
Assessing Chest Pain Management and Outcomes in Percutaneous Coronary Intervention Patients: A Retrospective Analysis in Saudi Arabian Emergency Departments

Tahani Alrougi and [Abdulellah Al Thobaity](#)*

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Article

Assessing Chest Pain Management and Outcomes in Percutaneous Coronary Intervention Patients: A Retrospective Analysis in Saudi Arabian Emergency Departments

Tahani Alrougi ^{1,2} and Abdullellah AL Thobaity ^{1,*}

¹ Nursing Department; Applied Medical sciences College, Taif University, Taif, Saudi Arabia
a.thobaity@tu.edu.sa

² Faisal Medical Complex, Taif, Saudi Arabia

* Correspondence: a.thobaity@tu.edu.sa

Abstract: This study aimed to investigate the characteristics and outcomes of patients who underwent percutaneous coronary intervention (PCI) and visited an emergency department (ED) with chest pain in Saudi Arabia. A retrospective analysis of patient data was conducted, focusing on demographics, risk factors, pain assessment, triage, diagnostic testing, and management. The results revealed a young adult population (40-59 years old) at risk for coronary heart disease (CHD), highlighting the need for increased awareness and education. Gender differences in cardiovascular disease (CVD) presentation and underdiagnoses in women also require attention for effective prevention and treatment. Accurate pain assessment during triage was found to be essential to prevent mistriage and negative patient outcomes. Chest pain and shortness of breath were common symptoms, emphasizing the importance of recognizing acute myocardial infarction (AMI) symptoms for proper triage, diagnostic testing, and prompt treatment. The study identified modifiable CVD risk factors, including diabetes (51.1%), hypertension (43.8%), and smoking (25.9%), stressing the importance of lifestyle modifications to reduce CVD risk. Saudi Arabia faces significant challenges in addressing cardiovascular disorders, but efforts to improve healthcare access and establish specialized centers are promising. In conclusion, this study underscores the need for increased awareness of CHD among young adults, accurate pain assessment during triage, and lifestyle modifications to address modifiable CVD risk factors. Furthermore, healthcare teams must stay updated on new chest pain guidelines in the ED and prioritize early detection of implicated arteries and prompt reperfusion. Further research investigating chest pain patient triage and assessments across Saudi Arabia is recommended to identify areas of improvement and implement necessary changes in clinical practice.

Keywords: Chest Pain; Percutaneous Coronary Intervention; Outcomes; Cardiovascular Disease; Emergency Department

1. Introduction

Chest pain is a highly prevalent symptom that frequently brings patients to the emergency department (ED) [1]. In fact, up to 25% of the general population may experience chest pain in various forms throughout their lives [2]. Although chest pain can be a manifestation of several different medical conditions, it is crucial to distinguish between cardiac and non-cardiac causes, as the latter can range from musculoskeletal issues to potentially severe emergencies such as acute coronary syndrome (ACS) [3]. Heart-related chest discomfort often presents as pain radiating to the neck, arm, or jaw, described as "heavy, crushing, burning, hurting, or tight" [4]. Prompt treatment of chest pain can reduce patient mortality, while delayed intervention may exacerbate adverse effects[5]. Consequently, early reperfusion is a critical component of myocardial infarction (MI) treatment, especially for high-risk patients, as it can significantly decrease mortality[5]. One effective treatment option for MI is percutaneous coronary intervention (PCI), which can be performed in facilities equipped with cardiac catheterization capabilities.

PCI has become the leading procedure for enhancing myocardial perfusion in the treatment of coronary artery disease. It effectively alleviates symptoms in patients with ACS, particularly in emergency treatment for those with ST-elevation MI [6]. The procedure involves inserting a stent into the obstructed coronary artery lumen to restore normal blood flow to the heart [7]. Successful PCI revascularization significantly improves survival rates for patients. In cases of MI with ST-segment elevation, primary angioplasty is favored over thrombolysis for patients admitted to hospitals with angioplasty facilities [8]. As a result, specialized cardiac centers across the Kingdom have increased catheterization services by 69% since early 2016, with the Ministry of Health continuing to expand access to these services by extending catheterization centers and providing facility-based care [9].

However, despite the importance of PCI, there is limited research on its outcomes in Saudi Arabia. A study focusing on young patients admitted to a cardiac center in Saudi Arabia for ACS found that smoking and family history were the highest risk factors, with low hospital mortality compared to older patients [10]. In contrast, another study in Riyadh examined all ED patients with STEMI, identifying the left anterior descending (LAD) artery as the most common culprit (52.5%), followed by the right coronary artery (RCA; 26.0%) [11]. While the first study concentrated on young patients, the second exclusively investigated patients with acute STEMI treated with PCI. Additionally, a prospective multi-center registry study in 50 hospitals across Saudi Arabia followed patients with acute MI (AMI) for one month and one year post-discharge [12]. While this study provided some evidence regarding the culprit lesions and closures, it still lacked a comprehensive analysis of PCI outcomes and their risk factors for chest pain patients undergoing catheterization laboratory tests from the ED, regardless of whether they initiated medical therapy.

Therefore, this study aims to fill the gap in understanding the characteristics of chest pain patients who undergo PCI, identify the most common culprit coronary arteries, and emphasize the importance of percutaneous coronary procedures in saving lives and reducing mortality. By analyzing PCI outcomes in patients presenting to the ED with chest pain, this research will contribute to a deeper understanding of the factors influencing treatment success and the potential for improved patient care.

2. Materials and Methods

This research employed a quantitative study design using a retrospective (cohort) data approach by obtaining data from patients' medical records. The study was conducted in one of the major hospitals, considered the cardiac center, in Taif, Saudi Arabia. The hospital has an extensive cardiac catheterization unit that conducted over 4000 procedures from 2018 to 2021 and thus has a 500-bed capacity, in addition to 29 beds in the ED. A random sample of 354 patients was selected from the hospital's health information system and data records of patients who have undergone PCI from 2018 to 2021. Inclusion criteria are all chest pain patients that come through the ED and have undergone PCI. Nationality, gender, and age were included in the study. Moreover, the exclusion criteria are patients with no chest pain. As a result, the sample included 354 patients. Data were exported from the hospital's health information system and data records and were collected randomly in an Excel sheet from October 9, 2022, to November 6, 2022. Data collection was performed after we obtained ethical approval from the Ethics Committee of the Research and Studies Department in the Directorate of Health Affairs, Makkah, with IRB registration number H-02-K-076-0622-747 on 30/06/2022. Patient consent was not needed because we used a retrospective approach. Patient health information was de-identified, and data confidentiality was taken and maintained. The data were saved in a particular drive with a password and will be used for research purposes only. The types of data collected include demographic factors, the procedure year, pain score, CTAS level, complaint, diagnosis, ED vital signs, ED laboratory, electrocardiogram (ECG) result, coagulation profile result, troponin result, procedure type, findings of the procedure, stent need, coronary artery bypass graft (CABG) need, closure, and closure percentage, previous PCI, effusion percentage, received thrombolytic therapy, death during the procedure, complication after the procedure, and pre-procedural risk factors (such as diabetes mellitus, hypertension, dyslipidemia, renal disease, smoking, previous cardiac problems, STEMI, and non-STEMI).

2.1. Data Analysis

The data were collected in an Excel sheet and then exported into an SPSS sheet (SPSS version 25) [13]. Frequency and descriptive statistics were used for data on demographic factors, vital signs, diagnosis, diagnostic test, assessment, laboratory, and culprit arteries. Chi-square (χ^2) was used to measure the relationship between gender and stent need, gender and troponin, gender and STEMI, and age and diabetes.

3. Results

Table 1 presents demographic data from a dataset, providing insights into various subgroups and their frequencies and percentages. The table reveals that the dataset comprises individuals of different age groups, with the majority falling into the 40-59 age range (57.1%), followed by the 60-79 age range (31.4%).

Table 1. Demographic data.

Group	Subgroup	Frequency	Percentage
age	40–59	320	57.1
	60–79	176	31.4
	20–39	37	6.6
	80 and above	17	4.8
	Total	560	100.0
gender	male	472	84.3
	female	88	15.7
	total	560	100.0
nationality	Saudi	411	73.4
	Bangladeshi	39	7.0
	Pakistani	30	5.4
	Egyptian	28	5.0
	Yemeni	10	1.8
	Indian	12	2.1
	Sudanese	8	1.4
	Tunisian	4	0.7
	Syrian	4	0.7
	Kuwaiti	1	0.2
	Afghani	1	0.2
	Turkistan	2	0.4
	Ethiopian	2	0.4
	Filipino	3	0.5
	Moroccan	1	0.2
Total	560	100.0	
pain score	mild	185	33.0
	moderate	370	66.1
	severe	5	0.9
	total	560	100.0
category	CTAS 1	23	4.1
	CTAS 2	485	86.6
	CTAS 3	52	9.3
	CTAS 4	0	0
	CTAS 5	0	0
	Total	560	100.0

In terms of gender, the dataset is predominantly male (84.3%). The nationality distribution shows a higher representation of individuals from Saudi Arabia (73.4%), with other nationalities making up smaller proportions. Pain scores indicate that most individuals experience moderate pain (66.1%). Lastly, the categorization based on the Canadian Triage and Acuity Scale (CTAS) shows that the majority of individuals belong to CTAS 2 (86.6%), while CTAS 1, 3, 4, and 5 have smaller or no representation. This comprehensive demographic information is valuable for understanding the composition of the dataset and its potential implications for further analysis or interpretation.

Table 2 presents data on the assessment of various parameters within a dataset, including vital signs and laboratory results. The table provides information on the percentage and frequency of abnormal and normal readings or results for each parameter. It reveals that abnormal readings are most prevalent for parameters such as systolic blood pressure (79.1%), diastolic blood pressure (65.2%), and prothrombin time (78.4%), while normal readings are more common for parameters such as heart rate (84.3%), respiratory rate (82.1%), and temperature (91.8%). Similarly, abnormal laboratory results are observed for parameters like prothrombin time (78.4%), partial thromboplastin time (43.8%), and international normalized ratio (31.1%), while normal results are more frequent for parameters like creatinine (89.1%), urea (77.5%), and potassium (86.1%). The table provides a comprehensive assessment of these parameters, offering insights into the distribution and prevalence of abnormal and normal readings or results within the dataset.

Table 2. Assessment.

Group	Subgroup	Normal		Abnormal	
		Frequency	Percentage	Frequency	Percentage
vital signs	Systolic blood pressure (BP)	117	20.9	443	79.1
	diastolic BP	195	34.8	365	65.2
	heart rate	472	84.3	88	15.7
	respiratory rate	460	82.1	100	17.9
	temperature	514	91.8	46	8.2
	oxygen on face mask	547	97.7	13	2.3
emergency department (ED) laboratory result	creatinine	499	89.1	61	10.9
	urea	397	70.9	126	22.5
	potassium	482	86.1	78	13.9
	prothrombin time (PT)	103	18.4	439	78.4
	partial thromboplastin time (PTT)	296	52.9	245	43.8
	international normalized ratio (INR)	367	65.5	174	31.1

Note: Thirty-seven, 18, 19, and 19 patients have missing laboratory data in urea, PT, PTT, and INR tests, respectively.

Table 3 presents data on the presence or absence of different signs and symptoms within a dataset. The table provides information on the percentage and frequency of cases exhibiting specific symptoms. The data reveals that the most prevalent symptoms are shortness of breath (74.5%), radiation (53.2%), and diaphoresis (86.6%). Other symptoms such as vomiting, nausea, dizziness, low level of consciousness, palpitations, cough, fever, and limb numbness are also present but with decreasing frequencies. The table allows for an understanding of the prevalence and distribution of these signs and symptoms within the dataset, providing valuable insights for further analysis or medical interpretation.

Table 3. Signs and symptoms.

Signs and Symptoms	Yes		No	
	Frequency	Percentage	Frequency	Percentage
shortness of breath	143	25.5	417	74.5
Radiation	262	46.8	298	53.2

Diaphoresis	75	13.4	485	86.6
vomiting	33	5.9	527	94.1
Nausea	14	2.5	546	97.5
Dizziness	10	1.8	550	98.2
low of level of consciousness	6	1.1	554	98.8
Palpitation	5	0.9	555	99.1
Cough	3	0.5	557	99.5
Fever	2	0.4	558	99.6
limb numbness	1	0.2	559	99.8

Table 4 presents information on the diagnosis and diagnostic tests in a dataset. The diagnosis section shows the frequency and percentage of cases for subgroups such as anterior MI (35.5%), inferior MI (31.4%), ACS (30.7%), lateral MI (1.4%), and posterior MI (0.9%). The diagnostic test section provides data on the Troponin test, with 23.8% of cases showing normal results and 76.3% showing abnormal results. The ECG test reveals percentages for different findings, including ST elevation (65.7%), ST depression (8.8%), T-wave depression (6.3%), pathological Q-wave (5.2%), poor R-wave (2.5%), and no change (11.6%). The table allows for an understanding of the distribution of diagnoses and results of diagnostic tests within the dataset.

Table 4. Diagnosis and diagnostic test.

Group	Subgroup	Frequency	Percentage
Diagnosis	anterior MI	199	35.5
	inferior MI	176	31.4
	acute coronary syndrome (ACS)	172	30.7
	lateral MI	8	1.4
	posterior MI	5	0.9
	total	560	100.0
Troponin	normal	133	23.8
	abnormal	427	76.3
	total	560	100.0
Electrocardiogram (ECG)	ST elevation	368	65.7
	ST depression	49	8.8
	T-wave depression	35	6.3
	pathological Q-wave	29	5.2
	poor R-wave	14	2.5
	no change	65	11.6
	total	560	100.0

Table 5 provides information on the frequency and percentage of various risk factors in a dataset. Out of the total cases, 51.6% have diabetes, 43.8% have hypertension, 25.9% are smokers, 17.1% have a history of cardiac disease, 3.0% have dyslipidemia, and 2.1% have renal disease. The table also indicates the percentage of cases without each risk factor, with the majority not having diabetes (48.4%), hypertension (56.3%), smoking (74.1%), cardiac disease (82.9%), dyslipidemia (97.0%), or renal disease (97.9%). The data provides insights into the prevalence and distribution of these risk factors within the dataset.

Table 5. Risk factors.

Risk Factors	Yes		No	
	Frequency	Percentage	Frequency	Percentage
diabetes	289	51.6	271	48.4

HTN	245	43.8	315	56.3
smoking	145	25.9	415	74.1
cardiac disease	96	17.1	464	82.9
dyslipidemia	17	3.0	543	97.0
renal disease	12	2.1	548	97.9

Table 6 displays the frequency and percentage of previous procedures in a dataset. Out of a total of 560 cases, 492 (87.9%) had no previous procedure, 62 (11.1%) had a previous percutaneous coronary intervention (PCI), and only 6 (1.1%) had undergone a previous coronary artery bypass grafting (CABG). The table provides a concise overview of the distribution of previous procedures, indicating that the majority of cases did not have any prior intervention, while a smaller proportion had a history of PCI or CABG.

Table 6. Previous procedure.

Procedure	Frequency	Percentage
previous PCI	62	11.1
previous CABG	6	1.1
none	492	87.9
total	560	100.0

Table 7 presents statistics on the closure percentages of three culprit arteries: LAD, RCA, and LCX. The LAD artery has the highest closure rates, with 22.27% of cases falling in the 91-100 closure percentage range, followed by the RCA artery with 14.7% in the same range. The LCX artery has a closure percentage of 7.42% in the 91-100 range. The table provides detailed frequencies and percentages for each closure percentage range, allowing for a comprehensive understanding of the distribution of closures among the arteries.

Table 7. Culprit arteries.

Artery	LAD (Left Anterior Descending Artery)	RCA (Right Anterior Artery)	LCX (Left Circumflex Artery)			
Closure Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
91-100	159	22.27	105	14.7	53	7.42
81-90	103	12.42	57	7.9	47	6.5
71-80	57	7.98	29	4.06	39	5.46
61-70	4	0.5	1	0.14	10	1.40
51-60	3	0.42	2	0.28	1	0.14
41-50	7	0.98	5	0.70	4	0.5
31-40	8	1.12	2	0.28	5	0.70
21-30	6	0.84	2	0.84	5	0.70
total	347	48.59	203	28.43	164	22.19

Most study participants were in the year 2022, nearly 35%, whereas, in 2021, nearly 33% participated. Approximately 5 percent of 29 patients were recommended by the healthcare team to undergo CABG in other accessible facilities because it is not applicable in the hospital under study. The success rate of the PCI procedure was remarkable. Although the CABG recommendation was only 5%, the percentage of successful PCI was nearly 99%, with 556 patients. In contrast, failed PCI was performed in only 4 patients, accounting for less than 1% of the patients. Moreover, the ejection fraction in nearly 41% of the patients was normal, whereas it was abnormal in approximately 59% of the patients. Additionally, 14 patients arrested in the ED, with 2.5% of the total participants, whereas 546 patients did not arrest (97.5%).

Variables were compared using independent sample χ^2 tests. A p -value $<.05$ was statistically significant. We measured the correlation between age and stent need, troponin, and diabetes in chest pain patients that underwent PCI. The finding indicates that (1) the χ^2 test of independence (with Yates's continuity correction) indicated a weak significant association between gender and stent need (χ^2 [1; $n = 560$] = 5.82a; $p = 0.02$; $\phi = 0.13$). (2) The χ^2 test of independence (with Yates's continuity correction) indicated a weak significant association between gender and troponin (χ^2 [1; $n = 560$] = 5.89a; $p = 0.02$; $\phi = 0.1$). (3) The χ^2 test of independence (with Pearson's χ^2) indicated a moderate significant association between age and diabetes (χ^2 [1; $n = 560$] = 47.23a; $p < .001$; $\phi = 0.29$). Moreover, we measured the correlation between gender and STEMI in chest pain patients that underwent PCI. The finding indicates that the χ^2 test of independence (with Yates's continuity correction) indicated a weak significant association between gender and STEMI (χ^2 [1; $n = 560$] = 4.03a; $p = 0.045$; $\phi = 0.09$).

4. Discussion

Patients who underwent PCI and visited an ED with chest pain were predominantly aged 40-59, indicating a young adult population at risk for CHD [14]. This aligns with the AHA's report on the rising prevalence of CHD in young adults, highlighting the need for increased awareness [15]. Insufficient CVD awareness in Saudi Arabia underscores the importance of education [16]. Interestingly, 37 patients aged 20-39 had PCI, consistent with increasing coronary artery disease in young individuals [17]. Males were more likely to present with chest pain than females, aligning with other findings [18]; however, CVD in women has been underestimated, leading to underdiagnoses and increased female mortality [19]. Recognizing gender differences in CVD is crucial for effective prevention and treatment [20], and management decisions should be based on thorough analysis of risk factors, clinical manifestations, and patient preferences, rather than gender [21, 22]. Moderate pain was reported by 66% of participants, indicating the need for better pain evaluation and treatment in the ED [23, 24]. Self-assessment is the most reliable method for evaluating pain intensity [24, 26], and accurate pain assessment during triage is essential to prevent mistriage and negative patient outcomes [27]. Most Saudi hospitals use the Canadian Triage and Acuity Scale (CTAS) for managing emergency cases [28], but 52 patients were categorized as CTAS 3, emphasizing the need for proper triage [29].

Chest pain is a common symptom in emergency departments, and shortness of breath (SOB) is reported in 25% of patients experiencing acute coronary syndrome (ACS) [32]. This underlines the need for increased awareness of acute myocardial infarction (AMI) symptoms to ensure proper triage, diagnostic testing, and prompt treatment [33]. Electrocardiography (ECG) is vital for chest pain diagnosis, with ST elevation observed in just above 65% of cases and no ECG changes in 11% [34]. Troponin, a key biomarker, is positive in around 76% of patients and negative in around 24% [35]. A single troponin measurement, combined with a clinician's clinical assessment and risk stratification, is considered safe [36]. Falsely low troponin concentrations can result from factors such as hyperbilirubinemia, cardiac troponin autoantibodies, lipemia, and biotin (vitamin B7) [37]. The majority of patients undergoing percutaneous coronary intervention (PCI) present with anterior myocardial infarction (MI) (35%), followed by inferior MI (31%) and ACS (30%) [17]. MI, as the most prevalent form of coronary heart disease (CHD), is a leading cause of morbidity and mortality worldwide [38, 39]. Rapid identification or exclusion of MI is crucial, necessitating immediate ECG and clinical evaluation, including cardiac biomarker testing.

Facts from our study reveal that 181 participants (51%) were affected by diabetes, making it the most significant modifiable CVD risk factor. Hypertension followed, impacting 245 patients (43%), and smoking was present in 145 patients (25%). High blood pressure has been identified as a key modifiable risk factor for CVD, with the highest exposure prevalence and strongest causation evidence [31]. Diabetes mellitus and CVD share a close relationship, with CVD being the primary cause of mortality and morbidity in diabetic populations [40]. In the United States, adults with confirmed DM have CVD death rates 1.7 times higher than those without DM, mainly due to increased risks of stroke and MI [41]. A healthy lifestyle is essential since daily habits significantly

influence the likelihood of developing CVD. Strategies to reduce CVD risk and improve quality of life include increased physical activity, a healthy diet, maintaining a healthy weight, quitting smoking, and stress management[42].

A considerable challenge for Saudi Arabia is cardiovascular disorders, evidenced by a 37% proportionate CVD death rate [43]. The Kingdom has improved healthcare access and increased specialized consultations [44], with a focus on establishing the National Center for the Control of Heart Diseases, diabetes, and endocrine centers, and activating early detection methods for chronic diseases via robust primary care and detection techniques [44]. Saudi Vision 2030 seeks to raise awareness and self-control of chronic diseases through health education clinics [44]. CVD history increases the risk of recurrent CVD events or death [45]. Our study found that 11% (62) and 1% (6) of patients had previously undergone PCI and CABG, respectively, while 492 patients (approximately 88%) had not undergone any procedure. This contrasts with a large observational cohort study of 123,780 patients in the United Kingdom, showing that nearly 10% of patients had a history of prior CABG [46]. Interventions to reduce recurrent CVD risk are essential for patients with significant risk factors. Patients with diabetes and chronic kidney disease experienced higher cardiovascular events and mortality rates compared to those without either condition [47]. Identifying culprit arteries is vital for patients presenting with chest pain and cardiac features in the ED.

The three most commonly implicated arteries in study participants were the LAD artery, found in 347 patients (48% of cases), followed by RCA occlusion in 203 patients (28% of cases), and LCX in 164 cases (22%). This is in line with previous studies investigating the most common culprit arteries [17]. A high death rate was observed in patients with LAD occlusion [48], underscoring the importance of early cardiac patient detection and culprit artery reperfusion. Our study showed a high success rate for PCI, with 99% successful PCI in 559 patients and only 3 failed procedures (less than 1%). This supports previous studies on PCI success rates [17]. Most PCI procedures involve stent placement, with stent failure leading to repeated revascularization primarily caused by stent thrombosis, restenosis, and stent fracture [49]. Early failure within 24 hours can be attributed to various risk factors and mechanisms, such as poor antiplatelet response (patient-related), severely calcified lesions (lesion-related), stent undersizing (stent-related), small gaps between the arterial wall and the stent, or failure to stretch the stent to the desired diameter [50]. Updating healthcare teams on new chest pain guidelines in the ED is crucial. Further research is recommended to investigate chest pain patient triage and assessments across Saudi Arabia.

5. Conclusions

In conclusion, this study highlights the importance of increased awareness and education on CHD among young adults, recognizing gender differences in CVD presentation, and accurate pain assessment during triage. Recommendations include promoting lifestyle modifications to address modifiable CVD risk factors, continuous improvements in healthcare access and early detection methods in Saudi Arabia, and staying updated on new chest pain guidelines in the ED. Early detection of implicated arteries and prompt reperfusion are vital for reducing mortality, while further research is recommended to investigate chest pain patient triage and assessments across Saudi Arabia for better patient outcomes.

Limitation

The goal of this study was to gain broad insight into how patients receiving emergency percutaneous coronary intervention for chest pain were managed and the resulting outcomes in Saudi Arabian emergency departments. The study included a mix of both STEMI and NSTEMI patients. However, the small sample size from a single center in Taif limits the generalizability of the findings.

Author Contributions: All authors have significant contributions to this study as the following: conceptualization, T.A. and A.A.; methodology, T.A.; software, A.A.; validation, T.A., A.A. and A.A.; formal analysis, A.A.; investigation, T.A.; resources, A.A.; data curation, T.A.; writing (original draft preparation), T.A.;

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