



The Relationship Between Troponin I Levels and Mortality in Patients with Acute Myocardial Infarction at Gunung Jati General Hospital in Cirebon, 2023–2024

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Keywords:

ABSTRACT

Troponin I Levels; Mortality; Acute Myocardial Infarction

The mortality rate of patients hospitalized due to Acute Coronary Syndrome (ACS) in Indonesia reached 32.3%, with Acute Myocardial Infarction (AMI) being one of the most fatal classifications. The cardiac troponin I test is the first-line standard for diagnosing AMI due to its high specificity and sensitivity. Troponin I not only reflects myocardial damage but also serves as a prognostic indicator for patient outcomes. This research aims to determine the relationship between troponin I levels and mortality in patients with Acute Myocardial Infarction at Gunung Jati Cirebon Hospital during the 2023–2024 period. This research employed a cross-sectional design using secondary data from medical records. A total sampling technique was applied, involving 240 patients who met the inclusion and exclusion criteria. Data were analyzed univariately and bivariately using the Spearman's rho correlation test. Troponin I levels had a median of 1.78 ng/mL (range: 0.03–10 ng/mL). The majority of patients were in the non-death category (207 patients; 86.25%). Bivariate analysis showed a significant relationship between troponin I levels and mortality ($p = 0.009$; $p < 0.01$) with a correlation coefficient (r) of 0.167, indicating that higher troponin I levels tend to be associated with increased mortality risk, although the correlation strength is weak. There is a significant correlation between troponin I levels and mortality in patients with Acute Myocardial Infarction, with weak correlation strength. Although the relationship is weak, these findings suggest that troponin I can still be used as one of the risk indicators for mortality in AMI patients.

INTRODUCTION

According to World Health Organization (WHO) 2020 data, an estimated 19 million deaths (37%) worldwide are caused by cardiovascular disease. Deaths in Indonesia due to cardiovascular disease reach 651,481 people per year. According to data from the 2018 Basic Health Research Report (RISKESDAS), in cases of SKA in Indonesia, the prevalence is 1.5% and in cases in West Java Province it is 1.6%. (PERKI, 2024)(Riset Kesehatan Dasar (Riskesdas), 2018)One form of classification of SKA is IMA (Acute Myocardial Infarction). The mortality rate of patients hospitalized due to SKA in Indonesia reached 32.3%. This figure is one of the highest in the world. The highest case fatality rate (CFR) occurred in IMA (13.49%), followed by heart failure (13.42%) and other heart diseases (13.37%).(Nugraha et al., 2022)

Troponin tests on the heart are the first-line standard for diagnosing the occurrence of acute myocardial infarction. Troponin is divided into 3, namely troponin C, troponin I, and troponin

T. Troponin I and T are markers of cardiac myocyte necrosis and are markers for the diagnosis of myocardial infarction. Troponin is said to be almost specific and very sensitive in detecting the presence of IMA. Troponin levels not only reflect heart damage but can also serve as a prognosis indicator for patients with cardiovascular conditions.(Lin et al., 2022)

The troponin I test, whether highly sensitive or not, is an important marker in diagnosing IMA. In high-sensitivity tests, even a slight increase in troponin levels can be detected, allowing for earlier and accurate diagnosis, especially for patients whose symptoms are still mild or unclear. Conventional troponin can detect at higher levels, patients with mild IMA are at risk of going undetected.(Duque-Ossa et al., 2023; Lin et al., 2022)

Several studies have examined the relationship between troponin levels and mortality in AMI patients. Potter et al. (2022) reported that elevated troponin levels may signal myocardial injury rather than infarction, and high-risk patients were identified with elevated cardiac troponin in pulmonary embolism and heart failure. Kaura et al. (2019) conducted a large cohort study of 250,000 patients across five UK acute care centres, demonstrating a significant association between troponin levels and mortality. Their findings indicated that even minor elevations in troponin were associated with increased mortality risk. Baechli et al. (2020) found that AMI patients with comorbidities had a 26% higher risk of mortality compared to those without comorbidities (adjusted OR 1.26, 95% CI 1.20–1.33), with a stronger association in younger patients. Staszczak et al. (2023) reported that hospital mortality (7% vs. 3.6%, $p < 0.05$) and 30-day mortality (7.7% vs. 5.1%, $p < 0.05$) were significantly greater among ST-segment elevation myocardial infarction (STEMI) patients compared to non-STEMI patients.

Despite extensive research on troponin as a prognostic marker, several gaps remain. First, most studies have been conducted in Western populations or large tertiary referral centres, with limited data from regional hospitals in Indonesia, particularly in West Java. Second, studies examining the relationship between troponin I levels and mortality specifically at Gunung Jati General Hospital Cirebon have not been previously conducted. Third, limited research has comprehensively analyzed other factors influencing mortality, including comorbidities and types of reperfusion therapy in this specific population. Fourth, there is a lack of recent data (2023–2024) on the prognostic value of troponin I in AMI patients in the Cirebon region.

This research offers several novel contributions. First, it provides the first comprehensive analysis of the relationship between troponin I levels and mortality in AMI patients at Gunung Jati General Hospital Cirebon, filling a gap in regional data for West Java. Second, the study uses the most recent data from the 2023–2024 period, reflecting current clinical practice and patient outcomes. Third, this research examines additional factors associated with mortality, including patient characteristics, comorbidities, and types of reperfusion therapy, providing a more complete picture of mortality risk factors. Fourth, the findings contribute to the limited body of knowledge on troponin I as a prognostic marker in Indonesian healthcare settings, which may differ from Western contexts in terms of patient demographics, healthcare access, and treatment patterns.

This study aims to determine the relationship between troponin I levels and mortality in patients with Acute Myocardial Infarction at Gunung Jati General Hospital Cirebon during the 2023–2024 period. The findings of this research are expected to provide several benefits. Theoretically, this study contributes to the development of medical science, particularly in the field of cardiology, by providing empirical evidence on the prognostic value of troponin I in

Indonesian AMI patients and enriching the academic literature on cardiac biomarkers in regional hospital settings. Practically, the results can assist clinicians in risk stratification and early identification of high-risk AMI patients based on troponin I levels, support evidence-based clinical decision-making regarding treatment intensity and monitoring, and provide hospital administrators with data for improving patient management protocols and resource allocation. From a policy perspective, this research informs the development of local clinical guidelines for AMI management at Gunung Jati General Hospital and contributes to quality improvement initiatives in cardiovascular care services. Furthermore, this study provides baseline data for future research on cardiac biomarkers and AMI outcomes in the Cirebon region.

METHOD

This study used an analytical observational research method with a Cross Sectional design using secondary data in the form of patient medical records. The sampling technique in this study is to use total sampling with inclusion criteria, namely: patients at Gunung Jati Cirebon Hospital who were diagnosed with Acute Myocardial Infarction (AMI) by a heart and vascular specialist during intratreatment in the period 01 January 2023 – 31 December 2024. The exclusion criteria in this study were: Incomplete medical record data including age, sex, diagnosis, presence of comorbidities, type of comorbidities, mortality of intra-care patients, troponin I levels, patient actions (Fibrinolytic, PCI, Non-reperfusion Medication). The data were analyzed univariate for each variable studied and bivariate analysis was carried out to find out both using the Spearmann's rho test. This research was carried out after receiving approval to have obtained Ethical Clearance from Gunung Jati General Hospital Cirebon and this research has been approved by the ethics committee of Gunung Jati Hospital with the following number No.013/LAIKETIK/KEPPKRSJGJ/II/2025 on February 17, 2025 and the research permit was submitted to the director of Gunung Jati Cirebon Hospital with the number 000.9.2/251-BANG.

RESULTS AND DISCUSSION

Overview of Patient Distribution

Acute Myocardial Infarction

Table 1. Sample Characteristics Distribution Overview

No.	Characteristics	Sample	
		Frequency (n)	Percentage (%)
1.	Age		
	0-17	0	0
	18-65	181	75,41
	66-79	53	22,08
	80-99	6	2,5
2.	Gender		
	Male	177	73,75
	Women	63	26,25
3.	Mortality		
	Died	33	13,75

	Not Dead	207	86,25
4.	Presence of Comorbidities		
	With comorbidities	205	85,41
	No comorbidities	35	14,58
5.	Types of Comorbidities*		
	Type-2 Diabetes Mellitus	70	34,14
	Congestive Heart Failure	52	25,36
	Kidney Failure	51	24,87
	Hypertension	42	20,48
	Pneumonia	23	11,21
6.	IMA Group		
	IMA EAST	120	50
	IMA-NEST	120	50

Source: Medical records of Gunung Jati General Hospital Cirebon, processed by the author (2026)

In this study, based on age, the most in the age category of 18-65 years as many as 181 patients (75.41%). Based on gender, the majority of patients were male as many as 177 patients (73.75%). Based on mortality, it was found that as many as 207 patients (86.25%) were declared not dead. Based on the presence of comorbidities, most patients had comorbidities, namely 205 patients (85.41%). Based on the types of comorbidities, the most comorbidities were found to be Type-2 Diabetes Mellitus as many as 70 cases (29.41%). And based on the classification of the IMA group, the distribution of patients between IMA with elevation of the ST segment (IMA-EST) and IMA without elevation of the ST segment (IMA-NEST) showed a balanced proportion, each of 120 patients (50%).

Table 2. Statistical Data on Troponin I Levels in IMA Patients

Variable	Median	Minimum	Maximum
Troponin I Levels	1,78	0,03	10

Source: Medical records of Gunung Jati General Hospital Cirebon, processed by the author (2026)

The median data of troponin I levels found was 1.78 with a minimum value of 0.03 ng/mL and a maximum value of troponin I levels of 10 ng/mL.

In this study, type 2 diabetes mellitus is a comorbid with the most patients, which is 70 patients. According to the Cardiovascular Prevention study of the Observational Cohort in Japan (EPOCH-JAPAN) shows that diabetes is a major risk factor for all causes and deaths of cardiovascular disease. Diabetes is associated with a two- to four-fold increased risk of death from cardiovascular disease and seventy percent of all deaths from diabetes are due to cardiovascular disease. The second most common comorbidity is congestive heart failure with 52 patients According to Wonoredjo (S. Li et al., 2019)et al. (2024) It was described that atherosclerosis interferes with blood flow to the heart, causing an imbalance between the oxygen supply and the oxygen needs of myocytes. Prolonged atherosclerosis can also lead to acute myocardial infarction, resulting in increased cardiac work which in turn leads to left ventricular hypertrophy. In addition, this condition can lead to heart failure if it continues. The third highest comorbid is kidney failure. Patients with CKD occur in >30% of patients with acute myocardial infarction and have been associated with lower guideline treatment rates and

poorer prognosis. The fourth highest comorbidity is hypertension in 42 patients In the study Pricillia (Wonoredjo & Ariwibowo, 2024)(Freese Ballegaard et al., 2024)et al. (2021) confirmed that hypertension increases the risk of acute myocardial infarction by 5,231 times compared to patients who have no history of hypertension. In hypertension, there are changes in the form of endothelial dysfunction, blood flow stasis, and hypercoagulation that will cause IMA. This endothelial disorder can be caused by increased oxidative stress, resulting in a decrease in nitric oxide (NO) production which leads to problems with vasodilation and increased blood vessel permeability. This causes the activation, adhesion, and aggregation of monocytes and lipids in the blood, resulting in atheromas. This atheroma can then experience bleeding, ulceration, calcification, or thrombosis, which will eventually result in static blood flow. The fifth highest comorbid is pneumonia, 23 patients The high mortality and morbidity rate is strongly related to heart and blood vessel problems that are the result of or occur concomitantly with acute pneumonia attacks. Pneumonia is able to trigger inflammatory reactions throughout the body that can lead to a severe decrease in blood flow as well as failure of several organs. A mismatch between ventilation and perfusion as well as deviant blood flow in the lungs results in hypoxemia, a temporary increase in serum endothelin-1 levels which is a vasoconstrictor substance and triggers an increase in blood clotting processes. The cardiovascular complications associated with community pneumonia are the result of the atherosclerosis process that causes damage to the endothelial as well as ischemia or abnormal myocardial behavior.(Pricillia et al., 2021)(Pricillia et al., 2021)(Krüger & Frechen, 2022)(Krüger & Frechen, 2022)(Krüger & Frechen, 2022)

The Relationship of Troponin I Levels with Mortality

Table 3. The Relationship between Troponin I Levels and Mortality in Acute Myocardial Infarction Patients at Gunung Jati Cirebon Hospital in 2023-2024

		Mortality	
		p-value	r
Spearman's rho	Troponin I Levels	0,009	0,167

Source: Author's data analysis (2026) using Spearman's rho correlation test

This study was conducted using the Spearman's rho correlation test which has a significant value at $p < 0.01$. In the table above, the results of the bivariate test in this study are $p = 0.009$ ($p < 0.01$) so that there is a significant correlation between troponin I levels and mortality, and the correlation coefficient value (r) is 0.167 which means that the higher the troponin I level, the possibility of mortality tends to increase. There is sufficient evidence to conclude that troponin levels have a statistically significant relationship with the mortality of acute myocardial infarction patients. This means that patients with higher troponin levels tend to have a higher risk of death than those with lower troponin, even though the strength of the relationship is weak.

Troponin I levels are determined in patients who arrive at the emergency room, not only due to complaints of chest pain but also for various other symptoms. Therefore, sometimes the results of the troponin test show positive separately, without any other signs that lead to cardiac ischemia, but with strong evidence of a different diagnosis, for example in pneumonia.(Kaura et al., 2019)

Troponin is the main cardiac biomarker in modern medicine to detect ischemia in acute myocardial infarction. Troponin shows improvement in most cases of IMA within 2 to 3 hours after the patient arrives at the emergency room. Troponin I is detected in skeletal muscle so that it is more sensitive and specific. Because cardiac troponin levels remain high in the blood for several days after AMI, they are not useful in evaluating cardiac myocyte re-infarction. However, there are some conditions that cause elevated troponin levels such as acute pulmonary embolism, end-stage kidney disease, pericarditis, myocarditis, Stanford A aortic dissection, acute or chronic heart failure, strenuous exercise, cardiotoxic chemotherapy, radiofrequency catheter ablation for arrhythmias, cardioversion of atrial fibrillation or atrial flutter, defibrillation for ventricular fibrillation or tachycardia, amyloidosis, cardiac contusion due to blunt trauma of the chest wall, sepsis, and rhabdomyolysis. (Patibandla S, Gupta K, 2024)(Patibandla S, Gupta K, 2024)(Patibandla S, Gupta K, 2024)In addition, researchers also looked at the frequency and percentage based on the mortality of Acute Myocardial Infarction patients. Analysis of other factors that may be related to mortality is also analyzed in this study.

Table 4. Overview of Sample Characteristics by Mortality

Acute Myocardial Infarction Patients

No.	Characteristics	Frequency (n) and Percentage (%) of Mortality		p-value
		Died n (%)	No Deaths n (%)	
1. Age				
	0-17	0 (0%)	0 (0%)	0,972
	18-65	25 (10,41%)	156 (65%)	
	66-79	7 (2,91%)	46 (19,16%)	
	80-99	1 (0,41%)	5 (2,08%)	
2. Gender				
	Male	26 (10,83%)	151 (62,91%)	0,479
	Women	7 (2,91%)	56 (23,3%)	
3. Presence of Comorbidities				
	With comorbidities	30 (12,5%)	175 (72,91%)	0,336
	No comorbidities	3 (1,25%)	32 (13,33%)	
4. IMA Group				
	IMA EAST	21 (8,75%)	99 (41,25%)	0,092
	IMA-NEST	12 (5%)	108 (45%)	

Source: Medical records of Gunung Jati General Hospital Cirebon, processed by the author (2026)

The table above shows the distribution of sample characteristics based on the mortality status of acute myocardial infarction patients. Based on age, the age group of 18-65 years experienced the highest mortality with 25 patients (10.41%) with the results of statistical tests showing a value of $p=0.972$, so there was no meaningful relationship with mortality based on age. Based on gender, men were the group that experienced the most deaths, namely 26 patients (10.83%), while women as many as 7 patients (2.91%). However, statistical tests showed a value of $p=0.479$, so there was no meaningful relationship with mortality based on gender. Most of the patients in this study had comorbidities, namely 205 patients (85.41%). Based on the group with comorbidities, as many as 30 patients (12.5%) died. The results of the statistical

test showed a value of $p=0.336$. This means that there is no statistically significant relationship between the presence of comorbidities and the mortality rate of acute myocardial infarction patients in this study. In the acute myocardial infarction type group, patients with elevated ST segment IMA (IMA-EST) had a higher number of deaths (21 patients; 8.75%) than non-elevation ST segment IMA (IMA-NEST) (12 patients; 5%). However, the value of $p=0.092$, so this relationship also does not reach statistical significance.

Overall, the results of the analysis showed that in this study no meaningful relationship was found in mortality based on age, sex, presence of comorbidities, types of comorbidities, or groups of acute myocardial infarction. Nevertheless, the distribution of mortality was more apparent in 18-65 years, male patients, patients with comorbidities, as well as in the IMA-EST group, which may clinically be a consideration in risk stratification although it is not statistically significant.

According to a study conducted by Potter et al. (2022) mentioned that elevated troponin levels may signal myocardial injury, not infarction. High-risk patients were identified with elevated cardiac troponin in pulmonary embolism and heart failure, but treatment did not affect them much. To date, increased cardiac troponin in adults has been associated with a poorer prognosis in all conditions studied.(Potter et al., 2022)(Potter et al., 2022)

In this study, the incidence of myocardial infarction was most common in men compared to women. This finding is in line with the results of research by Amriani (2024) who explained that women have the hormone estrogen, while men do not. The hormone estrogen is known to play a role in preventing atherosclerosis, which is the hardening and thickening of the walls of blood vessels. Increased age has a stronger association with increased cardiac troponin levels in women than in men. Women tend to achieve cardiac troponin concentrations equivalent to men about a decade later, suggesting that the progression of coronary artery disease or other heart disorders in women is likely to take place more (Amriani & Maricar, 2024)slowly.(De Bakker et al., 2023)

In the study of Baechli et al. (2020) stated that compared to AMI patients without comorbidities, comorbid patients had a 26% higher risk of mortality (adjusted odds ratio [OR] 1.26, 95% confidence interval [CI] 1.20 to 1.33) with a clear association in younger patients.(Baechli et al., 2020) It is also mentioned that the incidence of multimorbidity is increasing and is the most common in patients treated for acute myocardial infarction.(Baechli et al., 2020)

In this study, IMA EST and IMA-NEST patients were obtained 120 patients each. However, the highest number of patients died was in IMA-EST patients. This is in line with the research of Sraszczak et al. (2023). that hospital mortality (7% vs. 3.6%, $p < 0.05$) and 30-day mortality (7.7% vs. 5.1%, $p < 0.05$) were significantly greater among IMA-EST patients compared to IMA-NEST. (Staszczak et al., 2023)

Overview of the Distribution of Action Types in IMA-EST and IMA-NEST Patients

The distribution of action types is divided into three groups, namely fibrinolytic, PCI and non-reperfusion medicine.

Table 5. Overview of the Distribution of Action Types in IMA-EST and IMA-NEST Patients

Action Type	IMA EAST	IMA-NEST
	Frequency (n)	Frequency (n)
Fibrinolytic	27	0
PCI	27	9
PCI + Fibrinolytic	2	0
Non-Reperfusion Medicine	64	111

Source: Medical records of Gunung Jati General Hospital Cirebon, processed by the author (2026)

The table above shows the distribution of the types of procedures given to patients with IMA-EST and IMA-NEST. In IMA-NEST patients, the most common procedure is non-reperfusion medication, followed by PCI surgery. In IMA-EST patients, non-reperfusion medication was the most action, followed by PCI, fibrinolytic and PCI + fibrinolytic the least.

In addition, the researcher looked at the distribution of the types of actions both reperfusion and non-reperfusion medicine based on the mortality of acute myocardial infarction patients.

Table 6. Overview of the Distribution and Relationship of Types of Reperfusion and Medicated Treatment Types No-Reperfusion Based on Mortality in IMA Patients.

No	Action Type	Frequency (n) and Percentage (%) of Mortality		GOLD (95%CI)	p-value
		Died n (%)	No Deaths n (%)		
1.	Reperfusion Medicine				
	Fibrinolytic	4 (1,67%)	23 (9,58%)		
	PCI	6 (2,5%)	30 (12,5%)	0,832	0,654
	PCI + Fibrinolytic	0 (0%)	2 (0,83%)		
2.	Non-Reperfusion Medicine	23 (9,58%)	152 (63,33%)		

Source: Medical records of Gunung Jati General Hospital Cirebon, processed by the author (2026)

The table above shows the distribution of the types of reperfusion and non-reperfusion medicine on the mortality of acute myocardial infarction patients. Based on the data, most of the patients who died were in the non-reperfusion medicine group, which was 23 patients (9.58%). This number was much higher than the fibrinolytic (4 patients; 1.67%) and PCI (6 patients; 2.5%) groups. Meanwhile, in patients who received a combination of PCI and fibrinolytic, no cases of death were found (0%). Patients who received non-reperfusion medication also accounted for the largest proportion in the non-deceased group, which was 152 patients (63.33%). However, the proportion of mortality was relatively higher in the group without reperfusion treatment than in the reperfusion treatment group, which clinically suggests a possible difference in outcomes based on the type of therapy given.

The study conducted by Bambari et al. (2021) found that the mortality rate in IMA-EST patients in Indonesia who received reperfusion therapy was significantly lower than in patients who did not receive reperfusion therapy. Therefore, the implementation of reperfusion therapy

is very crucial for patients with the main goal of providing reperfusion quickly, consistently, and accurately. (Bambari et al., 2021)

The results of this distribution visually show that the administration of reperfusion therapy, both fibrinolytic and PCI, is associated with a lower mortality rate than non-reperfusion therapy, although further statistical tests are needed. Therefore, the researcher strengthened it with the Chi-Square Test to confirm the significance of the relationship between the type of action and mortality, although in this study no significant association was found between the type of action and the mortality rate of acute myocardial infarction patients listed in the table above.

Based on the explanation in the table above, it can be concluded that this may indicate that reperfusion medications, both fibrinolytic and PCI, have the potential to reduce the risk of mortality in patients with acute myocardial infarction compared to non-reperfusion medications.

Early reperfusion is essential for the management of IMA-EST. According to current guidelines, primary percutaneous coronary intervention is the preferred approach for patients within 12 hours of symptom appearing, but delayed procedures may reduce the benefits of reperfusion. In Li's (2022) study, it was stated in his study results that there was no significant difference in 12-month mortality, 30-day cardiogenic shock, and re-infarction in the hospital period. The success of the fibrinolytic strategy depends on early administration and should be done within the first 3 hours after the onset of symptoms and no more than 12 hours after the onset of symptoms. (K. Li et al., 2022)(K. Li et al., 2022)(Engel Gonzalez et al., 2020)

CONCLUSION

Based on the results of the research that has been carried out, it can be concluded that troponin I levels in acute myocardial infarction patients at Gunung Jati Cirebon Hospital in 2023–2024 had a median value of 1.78 ng/mL, with a minimum value of 0.03 ng/mL and a maximum value of 10 ng/mL. The mortality status of acute myocardial infarction patients during this period showed that most patients were in the non-death category, with 207 patients (86.25%) surviving. Furthermore, the bivariate analysis revealed a statistically significant relationship between troponin I levels and mortality, with a p-value of 0.009 and a correlation coefficient (r) of 0.167. This indicates that patients with higher troponin I levels tend to have a higher risk of death, although the strength of the relationship is weak. Based on these findings, several recommendations are proposed. For clinicians, troponin I levels should be utilized as one of the risk stratification tools in assessing mortality risk in AMI patients, particularly in conjunction with other clinical parameters such as age, comorbidities, and type of reperfusion therapy, while patients with elevated troponin levels require more intensive monitoring and aggressive treatment strategies. For the hospital, the weak but significant correlation suggests the need for standardized troponin I measurement protocols and regular evaluation of AMI management guidelines, as well as improved documentation of medical records to support future research and quality improvement initiatives. For future research, this study recommends prospective studies with larger sample sizes, longer follow-up periods, and inclusion of additional variables such as time to reperfusion, specific types of treatment received, and long-term outcomes to provide a more comprehensive understanding of mortality risk factors in AMI

patients. Additionally, multicenter studies across different regions in Indonesia are needed to validate these findings and develop region-specific clinical guidelines for AMI management.

REFERENCES

- Amriani, E. A., & Maricar, F. (2024). *Karakteristik Infark Miokard Akut Pada Usia Muda*. 8, 2996–3005.
- 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>
- Bambari, H. A., Panda, A. L., & Joseph, V. F. F. (2021). Terapi Reperfusi pada Infark Miokard dengan ST-Elevasi. *E-CliniC*, 9(2), 287. <https://doi.org/10.35790/eci.v9i2.32850>
- De Bakker, M., Anand, A., Shipley, M., Fujisawa, T., Shah, A. S. V., Kardys, I., Boersma, E., Brunner, E. J., Mills, N. L., & Kimenai, D. M. (2023). Sex Differences in Cardiac Troponin Trajectories Over the Life Course. *Circulation*, 147(24), 1798–1808. <https://doi.org/10.1161/CIRCULATIONAHA.123.064386>
- Duque-Ossa, L. C., García-Ferrera, B., & Reyes-Retana, J. A. (2023). Troponin I as a Biomarker for Early Detection of Acute Myocardial Infarction. *Current Problems in Cardiology*, 48(5), 101067. <https://doi.org/10.1016/J.CPCARDIOL.2021.101067>
- Engel Gonzalez, P., Omar, W., Patel, K. V., De Lemos, J. A., Bavry, A. A., Koshy, T. P., Mullasari, A. S., Alexander, T., Banerjee, S., & Kumbhani, D. J. (2020). Fibrinolytic Strategy for ST-Segment-Elevation Myocardial Infarction: A Contemporary Review in Context of the COVID-19 Pandemic. *Circulation: Cardiovascular Interventions*, 13(9), E009622. <https://doi.org/10.1161/CIRCINTERVENTIONS.120.009622>
- Freese Ballegaard, E. L., Lerkevang Grove, E., Kamper, A.-L., Feldt-Rasmussen, B., Gislason, G., Torp-Pedersen, C., & Carlson, N. (2024). Acute Myocardial Infarction and Chronic Kidney Disease: A Nationwide Cohort Study on Management and Outcomes from 2010 to 2022. *Clinical Journal of the American Society of Nephrology : CJASN*, 19(10), 1263–1274. <https://doi.org/10.2215/CJN.00000000000000519>
- Kaura, A., Panoulas, V., Glampson, B., Davies, J., Mulla, A., Woods, K., Omigie, J., Shah, A. D., Channon, K. M., Weber, J. N., Thursz, M. R., Elliott, P., Hemingway, H., Williams, B., Asselbergs, F., O’Sullivan, M., Kharbanda, R., Lord, G. M., Melikian, N., ... Mayet, J. (2019). Association of Troponin Level and Age with Mortality in 250 000 patients: Cohort Study Across five UK Acute Care Centres. *The BMJ*, 367. <https://doi.org/10.1136/bmj.l6055>
- Krüger, S., & Frechen, D. (2022). Cardiovascular Complications in Community-Acquired Pneumonia. *Clinical Pulmonary Medicine*, 22(2), 62–67. <https://doi.org/10.1097/CPM.0000000000000080>
- Li, K., Zhang, B., Zheng, B., Zhang, Y., & Huo, Y. (2022). Reperfusion Strategy of ST-Elevation Myocardial Infarction: A Meta-Analysis of Primary Percutaneous Coronary Intervention and Pharmacologic Invasive Therapy. *Frontiers in Cardiovascular Medicine*, 9(March), 1–9. <https://doi.org/10.3389/fcvm.2022.813325>
- Li, S., Wang, J., Zhang, B., Li, X., & Liu, Y. (2019). Diabetes Mellitus and Cause-specific Mortality: A Population-Based Study. *Diabetes and Metabolism Journal*, 43(3), 319–341. <https://doi.org/10.4093/dmj.2018.0060>
- Lin, Z., Cardelli, P., Marino, R., Lim, S. H., & Di Somma, S. (2022). Advantage of Using of High-Sensitivity Troponin I Compared to Conventional Troponin I in Shortening Time to Rule out/in Acute Coronary Syndrome in Chest Pain Patients Presenting to the Emergency Department. *Medicina (Lithuania)*, 58(10). <https://doi.org/10.3390/medicina58101391>

- Nugraha, A. K. S., Polii, N. C. I., & Rooroh, V. G. X. (2022). Role of Troponin Test in Diagnosis and Management of Acute Myocardial Infarction. *E-CliniC*, 10(2), 338. <https://doi.org/10.35790/ecl.v10i2.38288>
- Patibandla S, Gupta K, A. K. (2024). Cardiac Biomarkers. *StatPearls Publishing - NCBI Bookself*. <https://www.ncbi.nlm.nih.gov/books/NBK545216/>
- PERKI. (2024). *Pedoman Tata Laksana Sindrom Koroner Akut 2024*. 5. www.merckmanuals.com/professional/cardiovascular_
- Potter, J. M., Hickman, P. E., & Cullen, L. (2022). Troponins in Myocardial Infarction and Injury. *Australian Prescriber*, 45(2), 53–57. <https://doi.org/10.18773/austprescr.2022.006>
- Pricillia, A., Suprapti, S., & Pasaribu, R. P. (2021). Hubungan antara Hipertensi dengan Angka Kejadian Infark Miokard Akut pada Pasien Usia Lanjut di RSUP dr. Mohammad Hoesin Palembang Periode 2018-2019. *Sriwijaya Journal of Medicine*, 4(3), 181–185. <https://doi.org/10.32539/sjm.v4i3.136>
- Riset Kesehatan Dasar (Riskesdas). (2018). Laporan Riskesdas 2018 Nasional.pdf. In *Lembaga Penerbit Balitbangkes* (p. hal 156). [https://repository.badankebijakan.kemkes.go.id/id/eprint/3514/1/Laporan Riskesdas 2018 Nasional.pdf](https://repository.badankebijakan.kemkes.go.id/id/eprint/3514/1/Laporan%20Riskesdas%202018%20Nasional.pdf)
- Staszczak, B., Siudak, Z., Malinowski, K. P., Jędrychowska, M., Zabojszcz, M., Dolecka-ślusarczyk, M., Janion-Sadowska, A., Susuł, M., Tokarek, T., Bartuś, J., Pawlik, A., Socha, S., Surdacki, A., Bartuś, S., & Januszek, R. (2023). Clinical Outcomes in Patients with Acute Myocardial Infarction Treated with Primary Percutaneous Coronary Intervention Stratified According to Duration of Pain-to-Balloon Time and Type of Myocardial Infarction. *Cardiology Journal*, 30(5), 734–746. <https://doi.org/10.5603/CJ.a2021.0074>
- Wonoredjo, F. M., & Ariwibowo, D. D. (2024). *Karakteristik Infark Miokard Akut pada Pasien yang Mengalami Gagal Jantung di RSUD Cengkareng*. 5, 10258–10266.