong relationship between comorbid disease and hospital mortality in patients with acute myocardial infarction (Baechli et al., 2020).

However, other studies have shown that certain risk factors and comorbidities are not associated with an increased risk of cardiac arrest. In acute coronary syndrome patients who have an infarct, the risk of cardiac arrest is related to poor cardiac health, extent of infarct and clinical disease status. However, the severity of the patient has a higher risk for cardiac arrest regardless of the cardiovascular risk factors experienced by the patient (McManus et al. 2012)

Electrocardiogram

Most of the respondents are STEMI patients, however, the percentage of NSTEMI patients experiencing cardiac arrest is greater than STEMI, namely 12 people (17.6%) of all NSTEMI patients. While STEMI patients who experienced cardiac arrest were 19 people (16.8%) of the total STEMI patients. Although there is no association between electrocardiographic findings and specific mechanisms underlying cardiac arrest (Smilowitz et al., 2017), several electrocardiographic-based heart attack risk stratification methods have been studied and show variable effectiveness only as screening tools. To date, there are no individual ECG findings that can adequately stratify patients in terms of heart attack risk (Abdelghani et al., 2016). NSTEMI patients were associated with higher long-term all-cause mortality compared to STEMI patients. AMI patients with ventricular tachycardia are associated with higher mortality when it occurs 48 hours compared to <48 hours of AMI onset (Behnes et al., 2018). ECG changes such as a gradual decrease in heart rate within 15 minutes may have a direct prognostic impact on the timely treatment of some subjects with PEA and asystole which can improve survival of cardiac arrest patients (Attin et al., 2015).

Troponin enzymes

The number of cardiac arrest respondents from the reactive troponin group was 18 people (16.9%) of the total reactive patients, while the number of cardiac arrest respondents from the non-reactive group was 13 people (17.3%) of the total non-reactive patients. Overall, patients

with reactive troponin experienced more cardiac arrest, but the percentage of patients with cardiac arrest was higher than the non-reactive troponin group. Some of the obstacles in measuring troponin is that the examination is carried out at any time so that the time of the examination may occur when the troponin enzyme is not detected. Troponin levels should be measured when the patient arrives at the hospital and after 12 hours. Cardiac troponins are detectable 3-4 hours after the onset of infarction, peak at 12 hours and may remain elevated for up to 2 weeks. Often the troponin test also has false positive results due to other diseases such as pulmonary embolism, aortic stenosis, heart failure, cardiomyopathy and myocarditis. (Rampengan, 2015). In this study, patients who came to the hospital were randomly tested for troponin, often patients came with complaints >12 hours after onset and accompanied by other comorbidities that could obscure the results of the examination.

Predictor Factors of Cardiac Arrest

Killip class

The Killip classification system was introduced for clinical assessment of acute myocardial infarction (MI) patients by grouping individuals according to the severity of heart failure after myocardial infarction consisting of Killip 1 to 4 based on the clinical condition of the patient. Clinical assessment in the Killip classification aims to assess the severity of the disease and predict the prognosis. A high Killip grade predicts a poor short-term prognosis. Therefore, the Killip classification is a valid and reliable tool for early risk stratification in patients with STEMI, especially in resource-limited countries (Hashmi et al., 2020).

There was a significant relationship between Killip class and the incidence of cardiac arrest in patients with acute myocardial infarction with p-value 0.000 and $r = 0.431$. These results indicate that the higher the Killip class, the higher the risk of cardiac arrest in AMI patients. The majority of cardiac arrests occurred in Killip class 4 although the number of patients in this group was the least. The Killip classification is a short-term predictor of post-treatment outcomes for patients with acute coronary syndromes in cardiac rehabilitation programs as an indicator of cardiorespiratory function (Alhamid et al., 2021). The Killip class variable has the highest coefficient (B) of 1.104 so it is the most influential variable in this study. This factor is a strong predictor associated with the cause of death in hospital (Yang et al., 2019) and is an important independent predictor of the risk of death in acute myocardial infarction patients including cardiac arrest during hospitalization (de Mello et al., 2014).

Heart rate

This study shows that there is no relationship between heart rate and the incidence of cardiac arrest, but the heart rate is included in the multivariate analysis because it has a p-value <0.25 until the final modeling by obtaining a coefficient (B) of 0.709 so that it is one of the predictor factors in this study. Mortality and morbidity of patients with acute coronary syndromes can be determined by heart rate because an increase in heart rate at rest can disrupt the cardiovascular continuum and increase the pathogenesis of arterial hypertension (Custodis et al., 2013).

An increase in heart rate at discharge is associated with an increased risk of death within 5 years, and tends to be higher in the first year (Seronde et al., 2014). Heart rate

turbulence proved to be a strong independent predictor of the incidence of cardiac arrest in patients with acute myocardial infarction. However, the heart rate variable is influenced by other factors such as age, gender and drug history, so comparisons cannot be made on the entire AMI population. There are limitations to research on heart rate, namely the short recording period so that it does not provide a real picture of the heart rate turbulence as a whole (Alhamid et al., 2021). Heart rate must be combined with an ECG to achieve a substantial and unmeasurable value in hospitalized patients with atrial fibrillation. This is the main weakness that becomes a technical obstacle during the examination (Murukesan et al. 2013).

The association between heart rate at discharge and long-term mortality was significantly stronger than the relationship between heart rate at admission, starting with heart rate <60 bpm. Last heart rate in hospital is a stronger risk factor for 3-year mortality than heart rate at admission in patients with acute myocardial infarction (Alapati et al., 2019). Therefore, the heart rate is more related in predicting long-term mortality.

Length of Stay

The results of this study showed that respondents with length of stay < 5 days had an 18.1 times greater tendency to experience cardiac arrest than respondents who were treated > 5 days. However, these findings differ from previous findings that cardiac arrests occurring within 48 hours of hospitalization have a better prognosis than cardiac arrests occurring >48 hours during hospitalization. Myocardial ischemia causing cardiac electrical instability can lead to the development of early cardiac arrest, expansion of myocardial injury during hospitalization and hemodynamic instability contributing to an increased risk of cardiac arrest patients dying. Cardiac arrest that occurs later during hospitalization also indicates failure of hemodynamic stabilization (McManus et al. 2012).

Some of the differences in this study could be caused by comorbid factors and a history of previous infarction as well as conditions of heart failure and hypertension that affect the length of treatment. Older age and female sex as well as heart failure and ST segment depression on the initial ECG examination can lead to a longer length of stay (Khalista S.N, Magdaleni A.R, 2021).

In addition, there are a number of factors that can reduce the length of stay of patients with acute myocardial infarction. These factors include improvements in medical management and treatment time, improvements in the quality of physician practice, patient preferences, and economic pressures to increase inpatient efficiency. Several effective cardiac therapies have been shown to be associated with shorter hospital stays. Similarly, the increased use of PCI in patients with acute myocardial infarction allows for prompt revascularization, identifies other coronary lesions, and may eliminate the need for further risk in a stratified hospital which is also expected to reduce length of stay (Saczynski et al. 2010).

Systolic Pressure

There is a negative relationship between systolic blood pressure and cardiac arrest in AMI patients with a P-value of 0.002 and a correlation coefficient of -0.228 which indicates that the lower the systolic pressure, the higher the risk of cardiac arrest in patients with acute myocardial infarction. Previous studies have shown that low systolic pressure tends

to have a higher mortality. Patients who have a systolic pressure of 80 MmHg have a higher risk of cardiac arrest than patients with a systolic pressure of > 80 MmHg (Saczynski et al. 2010). Systolic pressure not only has a significant relationship with the incidence of cardiac arrest in patients with acute myocardial infarction, but also can affect the chances of occurrence of infarction in patients with acute coronary syndrome. Patients with high systolic blood pressure are at risk of infarction as much as 71.4%. This figure is much higher when compared with the risk of infarction in patients who have normal systolic pressure, which is as much as 25%. Therefore, the chance of infarction in patients with acute coronary syndrome with high systolic pressure is 7.5 times greater than in patients with normal systolic pressure in the first 24 hours (Halimuddin, 2016).

LIMITATION OF THE STUDY

There are some limitations that must be acknowledged in this study, mainly because it was carried out retrospectively with the inherent weakness of this design that we were not able to know the patient's condition directly. Second, all data obtained in this study were initial data and were measured on the patient's first day of admission. We were unable to assess changes in the patient's condition during hospitalization in the following days that might affect the results of the study. Third, this study did not include the impact of treatment given to patients during hospitalization that could affect cardiac arrest during treatment follow-up.

CONCLUSIONS AND SUGGESTIONS

From this study it can be concluded that most of the subjects were male, with the most type of ACS being STEMI with an average age of 55-65 years. Cardiac arrest is more common at the age above 65 years and the majority are women. Factors related to cardiac arrest in patients with acute myocardial infarction are age, diastolic pressure, systolic pressure, length of stay and Killip class. The predictor factors for cardiac arrest were systolic pressure, Killip class, length of stay and heart rate, while the strongest predictor factor was Killip class.

The hospital health team needs to be aware of the signs of worsening of acute myocardial infarction patients such as decreased systolic and diastolic pressure and an increase in Killip's classification in the elderly that leads to cardiac arrest. Therefore, it is necessary for early identification and interdisciplinary cooperation to take actions that can prevent cardiac arrest in patients with acute myocardial infarction.

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Ethical Considerations

This study was conducted in accordance with research ethical standards and all research protocols have received ethical approval from the research ethics committee of the Faculty of Medicine, Tanjungpura University with number 2339 /UN22.9/TA/2021

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REFERENCES

- Abdelghani, S. A., Rosenthal, T. M., & Morin, D. P. (2016). Surface electrocardiogram predictors of sudden cardiac arrest. *Ochsner Journal*, 16(3), 280–289.
- Alapati, V., Tang, F., Charlap, E., Chan, P. S., Heidenreich, P. A., Jones, P. G., Spertus, J. A., Srinivas, V., & Kizer, J. R. (2019). Discharge heart rate after hospitalization for myocardial infarction and long-term mortality in 2 us registries. *Journal of the American Heart Association*, 8(3), 1–12. <https://doi.org/10.1161/JAHA.118.010855>
- Alhamid, A. Z., Yulidia, H., & Supriatna, I. I. (2021). Simple Risk Stratification based on Killip Classification and the Six-minute Walk Test Borg Scale for Outcomes of Acute Coronary Syndrome for Papuanese People in Rural Hospital. 91–96.
- Andersen, L. W., Holmberg, M. J., Berg, K. M., Donnino, M. W., & Granfeldt, A. (2019). In-Hospital Cardiac Arrest: A Review. *JAMA - Journal of the American Medical Association*, 321(12), 1200–1210. <https://doi.org/10.1001/jama.2019.1696>
- Attin, M., Feld, G., Lemus, H., Najarian, K., Shandilya, S., Wang, L., Sabouriazad, P., & Lin, C. D. (2015). Electrocardiogram characteristics prior to in-hospital cardiac arrest. *Journal of Clinical Monitoring and Computing*, 29(3), 385–392. <https://doi.org/10.1007/s10877-014-9616-0>
- Attin, M., Tucker, R. G., & Carey, M. G. (2016). In-Hospital Cardiac Arrest: An Update on Pulseless Electrical Activity and Asystole. *Critical Care Nursing Clinics of North America*, 28(3), 387–397. <https://doi.org/10.1016/j.cnc.2016.04.010>
- Baechli, C., Koch, D., Bernet, S., Gut, L., Wagner, U., Mueller, B., Schuetz, P., & Kutz, A. (2020). Association of comorbidities with clinical outcomes in patients after acute myocardial infarction. *IJC Heart and Vasculature*, 29, 100558. <https://doi.org/10.1016/j.ijcha.2020.100558>
- Bărcan, A., Chițu, M., Benedek, E., Rat, N., Korodi, S., Morariu, M., & Kovacs, I. (2016). Predictors Of Mortality In Patients With ST-Segment Elevation Acute Myocardial Infarction And Resuscitated Out-Of-Hospital Cardiac Arrest. *The Journal of Critical Care Medicine*, 2(1), 22–29. <https://doi.org/10.1515/jccm-2016-0001>
- Behnes, M., Mashayekhi, K., Weiß, C., Nienaber, C., Lang, S., Reiser, L., Bollow, A., Taton, G., Reichelt, T., Ellguth, D., Engelke, N., Schupp, T., Ansari, U., El-Battrawy, I., Rusnak, J., Akin, M., Borggrefe, M., & Akin, I. (2018). Prognostic impact of acute myocardial infarction in patients presenting with ventricular tachyarrhythmias and aborted cardiac arrest. *Journal of the American Heart Association*, 7(19). <https://doi.org/10.1161/JAHA.118.010004>
- Canto J.G; Rogers W.J; Goldberg R.J; Peterson E.D; Wenger N.K; Vaccarino.V. (2012). Association of Age and Sex With Myocardial Infarction Symptom Presentation and In-Hospital Mortality. *JAMA*, 307(8), 813–822. <https://doi.org/10.1001/jama.2012.199>.Association
- Cui, L. P., Li, L. L., Liu, A. Q., Ding, P., Hu, S. H., Wang, C. H., Fang, M. H., Zhang, Y., Wang, Q. Q., Dai, S. H., Liu, M. R., & Qian, X. S. (2018). Clinical analysis for the death of 127 patients with acute myocardial infarction and nursing strategies. *Biomedical Research (India)*, 29(13), 2697–2702.

- <https://doi.org/10.4066/biomedicalresearch.29-17-3989>
- Custodis, F., Reil, J. C., Laufs, U., & Böhm, M. (2013). Heart rate: A global target for cardiovascular disease and therapy along the cardiovascular disease continuum. *Journal of Cardiology*, 62(3), 183–187. <https://doi.org/10.1016/j.jjcc.2013.02.018>
- David D. McManus, Farhan Aslam, Parag Goyal, Robert J. Goldberg, W. H. And, & Gore, J. M. (2012). Incidence, prognosis, and factors associated with cardiac arrest in patients hospitalized with acute coronary syndromes (the Global Registry of Acute Coronary Events Registry). *Coron Artery Dis*, 23(2), 105–112. <https://doi.org/doi:10.1097/MCA.0b013e32834f1b3c>.
- de Mello, B. H. G., Oliveira, G. B. F., Ramos, R. F., Lopes, B. B. C., Barros, C. B. S., de Oliveira Carvalho, E., Teixeira, F. B. P., Arruda, G. D. S., Revelo, M. S. C., & Piegas, L. S. (2014). Validation of the killip–kimball classification and late mortality after acute myocardial infarction. *Arquivos Brasileiros de Cardiologia*, 2, 107–117. <https://doi.org/10.5935/abc.20140091>
- Dharmawan, M., Hidayat, L. W., & Tiluata, L. J. (2019). Profil Infark Miokard Akut dengan Kenaikan Segmen-ST Di ICCU RSUD Prof W . Z . Johannes Kupang, Nusa Tenggara Timur, Januari-April 2018. *Jurnal Cermin Dunia Kedokteran*, 46(12), 727–730. <http://www.cdkjournal.com/index.php/CDK/article/view/391>
- Emaliyawati, E., Sutini, T., Ibrahim, K., Trisyani, Y., & Prawesti, A. (2017). Pengalaman Psikologis Pasien Infark Miokard Akut Selama Dirawat Di Ruang Intensif. *Jurnal Pendidikan Keperawatan Indonesia*, 3(1), 32. <https://doi.org/10.17509/jpki.v3i1.7477>
- Faridah, E. N., Pangemanan, J. A., & Rampengan, S. H. (2016). Gambaran Profil Lipid Pada Penderita Sindrom Koroner Akut Di Rsup. Prof. Dr. R. D. Kandou Periode Januari – September 2015. *E-Clinic*, 4(1). <https://doi.org/10.35790/ecl.4.1.2016.11023>
- Flint, A. C., Conell, C., Ren, X., Banki, N. M., Chan, S. L., Rao, V. A., Melles, R. B., & Bhatt, D. L. (2019). Effect of Systolic and Diastolic Blood Pressure on Cardiovascular Outcomes. *New England Journal of Medicine*, 381(3), 243–251. <https://doi.org/10.1056/nejmoa1803180>
- Halimuddin. (2016). TEKAMAN DARAH DENGAN KEJADIAN INFARK PASIEN Blood Pressure and Infarction in Acute Coronary Syndrome patients. *Idea Nursing Journal*, VII(3), 30–36.
- Han, K. W., Chen, S. Y., Weng, Y. M., Ng, C. J., Chiu, T. F., Hsieh, I. C., & Chen, J. C. (2017). Validation of different score systems in predicting cardiac arrest occurrence of ST-elevation myocardial infarction. *Hong Kong Journal of Emergency Medicine*, 24(5), 224–229. <https://doi.org/10.1177/1024907917724729>
- Hashmi, K. A., Adnan, F., Ahmed, O., Yaqeen, S. R., Ali, J., Irfan, M., Edhi, M. M., & Hashmi, A. A. (2020). Risk Assessment of Patients After ST-Segment Elevation Myocardial Infarction by Killip Classification: An Institutional Experience. *Cureus*, 12(12). <https://doi.org/10.7759/cureus.12209>
- Huma, S., Tariq, R., Amin Dr., F., & Mahmood Dr., K. T. (2012). Modifiable and non-modifiable predisposing risk factors of myocardial infarction -A review. *Journal of Pharmaceutical Sciences and Research*, 4(1), 1649–1653.
- Khalista S.N, Magdaleni A.R, A. D. . (2021). Jurnal Sains dan Kesehatan. *Jurnal Sains Dan Kesehatan*, 2(4), 432–437.
- Kontos, M. C., Fordyce, C. B., Chen, A. Y., Chiswell, K., Enriquez, J. R., de Lemos, J., & Roe, M. T. (2019). Association of acute myocardial infarction cardiac arrest patient volume and in-hospital mortality in the United States: Insights from the National Cardiovascular Data Registry Acute Coronary Treatment And Intervention Outcomes Network Registry. *Clinical Cardiology*, 42(3), 352–357. <https://doi.org/10.1002/clc.23146>
- Muhammad, G., & Ardianto, P. (2015). Profil Faktor Risiko Atherosklerosis Pada Kejadian Infark Miokard Akut Dengan ST-Segment Elevasi Di Rsup Dr Kariadi Semarang. *Jurnal Kedokteran Diponegoro*, 4(4), 849–858.
- Muhibbah, M., Wahid, A., Agustina, R., & Illiandri, O. (2019). Karakteristik Pasien Sindrom Koroner Akut Pada Pasien Rawat Inap Ruang Tulip Di Rsup Ulin Banjarmasin. *Indonesian Journal for Health Sciences*, 3(1), 6. <https://doi.org/10.24269/ijhs.v3i1.1567>
- Murukesan, L., Murugappan, M., & Iqbal, M. (2013). Sudden cardiac death prediction using ECG signal derivative (Heart Rate Variability): A review. *Proceedings - 2013 IEEE 9th International Colloquium on Signal Processing and Its Applications, CSPA 2013, January 2014*, 269–274. <https://doi.org/10.1109/CSPA.2013.6530054>
- Nguyen, H. L., Nguyen, Q. N., Ha, D. A., Phan, D. T., Nguyen, N. H., & Goldberg, R. J. (2014). Prevalence of Comorbidities and Their Impact on Hospital Management and Short-Term Outcomes in Vietnamese Patients Hospitalized with a First Acute Myocardial Infarction. *PLoS ONE*, 9(10), 1–7. <https://doi.org/10.1371/journal.pone.0108998>
- Putri, R. N., Suryanti, S., & Lestari, S. (2018). Gambaran Serum Elektrolit Pada Pasien Acute Miocard Infark (AMI) Di Ruang Intensive Kardiovaskuler Care Unit (ICVCU) RSUD Dr. Moewardi Di Surakarta. (*Jkg*) *Jurnal Keperawatan Global*, 3(2), 119–131. <https://doi.org/10.37341/jkg.v3i2.59>
- Qazi, Abdul H. Kennedy, K. Bradley, Steven M, Chan, P. S. (2018). Impact of Timing of Cardiac Arrest During Hospitalization on Survival Outcomes and Subsequent Length of Stay. *Resuscitation*, 121, 117–122. <https://doi.org/10.1016/j.resuscitation.2017.10.003>. Impact
- Rampengan, S. H. (2015). *Kegawatdaruratan jantung*. Badan Penerbit Fakultas Kedokteran Universitas Indonesia.
- Saczynski, J.S; Lessard, D; Spencer, F.A; Gurwitz, J.H; Gore, J.M; Yarzebski, J. (2010). Declining Length of Stay for Patients Hospitalized with AMI: Impact on Mortality and Readmissions. *Am J Med.*, 123(11), 1007–1015. <https://doi.org/10.1016/j.amjmed.2010.05.018>. Declining
- Saktiningtyastuti, F., & Astuti, S. L. D. (2017). FAKTOR YANG MEMPENGARUHI SERANGAN JANTUNG BERULANG PADA PASIEN AMI DI RUANG ICVCU RSUD Dr. MOEWARDI TAHUN 2016 Fransisca Saktiningtyastuti, Sri Lestari Dwi Astuti. *Junal Keperawatan Global*, 2(1), 35–45.
- Seronde, M. F., Geha, R., Puymirat, E., Chaib, A., Simon, T., Berard, L., Drouet, E., Bataille, V., Danchin, N., & Schiele, F. (2014). Discharge heart rate and mortality after acute myocardial infarction. *American Journal of Medicine*, 127(10), 954–962. <https://doi.org/10.1016/j.amjmed.2014.06.034>
- Smilowitz, N. R., Mahajan, A. M., Roe, M. T., Hellkamp, A. S., Chiswell, K., Gulati, M., & Reynolds, H. R. (2017). Mortality of Myocardial Infarction by Sex, Age, and Obstructive Coronary Artery Disease Status in the ACTION Registry-GWTG (Acute Coronary Treatment and Intervention Outcomes Network Registry-Get with the Guidelines). *Circulation: Cardiovascular Quality and Outcomes*, 10(12), 1–8. <https://doi.org/10.1161/CIRCOUTCOMES.116.003443>
- Sobieraj, P., Lewandowski, J., Siński, M., & Gaciong, Z. (2019). Low on-treatment diastolic blood pressure and cardiovascular

outcome: A post-hoc analysis using NHLBI SPRINT Research Materials. *Scientific Reports*, 9(1), 1–8. <https://doi.org/10.1038/s41598-019-49557-4>

Susilo, C. (2015). Identifikasi Faktor Usia, Jenis Kelamin Dengan Luas Infark Miokard Pada Penyakit Jantung Koroner (Pjk) Di Ruang Iccu Rsd Dr. Soebandi Jember. *The Indonesian Journal of Health Science*, 6(1), 1–7.

Takahashi, M., Kondo, Y., Senoo, K., Fujimoto, Y., & Kobayashi, Y. (2018). Incidence and prognosis of cardiopulmonary arrest due to acute myocardial infarction in 85 consecutive patients. *Journal of Cardiology*, 72(4), 343–349. <https://doi.org/10.1016/j.jjcc.2018.04.001>

Weber, M. A., Bakris, G. L., Hester, A., Weir, M. R., Hua, T. A., Zappe, D., Dahlof, B., Velazquez, E. J., Pitt, B., & Jamerson, K. (2013). Systolic blood pressure and cardiovascular outcomes during treatment of hypertension. *American Journal of Medicine*, 126(6), 501–508. <https://doi.org/10.1016/j.amjmed.2013.01.007>

Widiyaningsih, W., & Kusyati, E. (2019). Hemodinamik Pasien Akut Miokard Infark (AMI) Di Ruang Perawatan Kritis. *Journal of Holistic Nursing Science*, 6(1), 22–27. <https://doi.org/10.31603/nursing.v6i1.2391>

Yang, H. Y., Ahn, M. J., Jeong, M. H., Ahn, Y., Kim, Y. J., Cho, M. C., & Kim, C. J. (2019). Predictors of In-Hospital Mortality in Korean Patients with Acute Myocardial Infarction. *Chonnam Medical Journal*, 55(1), 40. <https://doi.org/10.4068/cmj.2019.55.1.40>

Zaman, S., & Kovoov, P. (2014). Sudden cardiac death early after myocardial infarction pathogenesis, risk stratification, and primary prevention. *Circulation*, 129(23), 2426–2435. <https://doi.org/10.1161/CIRCULATIONAHA.113.007497>