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## Troponin Profile Of Clopidogrel And Ticagrelor With Old Generation PPIs In Myocardial Infarction Patients

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### Abstract

*Myocardial infarction is a leading cause of cardiovascular death in Indonesia with an increasing prevalence. The interaction of clopidogrel-ticagrelor with older-generation PPIs can affect antiplatelet efficacy and troponin levels. This study aims to describe troponin levels in the use of clopidogrel and ticagrelor with older-generation PPIs and their relationship to patient characteristics and lipid profiles. A retrospective descriptive observational method was conducted on 76 myocardial infarction patients at March eleventh University Hospital (November 2024-November 2025) using medical record data. Univariate (frequency, mean) and bivariate (Chi-Square,  $p < 0.05$ ) analyses were processed using SPSS. The results showed that the majority of patients were male (66%), aged 46-65 years (64%). There was no significant association between gender ( $p = 0.542$ ), age ( $p = 0.415$ ), clopidogrel-PPI ( $p = 0.346$ ), ticagrelor-PPI ( $p = 0.368$ ), and LDL ( $p = 0.100$ ) with troponin, but triglycerides were significantly associated ( $p = 0.040$ ). The average troponin of clopidogrel was 9.465 ng/L, higher than that of ticagrelor (3.879 ng/L). It was concluded that triglycerides significantly influenced troponin, while patient characteristics and the combination of antiplatelet-PPI did not.*

**Keywords:** Clopidogrel, Myocardial Infarction, Proton Pump Inhibitor, Ticagrelor, Troponin.

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## INTRODUCTION

Myocardial infarction is a serious condition in which the blood supply to the heart muscle is disrupted, causing permanent damage to the myocardium due to cell necrosis triggered by inadequate blood perfusion. The prevalence of cardiovascular disease in Indonesia continues to increase, with cases of heart disease rising from 12.93 million in 2021 to 15.5 million in 2022, with myocardial infarction being a major contributor to mortality. Globally, cardiovascular disease caused 20.5 million deaths in 2021, nearly one-third of the world's total.

Clinical symptoms of myocardial infarction are usually characterized by typical chest pain that can radiate to the arms, neck, jaw, or epigastrium, accompanied by nausea, shortness of breath, cold sweats, and anxiety. The main risk factors include hypertension, diabetes mellitus, dyslipidemia, smoking, and lack of physical activity, with a high prevalence in Indonesia such as hypertension reaching 50% in myocardial infarction patients. [Raharjo et al., 2025] The 2018 Riskesdas data shows the prevalence of heart disease is 1.5% nationally, higher in Central Java (1.56%), while Sebelas Maret University Hospital recorded 1,222 cases in the latest study.

Problems arise from drug interactions in post-myocardial infarction antiplatelet therapy, particularly clopidogrel with older-generation PPIs such as omeprazole and lansoprazole, which inhibit the CYP2C19 enzyme, thereby reducing clopidogrel activation and increasing the risk of major cardiovascular events, including recurrent myocardial infarction. This concomitant use has the potential to reduce antiplatelet effectiveness by 40-50%, triggering excessive platelet aggregation and further myocardial necrosis. [Wijaya, 2021] A meta-analysis study showed an increased risk of myocardial infarction (HR=1.51) and stroke in PCI patients with the clopidogrel-PPI combination.

Ticagrelor, an alternative to P2Y<sub>12</sub> inhibitors, has been shown to interact less effectively with PPIs, but data on its effect on troponin levels in Indonesian patients with myocardial infarction are limited. The combination of ticagrelor with a PPI is safe in the short term after PCI in STEMI, without significantly increasing ischemic events, although PPIs reduce the risk of GI bleeding. However, poor medication adherence and polypharmacy exacerbate the risk, with studies highlighting an increase in 30-day mortality from myocardial infarction in Indonesia of up to 10.6%. [Dewi, 2020]

This study aims to describe troponin levels in patients with myocardial infarction (MI) treated with clopidogrel and ticagrelor combined with older-generation PPIs at Sebelas Maret University Hospital, as well as their relationship to patient characteristics and lipid profiles. The urgency lies in the high burden of CVD in Indonesia, which requires optimization of antiplatelet therapy to prevent recurrence and mortality. The novelty of this study is the specific analysis of drug interactions with troponin as a biomarker, which has been underexplored locally compared to global studies.

## RESEARCH METHODS

### Types and Methods of Research

This study used a descriptive observational design with a non-experimental approach and retrospective data collection from the medical records of myocardial infarction patients at Sebelas Maret University Hospital from November 2024 to November 2025. This type of descriptive observational study is cross-sectional, which aims to provide a picture of the phenomenon as it is without intervention, in accordance with Sugiyono's (2021) definition which emphasizes the observation of natural phenomena to describe variables quantitatively. This approach is also in line with Sudaryono (2021), who stated that descriptive methods are effective for identifying patterns of variable relationships in a health context without manipulation. In addition, Emzir (2012) supports the use of this design for secondary data analysis in medical studies, while Creswell and Creswell (2022) emphasize the flexibility of observational research designs for health studies.

### Data Analysis Instruments and Techniques

The main research instrument was electronic medical record data, including variables such as troponin levels, use of clopidogrel (75 mg), ticagrelor (90 mg), old-generation PPIs (omeprazole 20 mg, lansoprazole 30 mg), LDL, triglycerides, age, and gender, with operational definitions according to hospital medical record standards (normal troponin 0-25 ng/mL). Data collection techniques involved a preliminary study, ethical clearance, research permits, and manual secondary data extraction from complete medical records according to inclusion/exclusion criteria. Univariate data analysis used frequencies, percentages, means, and standard deviations to describe characteristics; bivariate analysis applied the Chi-Square test for categorical relationships ( $p < 0.05$  significant), processed with SPSS, as recommended by Sugiyono (2021) for non-parametric data in descriptive studies. Sudaryono (2021) added that the Chi-Square test is suitable for nominal variables such as gender and medication, while Emzir (2012) emphasized secondary data triangulation for validity. Creswell and Creswell (2022) support the integration of quantitative analysis into observational designs.

### Population and Sample

The study population consisted of all myocardial infarction patients receiving clopidogrel or ticagrelor in combination with older-generation PPIs at Sebelas Maret University Hospital between November 2024 and November 2025, with a total of 209 medical records. The sample was drawn using purposive sampling of 76 patients who met the inclusion criteria (diagnosis of myocardial infarction, use of targeted drugs, complete troponin/LDL/triglyceride data, age  $> 18$  years) and exclusion criteria (incomplete/damaged data). This technique is in accordance with Sugiyono (2021), who defines a sample as a representative population with specific criteria for retrospective studies. Sudaryono (2021) reinforces that purposive sampling is ideal for limited secondary data, while Emzir (2012) and Creswell and Creswell (2022) suggest verifying data completeness to reduce sampling bias.

### Research Procedures

The procedure begins with a preliminary study to identify hospital procedures, followed by ethical clearance from UDB Surakarta and research permit from UNS Hospital, then retrospective data collection from medical records (November 2024-November 2025) by researchers during December 2025-January 2026. Data are input into SPSS for univariate (frequency/mean table) and bivariate (Chi-

Square) analysis, with processing maintaining patient anonymity in accordance with ethics. This procedure is logical and systematic as outlined by Sugiyono (2021) for observational research, ensuring reliability through data verification. Sudaryono (2021) emphasizes the ethical-clearance-collection-analysis sequence for validity, supported by Emzir (2012) in secondary data analysis and Creswell and Creswell (2022) in procedural coherence.

## RESULTS AND DISCUSSION

### Research Description

The data source for this study was secondary data collected from medical records at Sebelas Maret University Hospital. The population was all myocardial infarction patients taking clopidogrel, ticagrelor, and older-generation PPIs at Sebelas Maret University Hospital. The sampling technique used was total sampling with specific criteria.

The sample criteria for this study used inclusion and exclusion criteria. The inclusion criteria were patients diagnosed with myocardial infarction with a prescription for clopidogrel, ticagrelor, and an old-generation PPI for whom complete data was available at Sebelas Maret University Hospital between November 2024 and November 2025. The exclusion criteria were incomplete, damaged, or illegible electronic medical records, no prescription for clopidogrel, ticagrelor, or an old-generation PPI, and age <18 years.

This study was conducted from December 2025 to January 2026. The population of myocardial infarction patients was 209 and the samples obtained were 76 from the medical records of myocardial infarction patients, 44 patients receiving clopidogrel & old generation PPI drugs, and 32 patients receiving ticagrelor & old generation PPI drugs in the period November 2024 - November 2025 at Sebelas Maret University Hospital.

### Respondent Characteristics

In this section, the researcher will provide an explanation regarding the description of the research results in the form of respondent characteristics including:

#### Patients by Gender

The gender of myocardial infarction patients who used clopidogrel, ticagrelor, old generation PPI drugs and underwent troponin checks at Sebelas Maret University Hospital can be seen as follows:

**Table 1. Percentage by Gender**

No	Gender	Number (n)	Percentage (%)
1.	Woman	26	34%
2.	Man	50	66%
	Total	76	100%

Source: Secondary data processed 2026.

Based on table 1 taken from medical records, it was found that patients suffering from myocardial infarction were more male than female, with a total of 50 patients (66%) compared to females who only numbered 26 patients (34%).

#### Patient Age

Age characteristics based on The Ministry of Health divides the population into three groups, namely 26-45 years (adults), 46-65 years (elderly), and over 65 years (seniors) (Al Amin et.al., 2017). The purpose of this grouping is to observe myocardial infarction patients who received prescriptions for clopidogrel, ticagrelor, old-generation PPIs and underwent troponin checks at Sebelas Maret University Hospital.

**Table 2. Percentage by Age**

No.	Age	Number (n)	Percentage (%)
1.	26-45	8	11%
2.	46-65	49	64%
3.	>65	19	25%
	Total	76	100%

Source: Secondary data processed 2026.

Based on Table 2 above, the highest incidence of myocardial infarction occurred in the 46-65 age group, at 64%. Second place was in the >65 age group, at 25%. The lowest incidence was in the 26-45 age group, at 11%.

### Identifying Patients Taking Clopidogrel with Old Generation PPIs

In this study, patients using clopidogrel with the old generation PPI class for myocardial infarction at Sebelas Maret University Hospital can be seen in the following table:

**Table 3. Percentage Based on Use of Clopidogrel & Old Generation PPI Drugs.**

Drug Name	PPI Old Generation	Number of Patients	Percentage (%)
Clopidogrel 75 mg	Lansoprazole 30 mg	29	38%
Clopidogrel 75 mg	Omeprazole 20 mg	15	20%
<b>Total</b>		44	58%

Source: Secondary data processed 2026.

From table 3 above, it shows that the most frequent use of clopidogrel 75 mg and lansoprazole 30 mg was 29 patients (38%), while 15 patients (20%) used clopidogrel 75 mg and omeprazole 20 mg.

### Identifying Patients Taking Ticagrelor with Old Generation PPIs

In this study, patients using ticagrelor with the old generation PPI class for myocardial infarction at Sebelas Maret University Hospital can be seen in the following table:

**Table 1. Percentage Based on Use of Ticagrelor & Old Generation PPI Drugs**

Drug Name	PPI Old Generation	Number of Patients	Percentage (%)
Ticagrelor 90 mg	Lansoprazole 30 mg	22	29%
Ticagrelor 90 mg	Omeprazole 20 mg	10	13%
<b>Total</b>		32	42%

Source: Secondary data processed 2026.

From table 4. above, it shows that the most frequent use of the drug ticagrelor 90 mg and lansoprazole 30 mg was 22 patients (29%), while the most frequent use of the drug ticagrelor 90 mg and omeprazole 20 mg was 10 patients (13%).

### Identifying Troponin Changes During Clopidogrel, Ticagrelor, and Old Generation PPIs

On This study examines troponin changes in patients using clopidogrel, ticagrelor, and old-generation PPIs for myocardial infarction in the outpatient and inpatient units of Sebelas Maret University Hospital in the period (November 2024 - November 2025), as shown below.

**Table 5. Average Troponin with Clopidogrel 75 Drug Use mg and PPI Old Generation**

No.	Drug	PPI Old Generation	Mean Troponin
1.	Clopidogrel 75 mg	Lansoprazole 30 mg	5289
2.	Clopidogrel 75 mg	Omeprazole 20 mg	4176
	<b>Total</b>		9465

Source: Secondary data processed 2026.

Based on table 5 above, it shows that myocardial infarction patients who took clopidogrel 75 mg and old generation PPI with a total of 44 patients had an average troponin of 9465. The normal troponin level value scale used was from the Medical Records data of Sebelas Maret University Hospital with a scale of 0-25 ng/ml.

**Table 6. Average Troponin with Ticagrelor 90 mg Use and PPI Old Generation**

No.	Drug	PPI Old Generation	Mean Troponin
1.	Ticagrelor 90 mg	Lansoprazole 30 mg	1014
2.	Ticagrelor 90 mg	Omeprazole 20 mg	2865
	<b>Total</b>		3879

Source: Secondary data processed 2026.

Based on table 6 above, it shows that myocardial infarction patients taking ticagrelor 90 mg and old generation PPI with a total of 32 patients had an average troponin of 3879. The normal troponin level value scale used was from the medical record data of Sebelas Maret University Hospital with a scale of 0 - 25 ng/ml.

**Bivariate Analysis**

Bivariate analysis aims to determine the relationship between independent and dependent variables. The results of the analysis of the variables studied at Sebelas Maret University Hospital are as follows:

**Relationship between Gender and Age Characteristics**

The results of the analysis of the relationship between gender and age with troponin levels in myocardial infarction are as follows:

**Table 7. Characteristics Analysis**

		Connection	Troponin I
Chi-Square Tests	Gender	Asymptotic Sig (2-sided)	.542
	Age	Asymptotic Sig (2-sided)	.415

Source: Secondary data processed 2026.

Based on Table 7, the Chi-Square Test analysis of gender and troponin showed an Asymptotic Significance (2-sided) p-value of 0.542. This value is greater than the standard significance of 0.05 ( $p > 0.05$ ). For age and troponin, an Asymptotic Significance (2-sided) p-value of 0.415 was obtained. This value is greater than the standard significance of 0.05 ( $p > 0.05$ ).

**The relationship between Clopidogrel, Ticagrelor with old generation PPIs, LDL, Triglycerides with Troponin Levels**

Results of the analysis of the relationship between Clopidogrel, Ticagrelor with old generation PPI, LDL, Triglycerides with Troponin levels in myocardial infarction patients.

**Table 8. Chi-Square Test Results**

		Connection	Troponin I
Chi-Square Tests	Clopidogrel and old generation PPIs	Asymptotic Sig (2-sided)	.346
	Ticagrelor and old generation PPIs	Asymptotic Sig (2-sided)	.368
	LDL	Asymptotic Sig (2-sided)	.100
	Triglycerides	Asymptotic Sig (2-sided)	.040

Source: Secondary data processed 2026.

Based on Table 8, the Chi-Square Test analysis of clopidogrel and old-generation PPIs with troponin levels, obtained an Asymptotic Significance value (2-sided) or p-value of 0.346. This value is greater than the standard significance of 0.05 ( $p > 0.05$ ). In ticagrelor and old-generation PPIs with troponin levels, obtained an Asymptotic Significance value (2-sided) or p-value of 0.368. This value is greater than the standard significance of 0.05 ( $p > 0.05$ ). In LDL levels with troponin levels, obtained an Asymptotic Significance value (2-sided) or p-value of 0.100. This value is greater than the standard significance of 0.05 ( $p > 0.05$ ). In triglyceride levels with troponin levels, obtained an Asymptotic Significance value (2-sided) or p-value of 0.040. This value is smaller than the significance standard of 0.05 ( $p < 0.05$ ).

**DISCUSSION**

Myocardial infarction is a disease triggered by ischemia, an imbalance between the high metabolic demands of the myocardium and the limited supply of oxygen and nutrients from the coronary circulation. Blood flow disruption is generally caused by occlusion due to thrombus formation on unstable atherosclerotic plaque. Atherosclerosis is a chronic condition in which plaque, made up of various substances such as fat, cholesterol, calcium, blood cells, and fibers, accumulates within the artery walls. This plaque gradually hardens and destroys the elasticity and normal function of the arteries, disrupting smooth blood flow (Directorate General of Health Services, 2024). Furthermore, narrowing of the coronary arteries exceeding 75%, either dynamically due to chronic

atherosclerosis or dynamic vasospasm, is a major factor in the reduced oxygen supply, leading to the death of heart muscle tissue (Rampengan, 2020).

### **Respondent Characteristics**

Patient characteristics based on gender aimed to determine how many myocardial infarction patients used clopidogrel, ticagrelor, and old-generation PPIs at Sebelas Maret University Hospital during the period of November 2024–November 2025. Based on the results of the study, the incidence of myocardial infarction was dominated by male patients with 50 patients (66%), while female patients numbered 26 patients (34%). These results indicate that the number of male patients is greater than female patients.

The results of this study align with previous research showing that the majority of myocardial infarction patients are men, as conducted by Paulus et al., 2021. Research conducted by Raharjo et al., 2025, showed that myocardial infarction occurs more frequently in men, at 67.5%. Common risk factors include atherosclerotic rupture in 60-65% of cases, associated with patients having a smoking habit or experiencing hyperlipidemia, diabetes mellitus, or hypertension. These are among the most common factors found in cases of myocardial infarction (Mendoza, 2023).

Women have a lower risk than men due to the presence of the hormone estrogen, which has been shown to be cardioprotective and protect heart cells from apoptosis (Leni, 2024). However, this protective benefit of estrogen only applies to women before menopause (Kurniawan et al., 2021). These results align with research by Ardhani (2022), which showed that the number of male patients with myocardial infarction was higher than that of female patients, with 53 (57.6%) patients.

Next, patient characteristics were determined by group. The 46-65 age group accounted for 64%. Second place was in the >65 age group, at 25%. The lowest percentage was in the 26-45 age group, at 11%. These results align with research conducted by Ahmed et al. (2020) that found the age group with the highest prevalence of myocardial infarction was 56.6 years old, with an average age of 56.6 years. Research conducted by Raharjo et al. (2025) also found that the highest prevalence of myocardial infarction occurred in patients aged 45-60 years. This is in line with research conducted by Muhibbah et al. (2019), which stated that the majority of myocardial infarction patients were over 45 years old.

As we age, blood vessels undergo gradual and continuous changes that can affect kidney function (Muhibbah et al., 2019). Increasing age increases the risk of myocardial infarction due to the accumulation of oxidative stress due to aging-related metabolic disorders, which can lead to susceptibility to cardiovascular disease (Ceo et al., 2016). Comorbidities such as hypertension can also contribute to myocardial infarction (Pricilia et al., 2018).

### **Relationship between Gender and Age Characteristics**

Based on the Chi-Square Tests analysis, the Asymptotic Significance (2-sided) value or p-value was 0.542. This value is greater than the standard significance of 0.05 ( $p > 0.05$ ), so it can be concluded that there is no significant relationship between gender and troponin in myocardial infarction patients in the outpatient and inpatient units of Sebelas Maret University Hospital. This means that troponin is not affected by gender.

The results of this study align with previous research by Zaman et al., 2017, which showed no significant association between gender and troponin. In the pathophysiological condition of ST-Elevation Myocardial Infarction (STEMI), total occlusion of the coronary artery occurs, triggering massive and rapid myocardial necrosis. The release of troponin protein into the systemic circulation during the acute phase increases, resulting in increased troponin levels. In this pathological condition, the size of the infarct area can become the primary determinant dominating troponin levels in the blood. Consequently, basal physiological differences, such as heart muscle mass, which is generally greater in men than in women, become insignificant in influencing laboratory results (Mueller et al., 2018).

Based on the Chi-Square Tests analysis, the Asymptotic Significance (2-sided) value or p-value was 0.415. This value is greater than the standard significance of 0.05 ( $p > 0.05$ ), so it can be concluded

that there is no significant relationship between age and troponin in myocardial infarction patients in the outpatient and inpatient units of Sebelas Maret University Hospital. This means that troponin is not affected by age.

Research by Kimenai et al. (2020) found that age and kidney function are the main determinants of cardiac troponin concentration. Elevated troponin levels in the elderly are not only caused by acute myocardial injury but can also be caused by a physiological decline in renal filtration function, which inhibits troponin clearance from the bloodstream.

#### **The relationship between the use of clopidogrel and old generation Proton Pump Inhibitors (PPIs) on troponin levels.**

Based on table 3, myocardial infarction patients at Sebelas Maret University Hospital for the period November 2024 – November 2025, the most patients used clopidogrel 75 mg and lansoprazole 30 mg were 29 patients (38%), while 15 patients (20%) used clopidogrel 75 mg and omeprazole 20 mg.

Based on the Chi-Square Tests analysis, the Asymptotic Significance (2-sided) value or p-value was 0.346. This value is greater than the standard significance of 0.05 ( $p > 0.05$ ) so it can be concluded that there is no significant relationship between clopidogrel and old-generation PPIs on troponin levels in myocardial infarction patients in the outpatient and inpatient units of Sebelas Maret University Hospital. This means that troponin is not affected by the use of clopidogrel and old-generation PPIs.

The results of this study indicate no significant association between the combination of clopidogrel and older-generation PPIs and troponin levels. This study differs from a pharmacodynamic study by Dewi (2020), which stated that proton pump inhibitors (PPIs) can affect clopidogrel metabolism, thereby reducing its platelet-inhibiting effect. The use of potent CYP2C19 inhibitors such as omeprazole and lansoprazole is known to significantly reduce clopidogrel efficacy and increase the risk of recurrent myocardial infarction.

In addition to drug factors, genetic polymorphisms in certain populations, such as Caucasians, also play a role in reduced efficacy. Based on drug interactions, combining clopidogrel with older-generation proton pump inhibitors (PPIs) can reduce clopidogrel's effectiveness in preventing heart attacks or strokes. According to Wijaya (2021), it is recommended to use proton pump inhibitors (PPIs) with weaker CYP2C19 inhibition, such as rabeprazole, pantoprazole, or dexlansoprazole, if necessary, as adjunctive therapy with clopidogrel.

#### **The relationship between the use of ticagrelor and old generation Proton Pump Inhibitors (PPIs) on troponin levels**

Based on table 4, it shows that myocardial infarction patients at Sebelas Maret University Hospital in the period November 2024 – November 2025 who used ticagrelor 90 mg and lansoprazole 30 mg were 22 patients (29%), while 10 patients (13%) used ticagrelor 90 mg and omeprazole 20 mg.

Based on the Chi-Square Tests analysis, the Asymptotic Significance (2-sided) value or p-value was 0.368. This value is greater than the standard significance of 0.05 ( $p > 0.05$ ) so it can be concluded that there is no significant relationship between ticagrelor and old-generation PPIs on troponin levels in myocardial infarction patients in the outpatient and inpatient installations of Sebelas Maret University Hospital. This means that troponin levels are not affected by the use of ticagrelor and old-generation PPIs.

The results of this study indicate that there is no significant association between the combination of ticagrelor and an older-generation Proton Pump Inhibitor (PPI) on troponin levels. This finding aligns with the theory that ticagrelor is a cyclopentatriazole pyrimidine that acts reversibly on the P2Y<sub>12</sub> receptor. The P2Y<sub>12</sub> receptor itself plays a crucial role in thrombus stabilization to prevent blood clot rupture. Therefore, if inhibited, thrombus formation becomes unstable and coronary blood flow is maintained (Zhu et al., 2021). Based on drug interactions, no drug interactions were found between ticagrelor and older-generation PPIs.

The advantages of ticagrelor lie in its rapid onset of action and favorable renal safety profile. Furthermore, unlike other antiplatelet agents, ticagrelor is not metabolized by the CYP2C19 enzyme

(Zaman et al., 2018). Therefore, its antiplatelet effect is unlikely to be clinically affected by combination therapy with PPIs (Zhang et al., 2020).

### **The use of clopidogrel, ticagrelor and old generation PPI drugs on troponin levels**

Based on table 5, myocardial infarction patients who consumed clopidogrel 75 mg and old generation PPI with a total of 44 patients had an average troponin of 9465 ng/L and in table 6, myocardial infarction patients who consumed ticagrelor 90 mg and old generation PPI with a total of 32 patients had an average troponin of 3879 ng/L.

The results of this study indicate a difference in average troponin levels. This difference is related to the metabolic pathways of the two drugs, where ticagrelor is independent of the CYP2C19 enzyme, while clopidogrel requires this enzyme to convert to its active metabolite. Because older-generation Proton Pump Inhibitors (PPIs) inhibit CYP2C19, clopidogrel activation is impaired, potentially worsening heart damage (Gao et al., 2020). As explained by Valgimigli et al., (2018), this myocardial tissue damage will trigger the release of troponin into the blood as an indicator of infarction.

From the bivariate analysis, it was concluded that the use of clopidogrel, ticagrelor, and old-generation PPIs did not show any correlation with troponin levels in myocardial infarction patients at Sebelas Maret University Hospital. This lack of correlation could be caused by several factors. According to Leksana et al., 2016, increased troponin levels could be caused by:

### **Damage due to relative myocardial ischemia (Type 2 Myocardial Infarction) due to supply-demand mismatch.**

Troponin levels may increase in the context of increased cardiac output requirements and relatively inadequate myocardial blood flow. This can occur in sepsis, septic shock, the systemic inflammatory response system (SIRS), hypotensive shock, hypovolemic shock, and cardiac arrhythmias (e.g., supraventricular tachycardia, atrial fibrillation with rapid ventricular rate, tachyarrhythmias).

### **Direct heart damage other than due to ischemia**

A violent blow to the chest can cause contusion of the heart, which can increase troponin levels due to direct injury to the ventricular muscle fibers. Myocarditis of any etiology (e.g., viral, fungal, mycobacterial, bacterial) can increase troponin levels due to direct injury to the ventricular myocytes. This results in membrane damage, myotic necrosis, and troponin release from injured or necrotic myocytes. Troponin levels may be elevated in the absence of ischemia in acute pericarditis due to ventricular myotic injury.

### **Elevated troponin levels with lung disease**

The presence of lung disease that causes significant right ventricular strain will increase right ventricular afterload, which can result from acute pulmonary embolism and chronic obstructive pulmonary disease (COPD) with pulmonary hypertension. Elevated troponin levels can be observed in large pulmonary emboli, possibly due to increased right heart strain.

### **Elevated troponin levels with kidney disease**

Evaluation of troponin levels is increased in patients with chronic kidney disease, because many patients with chronic kidney disease are asymptomatic, especially those receiving hemodialysis, troponin levels can be increased.

### **The Relationship of LDL to Myocardial Infarction Troponin**

Based on the Chi-Square Tests analysis, the Asymptotic Significance (2-sided) value or p-value was 0.100. This value is greater than the standard significance of 0.05 ( $p > 0.05$ ), so it can be concluded that there is no significant relationship between LDL and troponin in myocardial infarction patients in the outpatient and inpatient installations of Sebelas Maret University Hospital. This means that troponin is not affected by LDL.

A 2017 study by Darussalm & Muhammad showed normal cholesterol, LDL, HDL, and triglyceride levels. Normal levels in myocardial infarction patients can be caused by many factors, including dyslipidemia, smoking, hypertension, obesity, diabetes, and heredity. Other factors can

contribute to atherosclerosis, which can develop long before an attack occurs. Furthermore, patients have reduced their high-fat diet and received medication, so their lipid levels are no longer high.

Bivariate analysis concluded that LDL levels showed no correlation or relationship with troponin I levels in myocardial infarction patients at Sebelas Maret University Hospital. This lack of correlation could be caused by several factors, including:

#### **Time factor**

Elevated troponin I levels can indicate heart muscle damage and peak within hours or even after a heart attack. Blood lipids are more stable over the long term and do not change significantly immediately after a myocardial infarction (Darussalam et al., 2017).

#### **The complexity of cardiovascular disease**

Cardiovascular disease is influenced by various risk factors and complex pathophysiological mechanisms. Lipids are only one of many factors contributing to the risk of myocardial infarction in patients. Troponin I serves as a specific indicator of myocardial necrosis. The correlation between LDL and troponin is not clear because it can be influenced by other factors (Andayani et al., 2024).

#### **Individual variability**

Individual variability in the response process to atherosclerosis, inflammation, and myocardial damage can affect troponin I and lipid levels differently, thereby obscuring the correlation between LDL and troponin (Ridker et al., 2027).

#### **Relationship of Triglycerides to Myocardial Infarction Troponin**

Based on the Chi-Square Tests analysis, the Asymptotic Significance (2-sided) value or p-value was 0.040. This value is greater than the standard significance of 0.05 ( $p < 0.05$ ), so it can be concluded that there is a significant relationship between triglycerides and troponin in myocardial infarction patients in the outpatient and inpatient units of Sebelas Maret University Hospital. This means that troponin can be influenced by triglycerides.

A study by Wardah (2023) showed a relationship between triglycerides and troponin I. Triglycerides are the main fats in food, playing a role in transporting and storing fat in the blood (Mukharomaj, 2022). Excess fat is stored in adipose tissue under the skin or in the abdominal cavity. Symptoms of high triglycerides include shoulder pain, headaches, and vomiting. Symptoms of low triglycerides include dry skin, dry hair, brittle nails, and insomnia. Any amount of dietary fat and carbohydrates not immediately used will be stored in adipose tissue as triglycerides (Sarisa et al., 2017).

Triglycerides are hydrolyzed into free fatty acids and glycerol, which undergo oxidation during the energy production process (Sarisa et al., 2017). High triglyceride levels in the blood can trigger plaque accumulation on blood vessel walls, which leads to plaque buildup within the blood vessels and causes the blood vessels to narrow and harden, increasing blood pressure and reducing the amount of blood flowing through the body (Majid, 2017).

Elevated blood triglyceride levels can be caused by several factors, including high saturated fat intake in the diet, excessive energy intake, obesity, and low physical activity. Elevated blood triglyceride levels increase the risk of atherosclerosis. Triglyceride levels can be reduced pharmacologically through medication and non-pharmacologically through maintaining a healthy diet (Andayani et al., 2023).

## **CONCLUSION**

This study found that the majority of myocardial infarction patients were male (66%) with a dominant age of 46-65 years (64%), but gender ( $p=0.542$ ) and age ( $p=0.415$ ) were not significantly associated with troponin levels. The use of clopidogrel with old-generation PPIs ( $p=0.346$ ) or ticagrelor with old-generation PPIs ( $p=0.368$ ) also did not show a significant association with troponin, although the average troponin was higher in the clopidogrel group (9,465 ng/L) compared

to ticagrelor (3,879 ng/L). From the lipid profile, LDL had no effect ( $p=0.100$ ), but triglycerides had a significant association ( $p=0.040$ ), indicating its role as a predictor of myocardial damage.

However, limitations of the study include its retrospective design, which is susceptible to selection bias due to incomplete medical record data, and the failure to examine factors such as CYP2C19 genetic polymorphisms or other biomarkers (HDL, CK-MB). Suggestions for further research include prospective, longitudinal studies with larger sample sizes and MACE monitoring to validate long-term drug interactions. Practically, these results encourage pharmacists and physicians in hospitals to prioritize triglyceride control in patients with myocardial infarction, while considering ticagrelor as an alternative to clopidogrel to minimize cardiovascular risk without the concern of significant PPI interactions.

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