Factors Associated with Increased Length of Stay in Post Primary Percutaneous Coronary Intervention Patients: A Scoping Review

Firman Sugiharto [iD][1], Yanny Trisyani [iD][2], Aan Nuraeni [iD][2], Ristina Mirwanti[2], Azalia Melati Putri [iD][1], Nuraulia Aghnia Armansyah[1]

[1]Faculty of Nursing, Universitas Padjadjaran, Sumedang, Jawa Barat, Indonesia; [2]Department of Critical Care and Emergency Nursing, Faculty of Nursing, Universitas Padjadjaran, Sumedang, Jawa Barat, Indonesia

Correspondence: Firman Sugiharto, Faculty of Nursing, Universitas Padjadjaran, Jl. Raya Ir. Soekarno KM. 21, Hegarmanah, Jatinangor, Sumedang, West Java, 45363, Indonesia, Tel +6282218235600, Fax +622287793411, Email firman17001@mail.unpad.ac.id

Abstract: Several studies identify factors affecting increased length of stay (LOS) in patients with post-primary percutaneous coronary intervention (PCI). However, there has not been a review study that synthesizes these results. This study aimed to describe the duration of LOS and factors associated with increased LOS among patients with STEMI after PPCI. This study used scoping review using EBSCO-host Academic Search Complete, PubMed, Scopus, Taylor & Francis, and Google Scholar databases. The keywords used in English were "adults OR middle-aged" AND "length of stay OR hospital stay" AND "primary percutaneous coronary intervention OR PPCI" AND "myocardial infarction OR coronary infarction OR cardiovascular disease". The inclusion criteria for articles were: the article was a full-text in English; the sample was STEMI patients who had undergone a PPCI procedure; and the article discussed the LOS. We found 13 articles discussing the duration and factors affecting LOS in patients post-PPCI. The duration of LOS was the fastest 48 hours, and the longest of LOS was 10.2 days. Factors influencing LOS are categorized into three predictors: low, moderate, and high. Post-procedure complications after PPCI was the most influential factors in increasing the LOS duration. Professional health workers, especially nurses, can identify various factors that can be modified to prevent complications and worsen disease prognosis to increase LOS efficiency.

Keywords: length of stay, percutaneous coronary, revascularization, STEMI

Introduction

Acute Myocardial Infarction (AMI) is the main cause of death in the world. Globally, as many as 19.05 million people died from heart disease, including myocardial infarction, in 2020.[1] The most recent data shows that 1,522,669 AMI-related deaths were recorded in the United States during the last 10 years from 2012 to 2022.[1] Meanwhile, in Indonesia, as many as 1.5% or 15 out of 1000 Indonesians suffer from heart disease, including myocardial infarction.[2] This mortality rate is expected to continue to increase to 24.2 million people in 2030.[3]

ST-segment elevation Myocardial infarction (STEMI) indicates of total coronary artery occlusion.[4] The diagnosis of STEMI is established if there is a complaint of acute angina pectoris accompanied by persistent ST-segment elevation in two adjacent leads.[4,5] This situation requires revascularization as soon as possible to restore blood flow and myocardial reperfusion.[5] System delays to reperfusion correlate with higher mortality and morbidity rates.[6] Currently, primary percutaneous coronary intervention (PPCI) is the most effective acute management strategy for STEMI patients and is superior to fibrinolytic therapy.[5] The purpose of PPCI is to restore normal blood flow to the patient's heart by opening blocked coronary arteries.[4]

Although PPCI has been considered a safe general procedure, consideration of the severity of MI and further monitoring after the procedure is essential for optimal results.[7,8] Previous studies have proven that the severity of MI

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contributes to the success of the PPCI procedure.[7] Factors that may influence MI severity include location and size of infarction, coronary artery occlusion level, and time from symptom onset to appropriate treatment.[9] Patients with more severe MI may be at higher risk of experiencing post-PPCI complications such as bleeding or heart attack so that this will have an impact on increasing the length of stay (LOS) and mortality rate.[10,11]

LOS is an essential factor in determining the patient outcomes, especially for those suffering from severe conditions such as STEMI.[12] LOS is the number of days the patient is in the hospital (counted from the patient's admission until the patient is discharged or goes home), which is also an essential criterion in evaluating the efficiency of patient care management.[13,14] LOS can significantly impact a patient's recovery, as well as the overall cost of treatment.[15] Moreover, reducing LOS has been associated with decreased risks of opportunistic infections and medication side effects and with improved treatment outcomes and lower mortality rates.[16] An increase in LOS results in higher morbidity and mortality in hospitals.[12,17] Previous cohort studies suggest that LOS in-hospital is independently associated with an increased burden of comorbidities in PCI patients.[18]

Several studies in developed and developing countries report an increase in LOS in post-PPCI. Patients are usually discharged three days after treatment for a STEMI with an uncomplicated PPCI.[8] A study in Iran said that almost the majority (47%) of post-PPCI patients had LOS of 3–6.[19] In addition, a study in China showed that post-PPCI patients had an average LOS of more than 7 days.[13,20] Similarly, studies conducted in developed countries such as the UK and USA also reported that the average LOS in post-PPCI patients was more than 4 days.[21–24] Differences in the duration of LOS in patients after PPCI can be influenced by various factors apart from the similarity of disease diagnoses. A previous study said age, hypertension, chronic kidney diseases, and diabetes mellitus were the determining factors for increasing LOS in post-PPCI patients.[19] Also, the risk of LOS for more than six days was seen in subjects with post-procedure complications, admission problems, and primary comorbidities.[13] Therefore, paying more attention to predictor of LOS is essential because of its important role in saving hospital costs and improving overall health outcomes.

To date, there have been quite several studies that have found various predictors that influence LOS increases in post-PPCI patients. However, based on our literature search, there have been no reviewed studies that have systematically explored and synthesized these results in the post-PPCI patient population. Several previous reviews focused only on re-hospitalization,[25] factors that lead to depression,[26] and focused on mortality and readmission.[27] Previous studies have characterized a diverse population rather than focusing on post-PPCI patients. Considering the limitations of previous reviews, this study will focus more on post-PPCI patients. PPCI is now established as the reference treatment for the management of STEMI.[5] However, there are still studies showing differences in LOS in patients who undergo it. It is important to identify causal factors so that they can provide input to anticipate increasing LOS in these patients, and make PPCI effective as the main treatment referral.[28] Therefore, this study aims to identify the duration of LOS and factors associated with increased LOS among patients with STEMI after PPCI.

Materials and Methods
Design
The design used in this literature review is a scoping review. Scoping review is a flexible methodological technique for exploring new, rapidly developing topics.[29] This design has a more comprehensive conceptual range so that it can explain a variety of relevant study results. The framework of scoping review consists of 5 core stages, namely identifying research questions, identifying relevant study results, selecting studies, mapping data, compiling, summarizing and reporting results.[29]

Eligibility Criteria
The article selection process in this review was carried out by six reviewers based on the PRISMA Extension for Scoping Reviews (PRISMA-ScR) checklist and explained in the form of a chart (see Figure 1). Research questions and eligibility criteria for research articles using the PCC approach.

P (Population): adults and myocardial infarction patients
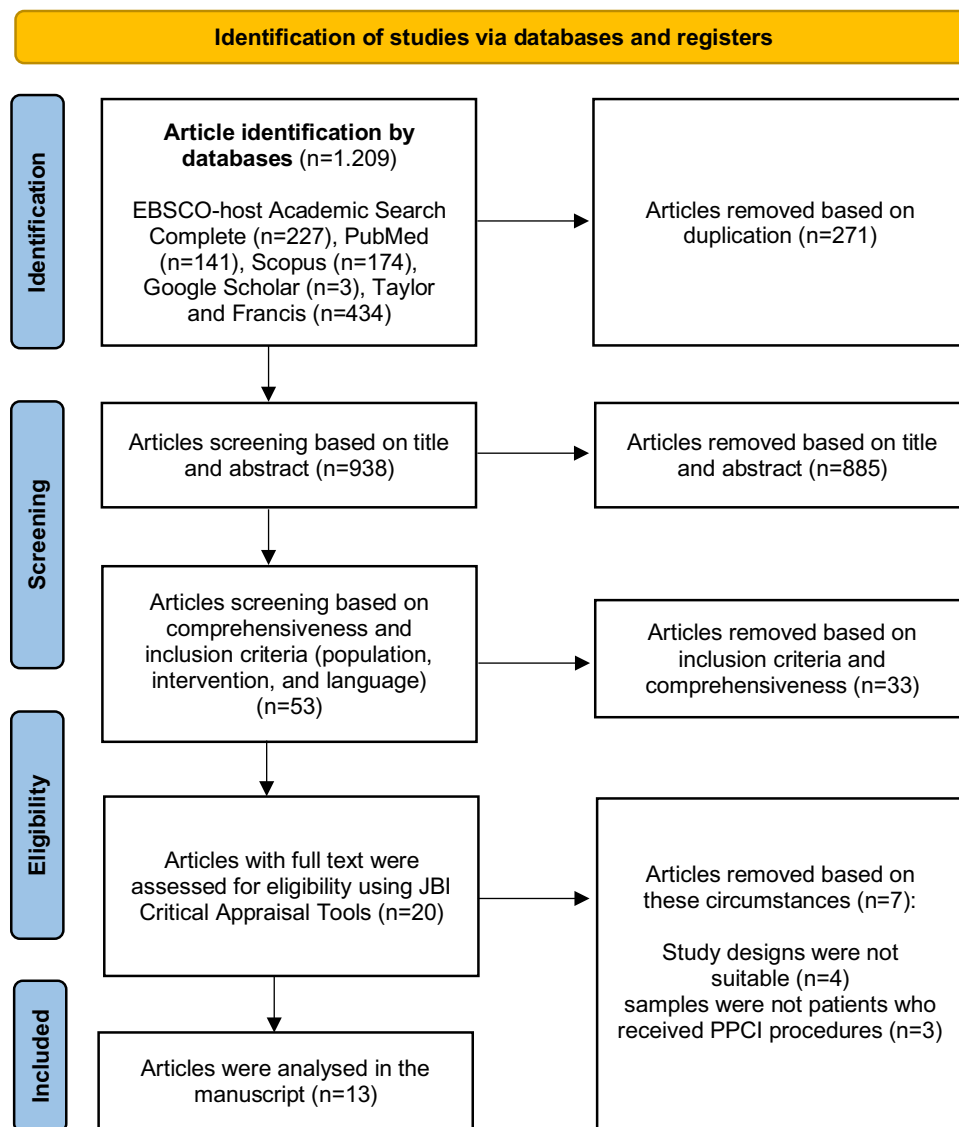
C (Concept): length of stay (LOS)

Figure 1 PRISMA flow diagram.

Notes: PRISMA figure adapted from Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71. Creative Commons.[30]

C (Context): primary percutaneous coronary intervention (PCI)

Secondary research, such as literature reviews and editorials were excluded from this review. The inclusion criteria were a full text in English; focused on adults who were defined as people aged more than 18 years, the sample was STEMI patients after PPCI; and the article discussed LOS. We do not limit the year of publication because we want to comprehensively identify the factors that influence LOS so that the results of the study can be generalized better.

Data Collection and Analysis
Search Strategy
The article searching process has been carried out using five primary databases: EBSCO-host Academic Search Complete, PubMed, Scopus, Taylor & Francis, and Google Scholar. The keywords used in English were "adults OR middle aged" AND 'length of stay OR hospital stay' AND 'primary percutaneous coronary intervention OR PPCI' AND 'myocardial infarction OR coronary infarction OR cardiovascular disease'. For each term verified by MeSH (Medical Subject Headings) synonyms were used to retrieve all possible relevant articles. The author uses the Boolean operators "AND" and "OR" to cut or expand the search results for various forms of words.

Study Selection

Three independent authors selected the studies that met the eligibility criteria. The article was removed based on duplication in the initial stage using the reference manager application. The authors also evaluate the relevance of the title and abstract after any duplicate article is removed. At the final stage, authors review all eligible full text articles according to inclusion and exclusion criteria. Then, the authors checked each article against the Joanna Briggs Institute (JBI) critical appraisal checklist.[31] Following the assessment, we eliminated any study with a JBI score <60%. The final determination of articles which is included or excluded in this review was carried out by the second and third authors provide a decision if there is a discrepancy in the selection results.

Data Extraction and Analysis

Data extraction in this study was carried out using the tabular form to describe all results related to the topics discussed. The table contains data related to author, year, country, research design, sample age, average and category of LOS, and findings of the results. The main points of discussion can be identified and grouped entirely for further discussion. This data extraction table was created to make it easier for the authors to describe the review results.

All included studies were primary studies with cohort and cross-sectional designs. Therefore, data analysis was carried out thematically using an exploratory, descriptive approach. The data analyzing process begins with the identification and presentation of the data obtained in tabular form. All authors analyzed and explained each finding based on factors that affect LOS in STEMI patients after PPCI therapy. The categorization of developed and developing countries refers to the website of the world bank.[32] In addition, in the predictor category the authors divide it into three classifications based on the odds ratio (OR) value. It is categorized as low if the OR value is less than or equal to 2, moderate if the OR value is more than 2 to 4, and high if the OR value is more than 4. Then, if the study does not include an OR value then it is considered to be in the uncategorized.

Results

Study Selection

1.029 articles were successfully identified in the initial search and totalled 758 after duplication was removed. Elimination based on titles and abstracts resulted in 53 articles which were then selected based on an analysis of full-text articles. As a results, the authors included 13 articles in this review as shown by the PRISMA flowchart (see Figure 1).

Study Characteristics

The results of this review show that the articles analyzed were cohort studies (n=12) and cross-sectional studies (n=1). Based on the results, the shortest and most prolonged LOS were 48 hours to 10.2 days. Most of the articles analyzed in this review were conducted in developed countries (see Table 1). All participants analyzed were myocardial infarction patients (n=858.115) who had undergone PPCI with an average age of 50 to 75.47 years. Several studies have also reported (>90%) patients who achieved full perfusion of infarct vessels with the final thrombolytic myocardial infarction (TIMI) flow in grade 3 after a PPCI procedure.[13,19,22,23,33]

Factors Associated with Increased Length of Stay

Factors related to increased of LOS in STEMI patients after PPCI are divided into several categories (see Table 2). Factors affecting increased LOS are age >68 years, gender, BMI >24.22 kg/m2, complications during treatment, comorbid diseases, Killip class >1, smoking, infarction area, and problem at admission.

These factors are divided into three categories based on the OR values, namely low (0 to ≤2), moderate (>2 to 4), and high (>4) (see Table 2). The higher the OR value, the independent factor becomes the most influential factor. This review shows that the predictors in the low category are age (> 68 years), gender, BMI >24.22, comorbid disease (Diabetes Mellitus (DM), hypertension (HTN), CKD), current smoker, and anterior STEMI. In addition, those included in the moderate category are complications (angiographic failure, bleeding, AKI), and also left ventricular ejection fraction (LVEF). Then, the predictors included in the high category are complications (Vascular complication and Post-procedure

Table 1 Characteristics of Study

Author & Year	Method	Country	Mean Age	Sample	Findings			Critical Appraisal
					Average LOS	Category of LOS	Predictors of Increased LOS	
[10]	Retrospective Study	Turkey	56.2	2.486	6 days	2 Category <6 days and >6 days	Anterior STEMI (OR 1.61; 95% CI 1.02–2.54) (p<0.001) Angiographic failure (OR 2.89; 95% CI 1.19–7.01) (p<0.001) PVC (OR 4.18; 95% CI 1.16–15.03) (p<0.001) Age >75 years (OR 1.76; 95% CI 1.25–2.49) (p=0.001) Female (OR 1.58; 95% CI 1.25–1.99) (p=0.001) Killip Class >1 (OR 4.68; 95% CI 2.60–8.42) (p<0.001) DM (OR 1.38; 95% CI 1.37–1.69) (p=0.001) HTN (OR 1.35; 95% CI 1.14–1.60) (p=0.001) Current smoker (OR 0.73; 95% CI 0.61–0.87) (p=0.001)	9/11
[22]	Retrospective Study	USA	73	33.920	4–5 days	3 Category <3 days, 4–5 days, and ≥5 days	Age (per 10-year increase) (OR 1.46; 95% CI 1.41–1.51) (p<0.001) Vascular complication (OR 3.88; 95% CI 2.88–5.22) (p<0.001) Bleeding complication (OR 2.61; 95% CI 2.30–2.95) (p<0.001) Male (OR 0.76; 95% CI 0.73–0.80) (p<0.001) Pre-procedural TIMI flow grade (p<0.001)*	9/11
[13]	Prospective Study	China	58.52	3.615	9 days	2 Category <7 days and >7 days	Age (per 1-year increase) (OR 1.01, 95% CI 1.00–1.01) (p<0.001) BMI (per 1kg/m2 increase) (OR 1.01, 95% CI 0.97–0.99) (p=0.042) HF (OR 5.59; 95% CI 1.58–19.71) (p<0.001) SBP (OR 0.99; 95% CI 0.99–0.99) (p=0.004) Killip Class>1 (OR 1.26; 95% CI 1.01, 1.57) (p=0.004) LVEF (per 1% increase) (OR 0.97; 95% CI 0.96–0.99) (p=0.001) Post-procedural TIMI Score (p=0.007)*	9/11
[34]	Cross-Sectional Study	Iran	59.36	561	3–6 days	3 Category ≤3 days, 3–6 days, and ≥6 days	Age (OR 0.9; 95% CI 0.81–1.00) (p=0.03) BMI (OR 1.56; 95% CI: 1.28–1.89) (p=0.016) Primary comorbidities (CKD, DM, HTN) (OR 1.75; 95% CI 1.35–2.27) (p=0.031) Post-procedure complications (OR 9.12; 95% CI: 7.22–11.53) (p<0.001) Problem at admission (OR 4.09; 95% CI 2.86–5.85) (p<0.001) Post-procedural TIMI Score (p<0.001)*	8/8
[23]	Prospective Observational Study	UK	63	467	4.5 days	N/I	LVEF (p<0.001)** Anterior STEMI (p<0.001)** Current Smoker (p=0.031)** Post-procedural TIMI Score (p=0.088)**	9/11
[20]	Retrospective Study	China	75.47	32	10.2 days	N/I	Patients with delirium have a longer LOS (p<0.000)**	8/11
[21]	Prospective Study	USA	62	20.339	7 days	N/I	Liver Cirrhosis patients had longer hospitalizations (p<0.001)*	8/11
[24]	Retrospective Study	USA	50	None	5.8 days	N/I	Gastrointestinal Bleeding (OR 2.62; 95% CI 2.40–2.92) (p<0.001)	7/11

(*Continued*)

Table 1 (Continued).

Author & Year	Method	Country	Mean Age	Sample	Findings			Critical Appraisal
					Average LOS	Category of LOS	Predictors of Increased LOS	
[33]	Retrospective Study	Singapore	59	115,113	4 days	2 Category, ≤2 days and >2 days	Age (OR 1.08; 95% CI 1.07–1.08) (*p*<0.001) Female sex (OR 1.22; 95% CI 1.18–1.25) (*p*<0.001) DM (OR 1.41; 95% CI 1.32–1.50) (*p*<0.001) Any complication (OR 2.87; 95% CI 2.50–3.30) (*p*<0.001) Post-procedural TIMI Flow (*p*<0.001)	9/11
[35]	Retrospective Study	Taiwan	64.7	519	8.8 days	N/I	Gastrointestinal bleeding (*p*=0.04)*	8/11
[28]	Retrospective Study	Turkey	54.8	267	48 hours	4 Category, 24 hours, 48 hours, 72 hours, and > 72 hours	Multi-vessel disease (*p*<0.001)** Killip Classification 3 (*p*<0.001)**	8/11
[36]	Prospective observational study	Netherland	63.3	2.323	6.7 days	2 category, <6 days and >6 days	Post-procedural TIMI Score (*p*<0.001)* LVEF (OR 2.06; 95% CI 1.54–2.76) (*p*<0.001)	8/11
[37]	Retrospective Study	USA	59.6	678.545	3.3 days	3 category, <2 days, 2–3 days, >3 days.	Age (OR 1.01; 95% CI 1.06–1.14) (*p*<0.001) Female (OR 1.25; 95% CI 1.21–1.29) (*p*<0.001) Smoking (OR 0.80; 95% CI 0.78–0.83) (*p*<0.001) DM (OR 1.11; 95% CI 1.07–1.15) (*p*<0.001) Heart Failure (OR 3.06; 95% CI 2.90–3.23) (*p*<0.001) CKD (OR 1.17; 95% CI 1.09–1.26) (*p*<0.001) AKI (OR 3.00; 95% CI 2.77–3.24) (*p*<0.001) Vascular Complication (OR 2.47; 95% CI 2.10–2.90) (*p*<0.001)	9/11

Notes: *Chi-Square test with Significant at p<0.05. **t-test with Significant at p<0.05.
Abbreviations: AKI, Acute kidney injury; BMI, Body mass index; CI, Confidence Interval; CKD, chronic kidney disease; DM, Diabetes Mellitus; HTN, Hypertension; LVEF, Left ventricular ejection fraction; LOS, Length of Stay; N/I, Not Information; OR, Odd Ratio; PVC, Peripheral Vascular Complication; SBP, Systolic blood pressure; STEMI, ST-Elevation Myocardial Infarction; UK, United Kingdom; USA, United States of America.

Table 2 Factors Associated with Increased LOS

Predictors	Highest Ratio OR (95% CI)	Lowest Ratio R (95% CI)	Category of Predictors	Author & Year
Age	1.76 (CI: 1.25–2.49)	0.9 (CI: 0.81–1.00)	Low	[10,13,19,22,33,37]
Gender Female Male	1.58 (CI: 1.25–1.99) 0.76 (CI: 0.73–0.80)	1.58 (CI: 1.25–1.99) 0.76 (CI: 0.73–0.80)	Low Low	[10,33,37] [22]
BMI	1.56 (CI: 1.28–1.89)	1.01 (CI: 0.97–0.99)	Low	[13,34]
Complication				
Vascular Complication	4.18 (CI: 1.16–15.03)	2.47 (CI 2.10–2.90)	High	[10,22,37]
Angiographic Failure	2.89 (CI: 1.19–7.01)	2.89 (CI: 1.19–7.01)	Moderate	[10]
Bleeding	2.62 (CI: 2.40–2.92)	2.61 (CI: 2.30–2.95)	Moderate	[22,24,35]
Post-procedure Complications	9.12 (CI: 7.22–11.53)	2.87 (CI 2.50–3.30)	High	[19,33]
AKI	3.00 (CI 2.77–3.24)	3.00 (CI 2.77–3.24)	Moderate	[37]

(*Continued*)

Table 2 (Continued).

Predictors	Highest Ratio OR (95% CI)	Lowest Ratio R (95% CI)	Category of Predictors	Author & Year
Delirium	P<0.001**	P<0.001**	Uncategorised	[20]
LVEF	2.06 (CI 1.54–2.76)	0.97 (CI; 0.96–0.99)	Moderate	[13,23,36]
Comorbid Disease				
DM	1.75 (CI: 1.35–2.27)	1.11 (CI 1.07–1.15)	Low	[10,19,33,37]
HTN	1.35 (CI: 1.14–1.60)	0.99 (CI:0.99–0.99)	Low	[10,13,19]
CKD	1.75 (CI: 1.35–2.2)	1.17 (CI 1.09–1.26)	Low	[19,37]
Heart Failure	5.59 (CI: 1.58–1.97)	3.06 (CI 2.90–3.23)	High	[13,37]
Liver Cirrhosis	p<0.001*	p<0.001*	Uncategorised	[21]
Multi-vessel Disease	p<0.001**	p<0.001**	Uncategorised	[28]
Killip Class >1	4.68 (CI: 2.60–8.42)	1.26 (CI: 1.01–1.57)	High	[10,13,28]
Current Smoker	0.80 (CI 0.78–0.83)	0.73 (CI 0.61–0.87)	Low	[10,23,37]
Infarction Area				
Anterior STEMI	1.61 (CI: 1.02–2.54)	1.61 (CI: 1.02–2.54)	Low	[10,23]
Problem at admission	4.09 (CI: 2.86–5.85)	4.09 (CI: 2.86–5.85)	High	[34]

Notes: *Chi-Square test with Significant at p<0.05.**t-test with Significant at p<0.05.
Abbreviations: AKI, Acute kidney injury; BMI, Body mass index; CI, Confidence Interval; CKD, chronic kidney disease; DM, Diabetes Mellitus; HTN, Hypertension; LVEF, Left ventricular ejection fraction; OR, Odd Ratio; STEMI, ST-Elevation Myocardial Infarction.

complications), heart failure (HF), Killip class >1, and problems at admission. Post-procedure complications were the most influential factors in increasing the LOS duration (OR: 9.12; 95% CI: 7.22–11.53; *p*<0.001). The predictors that are not categorized are delirium, liver cirrhosis and multivessel disease.

Discussion

This scoping review describes LOS duration and its associated factors among patients with STEMI who have undergone PPCI. Overall, the results showed that the duration of LOS in this review was the fastest 48 hours, and the longest of LOS was 10.2 days. 10 factors can affect the LOS in STEMI patients after primary PCI, namely age, gender, BMI, complications during treatment, comorbid diseases, Killip class >1, smoking, infarction area, and problems at admission. Then, the authors classify these factors into three predictor categories based on OR values, namely low, moderate, and high.

The factors that most influence the increase in LOS after PPCI in this review are included in the high category (see Table 2). Post-procedure complications were the most influential factors in increasing the LOS duration.[34] Regarding the incidence of post-PPCI complications, pulmonary edema is the most common while cardiogenic shock (CS) is the most rare complication.[34] Although rare, the occurrence of CS causes patients to experience a decrease in LVEF and has an impact on having a poor prognosis and high risk of death.[19,22,23,33] Hemodynamic deterioration, occurrence of multi-organ dysfunction and development of a systemic inflammatory response play a major role in the increased LOS and mortality of patients with CS complications post-PPCI.[22,33]

Several studies also reported that vascular complications were the most common post-PPCI complications.[10,22,37] The high frequency of bleeding events after surgery is the highest risk related to complications post PCI in the first 24 to 48 hours.[25] This bleeding can be caused by PVC.[10] The incidence of PCI-related PVCs could be due to hypertension, use of dual antiplatelet drugs and heparin, introducer sheath size and Glycoprotein IIb/IIIa during PCI procedures.[38] In addition, HF is the only comorbid disease that is a predictor in the high category. People with a history of HF are also at high risk

of experiencing a longer duration of hospitalization.[13] Prior HF as a predictor of fatality may contribute to adverse outcomes and a high risk of death in patients with AMI.[13,37] This is associated with ischemic sequelae that persist after cardiac arrest.[39]

Another predictor that is included in the high category is the Killip class.[10,13,28] A study in Turkey showed that patients with Killip class >1 had a 4.68-fold risk of having prolonged LOS.[10] Previous studies also said that most participants with Killip class >1 had LOS of more than 7 days.[13] The higher the Killip classification, the worse the patient's prognosis, affecting the LOS in the hospital.[10] One of the reasons for the increase in Killip class is the problems that occur during patient admission. Problems on admission are also among the most influential predictors of increasing LOS.[34] In this review, problems at admission are not related to delays in PPCI actions but can be a factor in increasing LOS when PPCI has been carried out. These problems include increased blood pressure, low LVEF, and decreased glomerular filtration rate (GFR).[19] Patients with problems during admission have a LOS of 3–6 days. STEMI patients who experience problems during admission will have an impact on the severity and prognosis, so they will certainly be at risk of experiencing a longer LOS after PPCI.[34]

Complications that are included in the predictors in the moderate category in this review are an angiographic failure, bleeding, and AKI.[10,22,24,35,37] Patients who are complicated by angiographic failure can have a prolonged LOS after PPCI is performed.[10] Previous studies found an independent association between ≥6 days of LOS with angiographic failure.[10] Angiographic failure (low post-procedure TIMI flow) is one of the Zwolle index criteria that defines a patient as being at high risk.[40] This tool is helpful for systematically evaluating patients for safe early discharge and optimizing clinical outcomes after undergoing PPCI.[41] In addition, AKI is the most common complication when patients experience bleeding and CS.[33,37,42] Bleeding events will certainly affect the perfusion to the kidney and cause the patient to experience AKI.[37] AKI is an independent prognostic factor for extended hospital stay and mortality among STEMI patients complicated by CS and treated with PPCI.[42] Previous studies said that the mortality rate was found to be 61.3% in this population.[43] The incidence of CS post-PPCI can be identified through its independent predictors, namely TIMsI post PCI, glucose levels, plasma lactate, and blood urea nitrogen levels.[43]

Several predictors are included in the low category that affects LOS in patients after PPCI. Age is an independent factor that is a predictor of LOS.[10,13,19,22,33,37] Previous studies said that the elderly with an average age of >68 years have a longer LOS.[10] Pathophysiological changes such as increased calcification, worse endothelial function, and a history of the cardiac disease contribute to the higher adverse event rate among the elderly undergoing PCI.[44] Another factor that influences LOS is gender.[10,22] This review found that both male and females' patients are at risk for prolonged LOS. However, some studies said females are more at risk.[10,33,37] Females have a 1.5 to 4 times higher risk of vascular complications than men and an increased risk of bleeding at the femoral artery access after PPCI (70.4%).[45] Pathophysiologically, female are more likely to develop thrombosis caused by endothelial erosion.[46] This can affect homeostatic processes in modulating metabolism, proliferation, permeability, response to inflammatory stimuli and apoptosis.[47] So that, in the end, affects the development of plaque and the characteristics of lesions that have the potential to rupture and result in longer LOS in female patients after PPCI.[47]

In another low-category predictor, the risk of prolonged LOS is also experienced by obese patients and smoker. Previous studies show that increased BMI was in line with prolonged LOS.[13,34] Patients with extreme BMI (<18.5 and >40kg/m2) are also at increased risk of adverse outcomes after PCI.[48] Patients post-PPCI who were treated for more than 7 days had an average BMI of 24.22 kg/m2.[13] There is a relationship between obesity and coronary atherosclerosis, with hemodynamic, metabolic, and inflammatory factors as well as oxidative stress contributing to the development of cardiovascular disease in obese patients.[48] This study also found that STEMI patients who smoked had a longer LOS than nonsmokers.[10,23,37] Smoking affects faster atherosclerosis, increased blood coagulability, and greater platelet reactivity, which will cause physiological effects and the risk of complications during treatment.[49] Previous studies have shown that most of the participants who smoke (59.9%) have LOS of more than 6 days.[10] Similarly, previous studies said smoking is associated with a worse prognosis after PPCI.[50]

Our findings showed that almost all comorbid diseases are included in the category of low predictors of affecting LOS after PPCI. DM, HTN, and CKD are the most commonly reported primary comorbidities and affect the longer of LOS (>5 days).[10,19,33,37] People with DM are at increased risk of coronary atherosclerosis, plaque burden, and inducing

endothelial dysfunction.[10,19,33,37] Other studies have shown that duration of LOS >6 days is more common in STEMI patients with a history of HTN.[10,13,19] This can be caused by several factors, such as endothelial damage, atherosclerosis, left ventricular hypertrophy, and arrhythmias that will impact the LOS.[13] STEMI patients with CKD also experience long hospitalization days (>7 days) due to procedural complications after PPCI.[19,37] The existence of vascular complications, including bleeding, occlusion site access, loss of distal pulse, dissection and pseudoaneurysm, will undoubtedly have an impact on LOS in patients with CKD.[51]

Our findings suggest that the location of infarction also determines the LOS post-PPCI patients.[10,23] Patients with an anterior infarction is at greater risk of experiencing a longer LOS.[10,23] In addition, the left anterior descending (LAD) area has been associated with poorer epicardial and microvascular reperfusion. LAD infarction carries a higher myocardial risk, results in more severe systolic dysfunction, and is more likely to embolize distal atherothrombotic material after PCI, all potential mechanisms of poorer final myocardial reperfusion that result in longer LOS.[52]

Uncategorized predictors, including delirium, liver cirrhosis, and multi-vessel disease have been reported by several studies to influence clinical outcomes and prolong the duration of LOS in patients after PPCI.[20,21,28] Complications such as delirium are known to be more common in older patients (>60 years) due to the effects of anesthesia and their sensitivity to non-anesthetic drugs.[53] Another complication that often occurs post-PPCI is vascular problems, especially in elderly patients.[54] This supports another study results which reported that patients with other comorbid conditions such as liver cirrhosis and multivessel disease are also at a much higher risk of experiencing vascular complications due to significant bleeding related to thrombocytopenia after PPCI and resulted in an extension of LOS.[21,28] Differences in the clinical outcome of each patient are very likely to be found in prolonging LOS depending on the type of comorbidities and complications experienced by the patient before or after the PPCI procedure.

The outcomes of each PPCI patient were highly heterogeneous. Thus, assessing the risk stratification of each patient, especially after undergoing PPCI is very important.[55] The commonly used tool to assess the success of PCI is the TIMI grade flow.[55] However, the results of this review indicate that only a few studies have reported the results of TIMI of flow post-PPCI.[13,19,22,23,33] In fact, evaluating the TIMI score after PCI indicates the success of the action, which is closely related to the prognosis and severity of the patient, so it influences LOS.[55] Also, assessing the patient's risk stratification is essential for further clinical and therapeutic decision-making.

In this review, the predictor of LOS among patients with STEMI after PCI is multifactorial. The author observes that almost every sample in each article reviewed has more than one factor, accompanied by the coexistence of other risk factors such as age, gender, comorbid disease, and other factors. Therefore, efforts must be made to improve the care of STEMI patients after PPCI by providing early discharge education earlier. Early discharge programs within 16–72 hours of STEMI patients after PCI are considered low risk, proven safe, and may be undertaken to reduce re-hospitalization rates and LOS.[56,57] In addition, the use of artificial intelligence (AI) in the last decades has been highly recommended and has shown its effectiveness in the management of patients with coronary artery disease (CAD) and atrial fibrillation (AF).[58] AI systems can be used to examine large amounts of patient data to detect risk factors for AF and assess the potential for developing the disease. Thus, the application of AI in the world of health is beneficial for health professionals in choosing the appropriate treatment based on patient needs.[58]

Limitations of This Study

The limitation of this scoping review is that it is difficult for the authors to categorize predictors of LOS into short-term and long-term because the studies analyzed did not compare these two factors. However, the authors divide it into three categories (low, moderate, and high) based on the OR value of each predictor. In addition, most of the studies analyzed did not identify a TIMI grade flow score or other risk stratification tool, so the review results cannot be generalized regarding risk stratification in this population. Then, the results of this review show that most of the articles analyzed in this review were conducted in developed countries, so similar research needs to be conducted in developing countries so that the results of this review can be generalized better.

Conclusion

This study shows that 13 articles from five databases discuss the description of LOS duration and the factors influencing LOS in post-PPCI patients. In this study, the shortest LOS duration was the fastest 48 hours, and the longest was 10.2 days. The factors affecting LOS in this population are classified into three categories: low, moderate, and high. Post-procedure complications (pulmonary oedema and CS) were the most influential predictor of increased LOS in PPCI patients. Many factors related to LOS are essential considerations for health workers, especially nurses, in evaluating and re-optimizing the quality of care for STEMI patients after PPCI. Nurses can identify various modifiable factors to prevent complications and worsen disease prognosis to increase LOS efficiency and care costs while in the hospital.

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