

## Phase I Cardiovascular Rehabilitation, Risk Stratification, and Length of Hospitalization in Post-Percutaneous Coronary Intervention (PCI) Patients

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### ABSTRACT

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Percutaneous Coronary Intervention (PCI) is one of the most effective actions for patients with Acute Coronary Syndrome (ACS), which can improve prognosis and minimize hospitalization time. To optimize medical therapy programs, PCI must be complemented with further preventive measures, such as cardiovascular rehabilitation, including lifestyle modification and risk stratification. This study aims to analyze the relationship between phase I cardiovascular rehabilitation, risk stratification, and length of hospitalization in post-PCI patients. The study design was a retrospective cohort sourced from electronic medical record data. Respondents were divided into groups: those exposed and those not exposed to phase I cardiovascular rehabilitation. Risk stratification and length of hospitalization were studied as study outcomes. Among 201 patients who were followed up during hospitalization, high-risk stratification was more in the unexposed group: exposed group (92.2%: 90.8%; RR 0.85, 95%CI 0.340-2.104). Length of hospitalization  $\geq 3$  days was more in the unexposed group: exposed group (63.1%: 59.2%; RR 0.904 95%CI (0.639-1.279). Length of hospitalization  $\geq 3$  days was more in the high stratification group: low stratification (63.6%: 35.3%; RR 0.555 95%CI (0.289-1.066). Phase I cardiovascular rehabilitation was not associated with risk stratification and length of hospitalization. Patient risk stratification was related to the length of hospitalization of post-PCI patients. Phase I cardiovascular rehabilitation is an integral part of medical therapy that can reduce adverse events in post-PCI patients.

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## INTRODUCTION

The prevalence of heart disease in Indonesia is 1.5% and is the highest cause of death from non-communicable diseases (Minsitry of Health Republic Indonesia, 2018). Coronary heart disease (CHD) is the most common cause of death worldwide, with Acute Coronary Syndrome (ACS) appearing to be the leading cause of death in the life-threatening phase of CHD (Qin et al., 2021). Percutaneous coronary intervention (PCI) is one of the most effective actions for patients with ACS, as it can improve prognosis and minimize hospitalization time (Zhang et al., 2018).

Medical intervention in the form of PCI in ACS patients does not reduce the risk factors that cause coronary artery disease, and it is found that patients are still at high risk of experiencing ACS again, where the average readmission rate is 16% (Ambrosetti et al., 2021). Treatment for ACS consists of medical intervention, surgical

approaches to treat blocked coronary arteries, and acute-phase cardiovascular rehabilitation (Chow et al., 2019). The series of ACS patient care is highly recommended to start as early as possible after the onset of a heart attack (diagnosis) and continue throughout the treatment process and after the patient goes home (Shajrawi et al., 2021)

Pack et al. (2019) stated that inpatient cardiac rehabilitation programs provide essential patient services by providing risk factor education, daily ambulation, and facilitating referrals for outpatient cardiac rehabilitation.

Cardiac catheterization services in Indonesia are still not optimal when implementing phase I cardiovascular rehabilitation (cardiac rehabilitation in hospitals). Phase I cardiovascular rehabilitation is integral to patient treatment and care both during hospitalization and after discharge. Patients must be able to independently carry out cardiovascular rehabilitation programs after being treated in the hospital.

Based on the problems found, researchers are interested in conducting research that aims to analyze the relationship between phase I cardiovascular rehabilitation, risk stratification, and length of hospitalization in patients with ACS post-PCI.

## METHOD

We conducted a retrospective cohort study on electronic medical record data from the Universitas Sumatera Utara Teaching Hospital in Medan (RSP USU). Data were extracted from the website <https://rsusu.periksa.tech>, which consisted of patient information data, laboratory test results, electrocardiogram test results, echocardiography test results, integrated patient progress notes, integrated education notes, discharge planning, and patient medical resumes. Before the data collection process, a research ethics test was carried out through the Health Research Ethics Committee of the University of North Sumatra (Research Ethics Approval No: 639/KEPK/USU/2024). This observational study is based on data from patients diagnosed with post-PCI ACS from the RSP USU Cardiac Catheterization Unit from June 2022 to April 2024 (235 respondents).

The medical record data of patients who underwent follow-up were patients who received cardiac catheterization intervention in the form of PCI; patients who were not diagnosed with ACS were not used as research objects. The medical record date observed started from the first day after PCI until discharge, and it contained information on the implementation of cardiovascular rehabilitation, clinical data on risk stratification, and length of hospitalization. Therefore, incomplete data in the sense that there was no data set about information and patients who died during treatment were excluded from the research object. The data was then inputted into the research observation sheet. The researcher carried out the data extraction process manually.

### Data extraction process

Structured data is inputted into the observation sheet, while researchers with specific criteria analyze unstructured data. Respondent characteristic data consists of age, gender, ACS classification, and comorbidities: smoking history, diabetes mellitus, dyslipidemia, hypertension, and obesity. Respondents are concluded to suffer from DM if they documented laboratory test results with the criteria: random

blood sugar ( $>200\text{mg/dL}$ ), fasting blood sugar ( $>126\text{mg/dL}$ ), and HbA1c test ( $>6.5\%$ ). Respondents are concluded to suffer from hyperlipidemia if they documented LIPID Profile test results with the criteria: total cholesterol ( $>200\text{mg/dL}$ ); LDL ( $>100\text{mg/dL}$ ); HDL ( $<60\text{mg/dL}$ ) and Triglycerides ( $>150\text{mg/dL}$ ). Respondents are concluded to suffer from obesity if documented weight (kg) and height (cm) data are then calculated for Body Mass Index (BMI) with the criteria of BMI value  $>25\text{kg/m}^2$ .

Data on nurses' implementation of phase I cardiovascular rehabilitation were extracted based on information regarding monitoring vital signs and post-PCI complications, administration of drugs and intravenous therapy, provision of emotional support and reassurance to anxious patients, patient education on disease control and risk factors, and implementation of physical exercise or early ambulation during treatment.

Risk stratification data can be structured and unstructured data obtained through reporting the cardiac exercise test process or without conducting a cardiac exercise test in the form of ventricular dysrhythmia, angina, significant symptoms, hemodynamics, and functional capacity if a cardiac exercise test is performed. Without conducting a cardiac exercise test, the clinical data are resting ejection fraction, complications of myocardial infarction or PCI procedures, silent ischemia, signs of congestive heart failure, symptoms or signs of post-PCI ischemia, and signs of clinical depression.

Researchers calculated the length of hospitalization days by researchers, in the form of documentation of the day when the respondent completed the PCI procedure and was treated in the inpatient room or intensive care unit (ICU) until the day they went home.

### Statistical analysis

Respondent characteristics, cardiovascular rehabilitation phase I, risk stratification, and length of stay of post-PCI patients were analyzed using frequency distribution (f) and percentage (%). Cardiovascular rehabilitation phase I presents data on exposed and unexposed post-PCI patient groups. Post-PCI patients' Risk stratification consists of low, moderate, and high risk. Length of stay consists of  $\leq 2$  days and  $\geq 3$  days.

The statistical test carried out was the Chi-Square test. ( $\chi^2$ ) to analyze the relationship between variables, namely: phase I cardiovascular rehabilitation and risk stratification of post-PCI patients, phase I cardiovascular rehabilitation and length of stay of post-PCI patients, and risk

stratification and length of stay of post-PCI patients. Hypothesis testing is carried out on the  $\rho$  value with a Confidence Interval (CI) of 95% or  $\alpha=0.05\%$ . If the  $\rho$ -value is  $<0.05$ , then there is a relationship between the research variables ( $H_0$  rejected). The relative risk (RR) value at 95%CI was also identified to identify the difference in the magnitude of the odds in the exposed and unexposed groups of phase I cardiovascular rehabilitation.

## RESULTS

Table 1 shows respondent characteristics were in the age range of 55-65 (38.8%), male (65.7%), and education level was high school (47.3%). Classification of ACS (53.7%) was STEMI with the most comorbidities in order of hypertension (52.2%), obesity (52.2%), smoking history (51.2%), diabetes mellitus (34.5%), and dyslipidemia (17.4%). Post-PCI patients were more likely not exposed to phase I cardiovascular rehabilitation (51.2%) with risk stratification in the high-risk category (91.5%) and length of hospitalization  $\geq 3$  days (61.2%).

Table 2 shows that Post-PCI patients who were not exposed to phase I cardiovascular rehabilitation with low-risk stratification were only 8 people (7.8%), and 95 people (92.2%) had high-risk stratification. In the group exposed to phase I cardiovascular rehabilitation, 9 people (9.2%) had low-risk stratification, and 89 people (90.8%) had high-risk stratification. The calculation results showed that high-risk stratification had an RR (relative risk) value of 1.016 (0.934-1.105) compared to low-risk stratification with an RR value of 0.846 (0.340-2.104). This means that the risk will be 1.016 times in the high-risk group compared to the low-

risk group, with a risk value of 0.846 times. *Chi-Square* test with  $\rho$ -value 0.457 ( $\rho$ -value $>\alpha=0.05$ ), so  $H_0$  failed to be rejected, which means there is no relationship between risk stratification in the unexposed and exposed groups of cardiovascular rehabilitation phase I.

**Table 1. Respondent characteristics**

Variables	f	%
<b>Age</b>		
26-35 years	1	0.5
36-45 years	14	7.0
46-55 years	52	25.9
55-65 years	78	38.8
> 65 years	56	27.9
<b>Gender</b>		
Man	132	65.7
Woman	69	34.3
<b>Level of education</b>		
No school	52	25.9
Elementary school	8	4.0
Junior high school	11	5.5
Senior high school	95	47.3
Bachelor	35	17.4
<b>SKA Classification</b>		
APTS (Unstable Angina Pectoris)	52	25.9
NSTEMI (Non-ST Elevation Myocardial Infarction)	41	20.4
STEMI (ST Elevation Myocardial Infarction)	108	53.7
<b>Cardiovascular Rehabilitation phase I</b>		
Not Exposed	103	51.2
Exposed	98	48.8
<b>Risk Stratification</b>		
Low risk	17	8.5
Medium risk	0	0.0
High risk	184	91.5
<b>Length of Hospitalization</b>		
$\leq 2$ days	78	38.8
$\geq 3$ days	123	61.2

**Table 2. Relationship between Phase I Cardiovascular Rehabilitation and Risk Stratification**

Phase I cardiovascular rehabilitation	Risk stratification				Total		RR 95%CI	$\rho$ -value
	Low		Tall					
	n	%	n	%	n	%		
Not exposed	8	7.8	95	92.2	103	100	0.846 (0.340-2.104)	0.457 *
Exposed	9	9.2	89	90.8	98	100	1.016 (0.934-1.105)	
Amount	17	8.5	184	91.5	201	100		

\*  $\rho$ -value is considered significant if  $\rho$ -value is less than 0.05

**Table 3. Relationship between Phase I Cardiovascular Rehabilitation and Risk Stratification**

Phase I cardiovascular rehabilitation	Length of Hospitalization				Total		RR 95%CI	$\rho$ -value
	$\leq 2$ days		$\geq 3$ days					
	n	%	n	%	n	%		
Not exposed	38	36.9	65	63.1	103	100	0.904 (0.639-1.279)	0.335 #
Exposed	40	40.8	58	59.2	98	100	1,066 (0,855-1,330)	
Amount	78	38.8	123	61.2	201	100		

\*  $\rho$ -value is considered significant if  $\rho$ -value is less than 0.05

Post-PCI patients who were not exposed to phase I cardiovascular rehabilitation with a length of stay  $\leq 2$  days were 38 people (36.9%) and 65 people (63.1%) with a length of stay  $\geq 3$  days. In the group exposed to phase I cardiovascular rehabilitation, 40 people (40.8%) were treated for  $\leq 2$  days, and 58 people (59.2%) with a length of stay  $\geq 3$  days. The calculation results showed that a length of stay  $\geq 3$  days had an RR (relative risk) value of 1.066 (0.855-1.330) compared to a length

of stay  $\leq 2$  days with an RR value of 0.904 (0.639-1.279). This means that in the group with a length of hospitalization  $\geq 3$  days, the risk will be 1.066 times greater than the group with a length of hospitalization  $\leq 2$  days with a risk value of 0.904 times. Chi-Square test with a  $p$ -value of 0.335 ( $p$ -value  $> \alpha = 0.05$ ), so  $H_0$  fails to be rejected, which means there is no relationship between the length of hospitalization in the group not exposed and exposure to phase I cardiovascular rehabilitation.

**Table 4. Relationship between risk stratification and length of hospitalization**

Risk Stratification	Length of Hospitalization				Total		RR 95%CI	$\rho$ -value
	$\leq 2$ days		$\geq 3$ days		n	%		
	n	%	n	%				
Low	11	64.7	6	35.3	17	100	1.777 (1.192-2.650)	0.022 *
Tall	67	36.4	117	63.6	184	100	0.555 (0.289-1.066)	
Amount	78	38.8	123	61.2	201	100		

\*  $p$ -value is considered significant if  $p$ -value is less than 0.05

Post-PCI patients with low-risk stratification were found to have a length of stay of  $\leq 2$  days; there were 11 people (64.7%) and 6 people (35.3%) who had a length of stay of  $\geq 3$  days. In the high-risk stratification group, there were 67 people (36.4%) who were treated for  $\leq 2$  days and 117 people (63.6%) with a length of stay of  $\geq 3$  days. The calculation results showed that the low-risk group had an RR (relative risk) value of 1.777 (1.192-2.650) compared to the high-risk group with an RR value of 0.555 (0.289-1.066). This means that in the low-risk stratification group, the risk will be 1.777 times compared to the high-risk stratification group with a risk value of 0.555 times. Chi-Square test with  $p$ -value 0.022 ( $p$ -value  $< \alpha = 0.05$ ), so  $H_0$  is rejected, which means there is a relationship between high and low-risk stratification groups with length of hospitalization.

## DISCUSSION

This study showing that the majority were male patients receiving cardiovascular rehabilitation align with results from the University of Michigan Hospital (Sola et al., 2019). Research on barriers to implementing physical activity in cardiovascular rehabilitation in Egypt also found that most respondents were male (77%) (Ahmed et al., 2022). Men experience more ischemic heart disease than women (19.1% versus 14.2%) because women have biological defenses against coronary artery disease before menopause, which causes a delay of decades in symptoms of coronary artery disease (Gheisari et al., 2020).

The classification of ACS in post-PCI patients is the characteristic with the most

findings, namely 108 respondents experienced STEMI (53.7%). Qin et al. (2021) identified respondents who participated in a study from the perspective of post-PCI patients with a total of 75% STEMI diagnosis. The high incidence of STEMI in ACS diagnosis confirms the need for cardiac revascularization, one of which is PCI.

The characteristics of comorbidities in order from the most are hypertension, obesity, smoking history, diabetes mellitus, and the least is dyslipidemia. In this study, it was found that respondents did not only have one comorbidity but more than one comorbidity. This finding is in line with the results of a study that identified the majority of patients with cardiovascular disease risk factors with a total of two comorbidities of 30% in patients treated at community cardiac rehabilitation centers in Italy (Corrà et al., 2022)

Phase I cardiovascular rehabilitation implementation mostly respondents not exposed. This finding is in line with the results of a study on patients who received cardiovascular rehabilitation services in hospitals at 458 hospitals in America with a sample size of 370,324 post-PCI patients. Phase I cardiovascular rehabilitation was implemented in 98,717 patients (26.7%) (Pack et al., 2019). Patients are the source of obstacles in cardiovascular rehabilitation, as Saripudin et al. (2018) reported in patients with coronary heart disease at Hasan Sadikin Hospital, Bandung. Obstacles based on logistical aspects are obstacles with the highest average score (mean) of 2.29. Next are obstacles based on time aspects, with an average score of 2.24, then based on health service aspects, with an average score of 2.19, and the lowest average score is based on patient functional status, namely 2.14. Distance and patient ignorance regarding cardiac rehabilitation

were two barriers with the highest average scores, 2.52 and 2.38.

Most post-PCI respondents were identified with high-risk stratification, namely 184 respondents (91.5%), while there were no respondents with moderate risk stratification and only 17 respondents (8.5%) with low-risk stratification. The use of instruments to evaluate the risk stratification of patients undergoing cardiovascular rehabilitation based on the AACVR guidelines was reported in previous studies with a sample size of 657 patients with low, moderate, and high-risk category results, respectively, 71 respondents (11%); 205 (31%); and 381 (58%). In this study, no exercise criteria (stress test) were used to implement the study (Bhat et al., 2021). The research findings in the electronic medical records of post-PCI patients while in the hospital identified that there was never any documentation of risk stratification by doctors or nurses. In addition, there was no documentation of the results of stress tests for post-PCI patients during treatment; records of stress test results were found when post-PCI patients underwent outpatient control (phase II cardiovascular rehabilitation).

The majority of post-PCI patient hospitalization days were  $\geq 3$  days. Post-PCI patients who received phase I cardiovascular rehabilitation at 458 hospitals in the United States reported an average length of stay of 2 days (1-4 days) with an average dose of phase I cardiovascular rehabilitation for 1 day (1-2 days). The length of stay for post-PCI patients will be longer in hospitals or cardiac rehabilitation centers with policies for implementing various phase I cardiovascular rehabilitation programs. The research findings were reported with median and interquartile range data with the results: 15 (12-20) vs. 13 (9-17); in the group undergoing phase I cardiovascular rehabilitation, the length of stay was longer than the group not undergoing phase I cardiovascular rehabilitation (Kanazawa et al., 2020).

Both  $p$ -values were statistically insignificant in identifying the relationship between phase I cardiovascular rehabilitation on risk stratification and length of hospitalization in post-PCI patients. Kaneko et al. (2021) identified the length of hospitalization in heart failure patients who underwent phase I cardiovascular rehabilitation and those who did not undergo phase I cardiovascular rehabilitation in Japan with an average length of hospitalization of 16 days (11-25) versus 17 days (11-27); 1 day longer in the group that did not undergo cardiovascular rehabilitation with a  $p$  value  $< 0.001$  ( $p < 0.05$ ). The

resulting outcomes concluded that earlier phase I cardiovascular rehabilitation implementation was associated with lower mortality rates, shorter hospital stays, and longer readmission to hospital than 30 days.

The  $p$ -value in the Chi-Square test of the effect of risk stratification on the length of hospitalization of post-PCI patients is 0.022 ( $p < 0.05$ ). This value is statistically significant, indicating a relationship between risk stratification and the length of hospitalization of post-PCI patients. The majority of patient risk stratification in this study was at high risk. Hence, they had more than one clinical condition that described coronary artery disease that resulted in impaired heart function. In addition, it was also influenced by various variations in cardiovascular disease risk factors so that the risk stratification was in the high category, which caused the length of hospitalization to be  $\geq 3$  days or exceeded the provisions of the clinical practice guidelines set by the Indonesian Cardiovascular Association for post-PCI patients. A study of the ECG of patients with heart disease after cardiovascular rehabilitation at the Integrated Heart Disease Installation at the dr Saiful Anwar Malang Regional General Hospital in Malang showed a change in normal ECG from before the intervention by 68.75% to 87.5% (Romelah, 2021).

### Research limitations

Researchers realize that there are still limitations in the data extraction procedure, such as using a web scraping platform or a machine learning program platform (artificial intelligence technology), whose observations are carried out manually without the help of system automation. The number of research samples for the retrospective cohort design in this study is also thought to affect the results of the statistical tests. A larger number of research samples is needed to obtain more valid results.

### CONCLUSION

There is no relationship between phase I cardiovascular rehabilitation and risk stratification and length of stay of post-PCI patients. Researchers identified that clinical conditions and non-cardiac comorbidities affect the length of stay of patients, as evidenced by the relationship between risk stratification and the length of stay of post-PCI patients. Optimizing the implementation of phase I cardiovascular rehabilitation through various managerial (such as nutritional

management, psychological management, etc) approaches will have an impact on risk stratification, and the length of stay of patients can be implemented by cardiac rehabilitation centers with cardiac catheterization services. Further research recommends a larger sample size and direct follow-up of post-PCI patients undergoing phase I cardiovascular rehabilitation.

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## CREDIT AUTHOR STATEMENT

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