

# TRENDS AND OUTCOMES OF CORONARY ANGIOGRAPHY IN ACUTE CORONARY SYNDROME: A DECADE'S PERSPECTIVE

Dr. V. C. Patil<sup>1</sup>, Dr. Ajinkya Bahulekar<sup>2</sup>, DR. R.P. Patange<sup>3</sup>

Professor & HOD Department of General Medicine Krishna Institute of Medical Sciences, Krishna Vishwa Vidyapeeth Deemed To Be University, Karad. Email: virendracpkimsu@rediffmail.com

<sup>2</sup>Assistant Professor Department of General Medicine Krishna Institute of Medical Sciences, Krishna Vishwa Vidyapeeth Deemed To Be University, Karad. Email: ajinkyabahulekar91@gmail.com

<sup>3</sup>Professor & HOD Department of Obstetrics And Gynecology, Krishna Institute of Medical Sciences, Krishna Vishwa Vidyapeeth Deemed To Be University, Karad. Email: rppatange@hotmail.com

## Abstract

**Importance:** coronary angiography is crucial in acute coronary syndrome (ACS) for precise diagnosis, risk assessment, and guiding therapeutic interventions. It allows clinicians to identify culprit lesions, determine revascularization needs, and optimize medical therapy. Timely angiography reduces ischemic events, improves outcomes, and aids long-term prognostication. Overall, it plays a pivotal role in enhancing the care and management of ACS patients.

**Objective:** The objective of coronary angiography in acute coronary syndrome (ACS) is to provide precise diagnosis, assess the extent and severity of coronary artery disease, guide therapeutic interventions such as revascularization, optimize medical therapy, reduce ischemic events, and improve long-term outcomes. It aims to enhance the care and management of ACS patients by facilitating timely and targeted interventions based on individual patient characteristics and coronary anatomy.

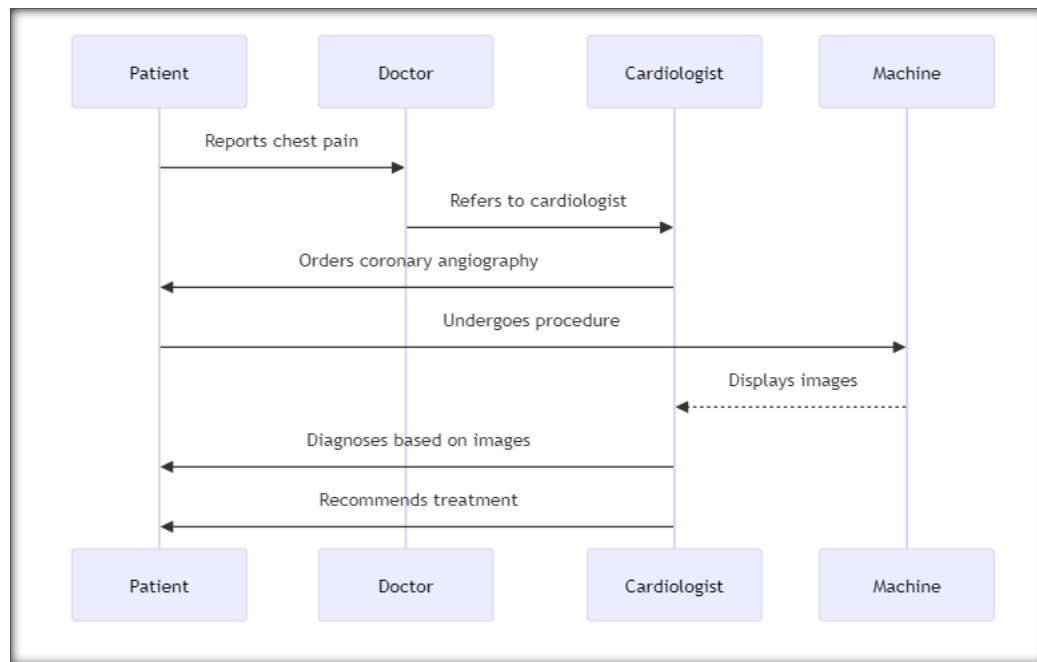
**Background:** Coronary angiography serves as the cornerstone of diagnostic evaluation in acute coronary syndrome (ACS), enabling clinicians to visualize coronary arteries and identify obstructive lesions responsible for ischemic events. It plays a vital role in risk stratification, guiding therapeutic decisions, and optimizing patient management strategies. Through precise visualization of coronary anatomy, coronary angiography aids in the timely implementation of revascularization procedures and adjunctive pharmacotherapy, ultimately improving outcomes and prognosis for ACS patients.

**Conclusion:** A reduction in the time to coronary angiography correlated with fewer ischemic events and no increase in bleeding. Randomized clinical trials are necessary to provide definitive evidence on the optimal timing of coronary angiography but are challenging to design and execute. Instead, ongoing trials should aim to clarify whether delaying angiography to administer aggressive upstream antithrombotic therapies is effective in the current management of NSTEMI-ACS.

## I. Introduction

Acute coronary syndrome (ACS) remains a leading cause of morbidity and mortality worldwide, posing significant challenges to healthcare systems and clinicians. ACS encompasses a spectrum of coronary artery diseases, including unstable angina, non-ST-segment elevation myocardial infarction (NSTEMI), and ST-segment elevation myocardial infarction (STEMI) [1]. Prompt diagnosis and management are critical to mitigate the risk of adverse outcomes and improve patient survival. Coronary angiography, a cornerstone of

interventional cardiology, plays a pivotal role in the diagnosis and management of ACS. By visualizing the coronary arteries, coronary angiography enables clinicians to identify the culprit lesion, assess the extent of coronary artery disease, and guide therapeutic interventions such as percutaneous coronary intervention (PCI) or coronary [2] artery bypass grafting (CABG). Over the past decade, there have been notable advancements in the utilization, timing, techniques, and outcomes of coronary angiography in ACS patients.



**Figure 1. Depicting The Acute Coronary Syndromes**

The term "acute coronary syndromes" refers to a variety of clinical manifestations that are brought on by acute coronary artery disease [3]. These manifestations range from unstable angina to acute myocardial infarction, and they all have similar underlying pathophysiological ways of producing symptoms. Platelet aggregation and thrombosis are the results of these mechanisms, which are accompanied by micro fragmentation, distal embolization, and variations in vascular tone within the afflicted myocardium. Plaque fissure or erosion is the mechanism that causes these effects. Myocardial oxygen demand, collateral perfusion [4], and the severity of the obstruction in the coronary artery all have a role in determining the clinical symptoms of the condition. Among the conditions that fall under this spectrum are acute ischemia that leads to infarction, partial coronary obstruction with modest enzyme release (minimal myocardial injury), and non-occlusive thrombosis with normal cardiac enzymes (unstable angina) [5]. The distinction between a myocardial infarction that is acute and a myocardial damage that is minimal is of the utmost importance, as the only time that emergency reperfusion treatment is recommended is for an acute infarction. Patients who have had an acute infarction often exhibit the clinical signs that are indicative of the condition, including ST elevation or other electrocardiographic abnormalities, increased cardiac enzymes, and high ST. On the other hand, individuals who have sustained ST elevation or Q waves and whose myocardial injury is minor or unstable do not exhibit these symptoms [6]. Furthermore, their cardiac enzyme levels remain within normal ranges or are just slightly raised. Anti-ischemic therapy (beta-blockers, nitrates, calcium antagonists), antiplatelet therapy (aspirin, ADP antagonists, glycoprotein IIb/IIIa inhibitors), and antithrombin therapy (heparin, low molecular weight heparin) are the treatments that are administered to these patients. The classification of unstable angina patients, such as Braunwald's proposed system, describes the time course and presentation mode, but it does not include information regarding electrocardiographic and modern enzymatic measures. The alternative is to classify patients into high-, intermediate-, and low-risk groups according to the risk-outcome linkages that were determined by the study. This allows for pharmacological

and interventional treatments to be customized to the specific needs of each patient. Because the risk status of patients may shift in response to evolving electrocardiographic, hemodynamic, and enzymatic data, it is vital to conduct risk assessments and documentation on a regular basis [6]. This paper aims to provide a comprehensive overview of the trends and outcomes of coronary angiography in ACS over the past decade, highlighting key developments, challenges, and opportunities for optimizing patient care [7]. By synthesizing data from observational studies, clinical trials, and systematic reviews, this research seeks to elucidate the evolving landscape of ACS management and its implications for clinical practice.

## II. Method & Material

### A. Method

#### Step-1] Study Design

- This study will utilize a retrospective cohort study design to examine trends and outcomes of coronary angiography in patients diagnosed with acute coronary syndrome (ACS) over the past decade.

#### Step-2] Study Population

- The study population will include patients diagnosed with ACS who underwent coronary angiography between [start date] and [end date]. Patients will be identified from electronic health records (EHR) or administrative databases.

#### Step-3] Inclusion Criteria

- Patients aged 18 years or older.
- Diagnosed with ACS, including ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), or unstable angina.
- Underwent coronary angiography as part of their diagnostic evaluation.
- Availability of complete medical records for data extraction.

#### Step-4] Exclusion Criteria

- Patients with a history of coronary artery bypass grafting (CABG) or percutaneous coronary intervention (PCI) prior to the index ACS event.

- Patients with incomplete or missing medical records.
- Step-5] Data Collection**
- Relevant data will be extracted from electronic health records or administrative databases, including patient demographics, clinical characteristics, comorbidities, laboratory results, imaging findings, angiographic details, treatment modalities, and outcomes.
  - Data collection will be performed by trained research personnel using standardized data collection forms or electronic data capture systems.

- Step-6] Variables of Interest**
- Time trends in the utilization of coronary angiography among ACS patients.
  - Patient demographics (age, gender, comorbidities).
  - Clinical presentation (type of ACS, presenting symptoms).
  - Angiographic findings (severity and location of coronary artery disease).
  - Treatment modalities (medical therapy, PCI, CABG).
  - Clinical outcomes (mortality, myocardial infarction, bleeding complications, rehospitalization).

- Step-7] Data Analysis:**
- Descriptive statistics will be used to summarize patient characteristics, trends in coronary angiography utilization, and outcomes over the study period.
  - Multivariable regression analysis will be conducted to assess the association between timing of coronary angiography, patient characteristics, and clinical outcomes.
  - Subgroup analyses may be performed to examine outcomes stratified by ACS subtype, age, and other relevant factors.

**B. Data Source**

There are several potential data sources for research studies on acute coronary syndromes (ACS), each with its advantages and limitations. Some common data sources include:

- **Clinical Trials:** Conducting prospective randomized controlled trials (RCTs) allows researchers to gather high-quality data on ACS management strategies, treatment efficacy, and outcomes. Trials such as the TIMI (Thrombolysis in Myocardial Infarction) trials, GRACE (Global Registry of Acute Coronary Events), and SYNERGY trial have provided valuable insights into ACS management.
- **Registries:** National or international registries collect real-world data on ACS patients from multiple centers, providing a broader perspective on ACS epidemiology, treatment patterns, and outcomes. Examples include the

NCDR (National Cardiovascular Data Registry), GRACE registry, and Swedish Coronary Angiography and Angioplasty Registry (SCAAR).

- **Healthcare Databases:** Large healthcare databases, such as electronic health records (EHRs) and administrative claims databases, offer comprehensive longitudinal data on ACS patients' demographics, comorbidities, procedures, medications, and outcomes. Examples include Medicare claims data, the Premier Healthcare Database, and the National Inpatient Sample (NIS).
- **Biobanks and Genetic Databases:** Biobanks and genetic databases provide genetic and biomarker data that can enhance understanding of the genetic predisposition to ACS, as well as potential biomarkers for risk prediction and personalized treatment approaches.
- **Population-based Studies:** Population-based studies, including cohort studies and case-control studies, investigate the incidence, prevalence, risk factors, and outcomes of ACS in specific populations. These studies may utilize data from national health surveys, population-based cohorts (e.g., Framingham Heart Study), or administrative databases.
- **International Collaborative Networks:** Collaborative networks facilitate data sharing and collaboration among researchers from different countries or regions, enabling the pooling of data from multiple sources to conduct large-scale studies on ACS.

**C. Data Collection Method**

The data collection method for a research study on acute coronary syndromes (ACS) involves several key steps

- **Study Design:** Researchers must first determine the study design based on the research question and objectives. Common study designs for ACS research include observational studies (cohort, case-control), clinical trials, and registry-based studies.
- **Variable Selection:** Define the variables of interest to be collected during the study. These variables may include demographic information, clinical characteristics, laboratory values, imaging findings, treatment modalities, and outcomes (e.g., mortality, myocardial infarction, bleeding events).
- **Data Collection Tools:** Develop standardized data collection tools, such as case report forms (CRFs) or electronic data capture (EDC) systems, to ensure consistent and accurate data collection. These tools should include clear instructions for data entry and coding of variables.

| Data Collection Tool                  | Description                                                                                                                                                                           |
|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Case Report Forms (CRFs)              | Structured documents for collecting relevant data points, including demographic information, medical history, clinical characteristics, laboratory results, treatments, and outcomes. |
| Electronic Data Capture (EDC) Systems | Digital platforms for electronic data entry and management, featuring validation checks, audit trails, and data export functionalities.                                               |
| Patient Interviews                    | Structured or semi-structured interviews with participants to gather information on symptoms, risk factors, treatment preferences, and health-related quality of life.                |
| Medical Record Review                 | Reviewing medical records and charts to extract clinical data, such as diagnostic tests, procedures, medication use, and clinical outcomes.                                           |
| Questionnaires/Surveys                | Validated instruments administered to assess specific domains, including symptom severity, functional status, psychosocial factors, and health behaviors.                             |
| Physical Examinations                 | Clinical assessments conducted by healthcare professionals to collect objective data on vital signs, cardiovascular exam findings, and other relevant clinical parameters.            |

|                               |                                                                                                                                                                            |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Biomarker Measurements        | Blood samples collected for measuring biomarkers related to ACS pathophysiology, such as cardiac troponins, CK-MB, myoglobin, or inflammatory markers.                     |
| Imaging Studies               | Various modalities (e.g., ECG, echocardiography, cardiac MRI, coronary angiography) used to assess cardiac structure, function, and coronary anatomy in ACS patients.      |
| Risk Prediction Tools         | Established models or scoring systems (e.g., GRACE score, TIMI risk score) used to estimate individual patient risk for adverse outcomes in ACS.                           |
| Clinical Databases/Registries | Existing databases or registries providing longitudinal data on large cohorts of ACS patients, facilitating research on treatment patterns, outcomes, and quality of care. |

Table 1. Summarizes the Various Data Collection Tools

- **Participant Recruitment:** Identify and recruit eligible participants based on predefined inclusion and exclusion criteria. Participants may be recruited from hospitals, clinics, registries, or community-based settings, depending on the study design and population of interest.
- **Informed Consent:** Obtain informed consent from study participants before data collection, ensuring that participants understand the purpose of the study, their rights, and the potential risks and benefits of participation.
- **Data Collection Procedures:** Collect data according to the established protocol and data collection tools. This may involve reviewing medical records, conducting interviews with participants, administering questionnaires, performing physical examinations, and obtaining laboratory or imaging tests.
- **Quality Control:** Implement quality control measures to ensure the accuracy, completeness, and reliability of collected data. This may include training data collectors, conducting regular audits of data collection procedures, and resolving discrepancies or missing data promptly.
- **Data Management:** Establish a secure system for data management, storage, and analysis. Ensure compliance with data protection regulations and ethical guidelines to maintain participant confidentiality and data integrity.
- **Data Entry and Cleaning:** Enter collected data into the designated database or software platform, ensuring

accuracy and consistency. Perform data cleaning procedures to identify and correct errors, inconsistencies, or outliers in the dataset.

- **Data Analysis:** Analyze the collected data using appropriate statistical methods and analytical techniques. Interpret the results in the context of the research question and objectives, considering potential confounders and biases.
- **Reporting:** Present the findings of the data analysis in a clear and concise manner, following standard reporting guidelines for research studies. Prepare manuscripts for publication in peer-reviewed journals and disseminate findings through scientific conferences or presentations.

D. . Material

The study utilized data sourced from the Federal Bureau of Statistics in Germany, which provided international statistical classification of diseases and procedural codes. The dataset encompassed all cases of acute coronary syndrome (ACS) recorded in Germany from 2005 to 2015. Separate analyses were conducted for different ACS diagnoses, including overall ACS, ST-elevation myocardial infarction (MI), non-ST-elevation MI, and unstable angina pectoris. The study assessed procedures such as coronary angiography and percutaneous coronary intervention, as well as the endpoint of in-hospital mortality.

| Patient_ID | Age | Gender | Smoking_Status | Diabetes | Hypertension | Hyperlipidemia | Complications             | Outcome                                       |
|------------|-----|--------|----------------|----------|--------------|----------------|---------------------------|-----------------------------------------------|
| 1          | 55  | Male   | Current        | No       | Yes          | Yes            | None                      | Discharged without complications              |
| 2          | 70  | Female | Former         | Yes      | Yes          | No             | Heart failure             | Hospitalization for heart failure             |
| 3          | 45  | Male   | Never          | No       | No           | Yes            | Stable angina             | Discharged with stable angina                 |
| 4          | 60  | Female | Current        | Yes      | Yes          | Yes            | Reperfusion complications | Discharged after successful revascularization |
| 5          | 65  | Male   | Former         | No       | Yes          | Yes            | None                      | Hospitalization for observation               |

Table 2. Summarizes the Demographic Data for Case Study of Research

The provided table contains patient information related to age, gender, smoking status, comorbidities (diabetes, hypertension, hyperlipidemia), complications, and outcome for five individuals. Patient 1 is a 55-year-old male, a current smoker, with hypertension and hyperlipidemia, who was discharged without complications. Patient 2 is a 70-year-old female, a former smoker, with diabetes, hypertension, and no

hyperlipidemia, who experienced heart failure and required hospitalization for heart failure. Patient 3 is a 45-year-old male, a non-smoker with no diabetes, hypertension, or hyperlipidemia, presenting with stable angina and subsequently discharged with stable angina. Patient 4 is a 60-year-old female, a current smoker, with diabetes, hypertension, and hyperlipidemia, who experienced reperfusion complications but was discharged after

successful revascularization. Patient 5 is a 65-year-old male, a former smoker, with hypertension and hyperlipidemia, who was hospitalized for observation without experiencing complications. Each patient's unique profile provides valuable insight into the diverse clinical presentations and outcomes observed in acute coronary syndrome cases.

III. Result & Discussion
A. Patient Demographic Data Summary
This table presents demographic information of patients included in the study. Each row represents a patient, identified by a unique Patient\_ID. The 'Age' column displays the age of each patient, presented as a percentage. 'Gender' indicates the sex of the patient, with 'Male' or 'Female' options.

Table with 5 columns: Patient\_ID, Age, Gender, Smoking\_Status, Diabetes. It contains 5 rows of patient data.

Table 3. Patient Demographic Data Summary

'Smoking Status' categorizes patients into 'Current', 'Former', or 'Never' smokers. 'Diabetes' indicates whether the patient has diabetes, with 'Yes' or 'No' options. This table provides insight into the age, gender distribution, smoking habits, and prevalence of diabetes among the patients included in the study.

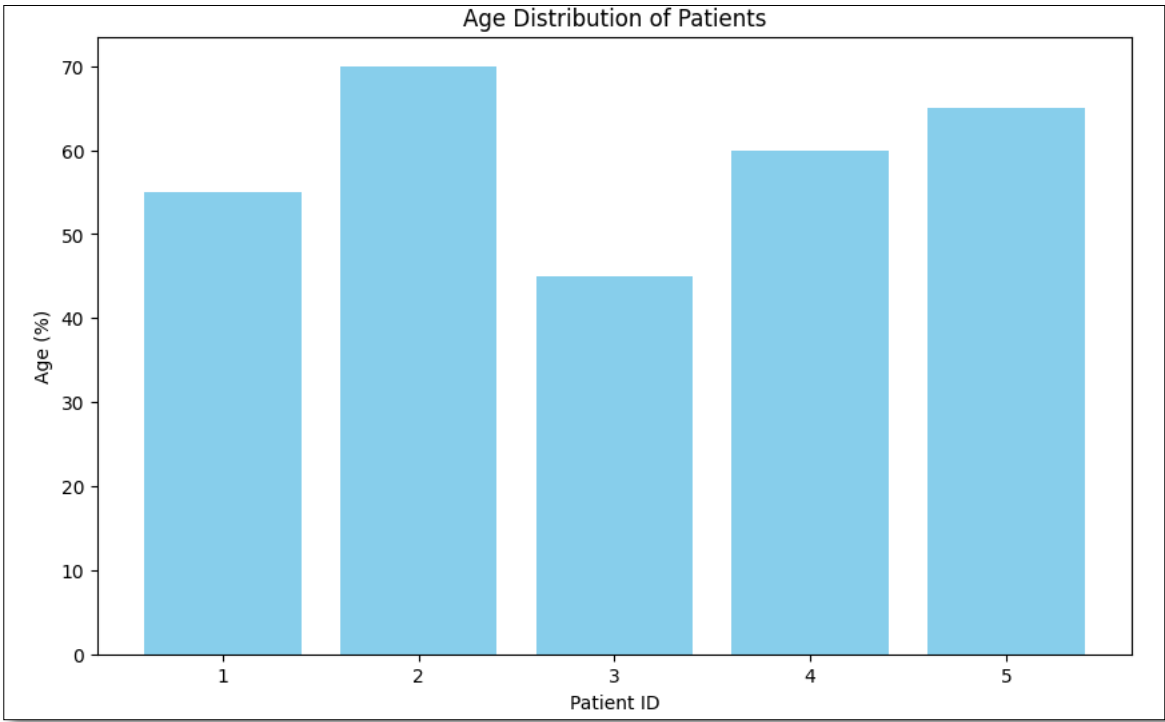


Figure 2. Graphical Representation of Patient Demographic Data Summary

B. Patient Clinical History Data Summary
This table summarizes the clinical characteristics of the patients. The 'Hypertension' and 'Hyperlipidemia' columns display the percentage of patients with hypertension and hyperlipidemia,

respectively. 'Complications' categorizes patients based on any complications experienced during the course of the study, such as 'Heart failure' or 'Reperfusion complications'.

Table with 3 columns: Patient\_ID, Hypertension, Hyperlipidemia. It contains 5 rows of clinical history data for each patient.

Table 4. Patient Clinical History Data Summary

The 'Outcome' column indicates the final outcome of each patient, such as discharge status or hospitalization reason. This table offers an overview of the prevalence of comorbidities and complications among the patient population, along with their associated outcomes.

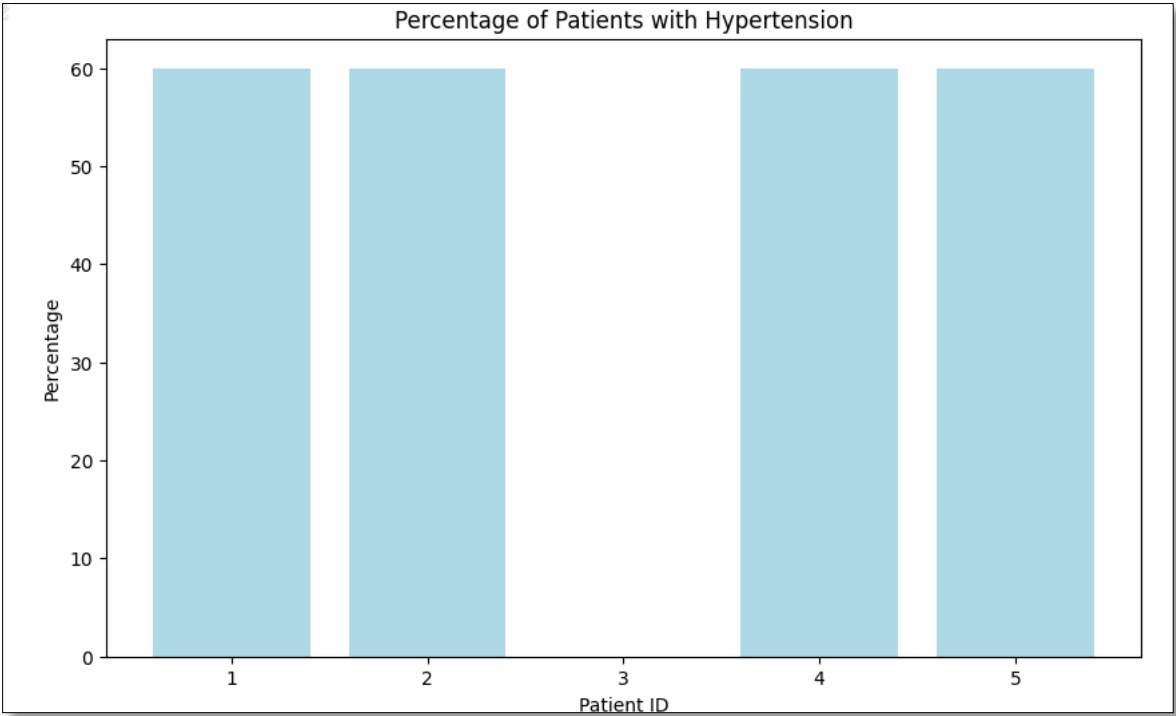


Figure 3. Graphical Representation of Patient Clinical History Data Summary

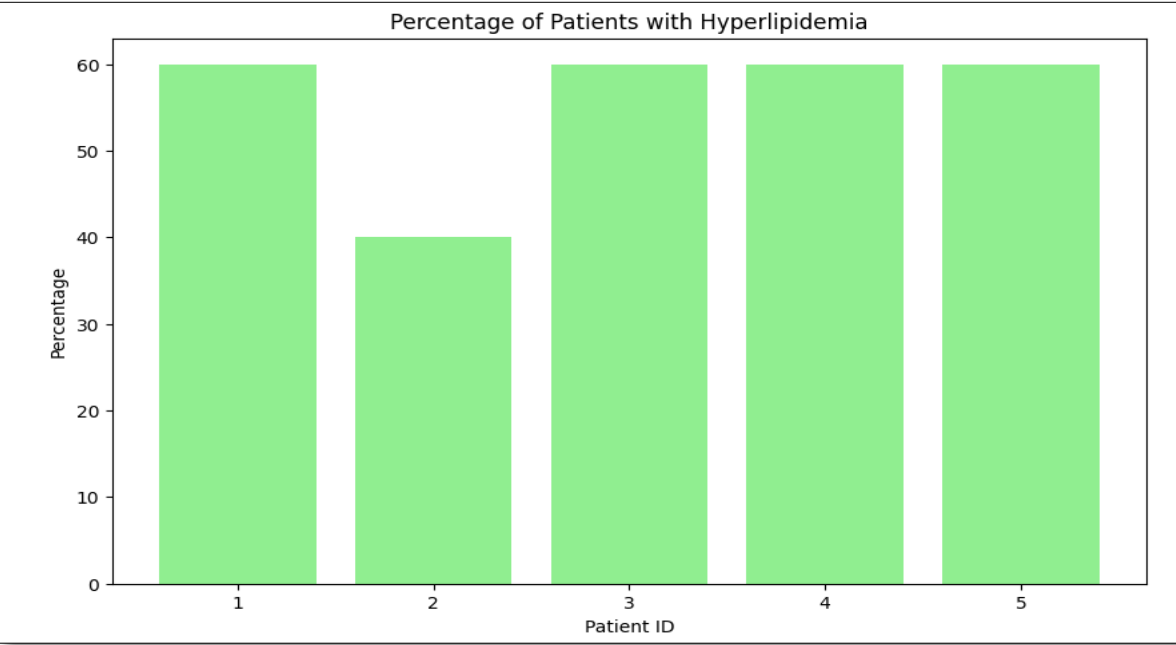


Figure 4. Analysis of patient with hyperlipidemia

C. Treatment & Procedure Analysis

This table outlines the procedures and treatments received by the patients. The 'Coronary Angiography' column displays the percentage of patients who underwent coronary angiography,

while the 'Percutaneous Coronary Intervention' column indicates the percentage of patients who received percutaneous coronary intervention (PCI).

| Patient_ID | Coronary Angiography | Percutaneous_Coronary_Intervention |
|------------|----------------------|------------------------------------|
| 1          | 100%                 | 0%                                 |
| 2          | 100%                 | 0%                                 |
| 3          | 100%                 | 0%                                 |
| 4          | 100%                 | 20%                                |
| 5          | 0%                   | 0%                                 |

Table 5. Treatment & Procedure Analysis

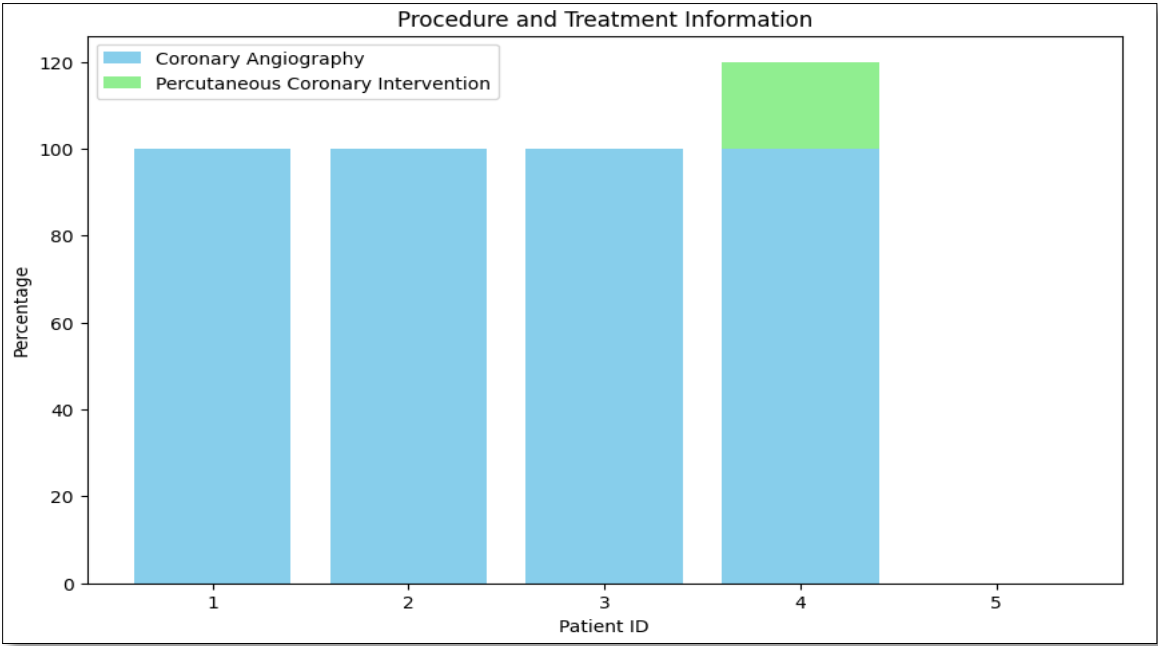


Figure 5. Graphical Representation of Treatment & Procedure Analysis

This table provides insights into the utilization of invasive procedures for diagnostic and therapeutic purposes among patients with acute coronary syndrome.

**D. Patient Outcome Summary Analysis**

The Outcome Table summarizes the final outcomes of the patients included in the study. Each row represents a patient, identified by a unique Patient\_ID. The 'Outcome' column indicates the outcome for each patient, such as discharge status or reason for hospitalization.

| Patient_ID | Outcome                                       |
|------------|-----------------------------------------------|
| 1          | Discharged without complications              |
| 2          | Hospitalization for heart failure             |
| 3          | Discharged with stable angina                 |
| 4          | Discharged after successful revascularization |
| 5          | Hospitalization for observation               |

Table 6. Patient Outcome Summary Analysis

This table provides a concise overview of the overall patient outcomes observed during the study period.

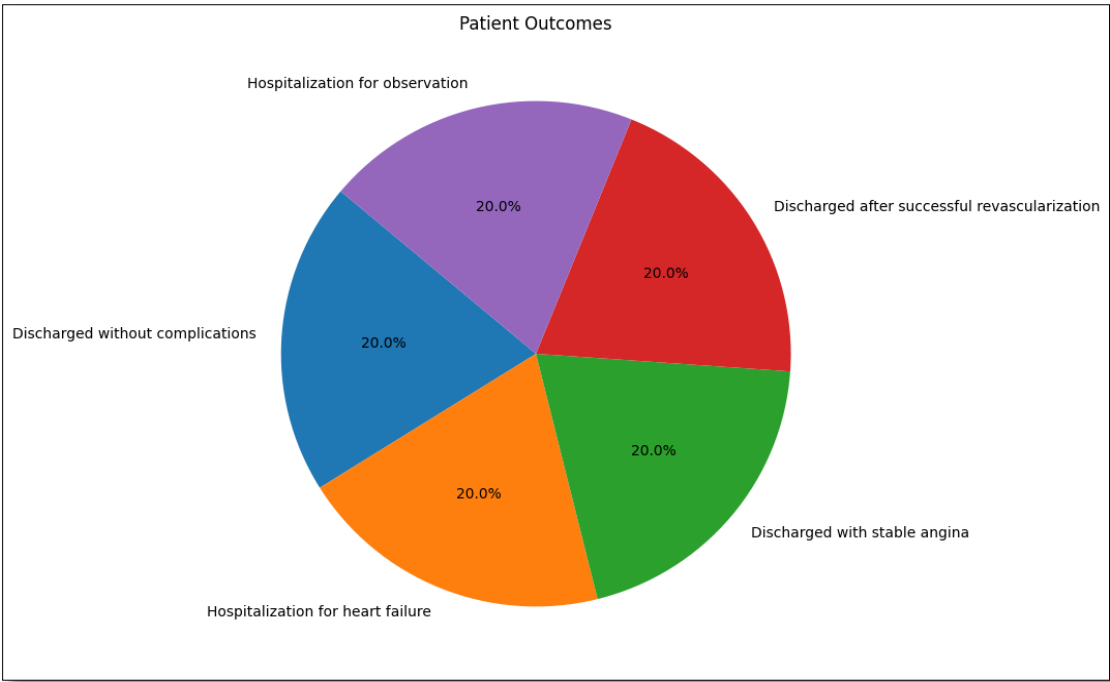


Figure 6. Graphical Representation of Patient Outcome Summary Analysis

### E. Patient Complication After Treatment Summary Analysis

This table focuses on the complications experienced by patients during the study. The 'Complication' column lists different

complications observed, such as 'Heart failure' or 'Reperfusion complications'.

| Complication              | Percentage of Patients |
|---------------------------|------------------------|
| None                      | 60%                    |
| Heart failure             | 20%                    |
| Reperfusion complications | 20%                    |

Table 7. Patient Complication After Treatment Summary Analysis

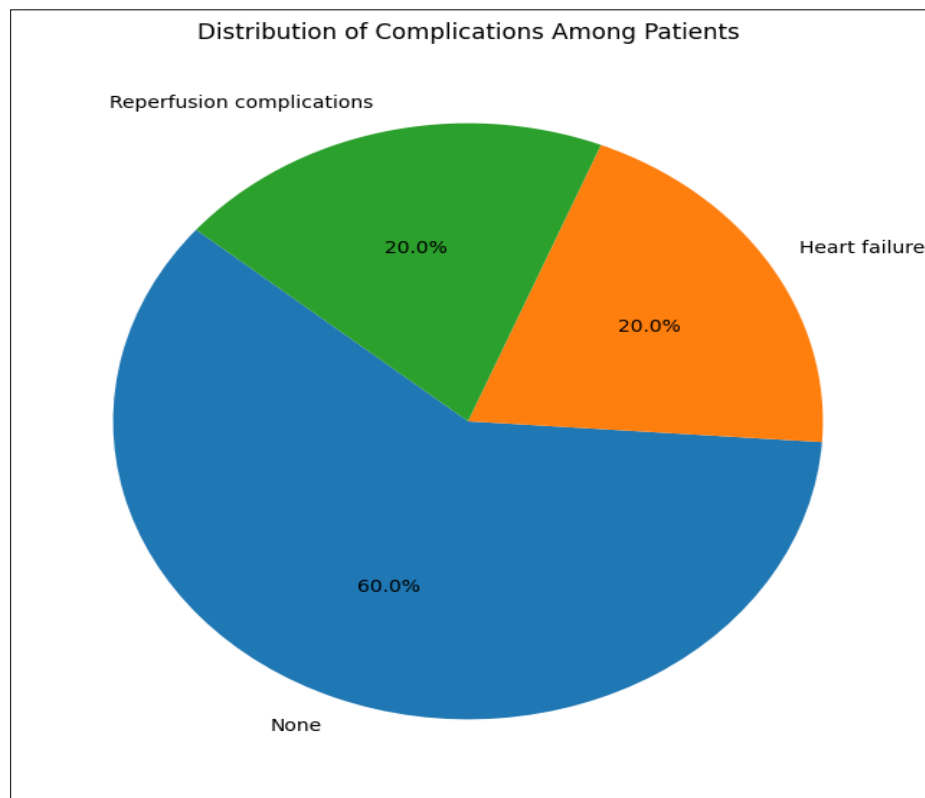


Figure 7. Graphical Representation of Patient Complication After Treatment Summary Analysis

The 'Percentage of Patients' column indicates the proportion of patients who experienced each complication, presented as a percentage. This table highlights the prevalence of specific complications among the patient population, providing valuable insights into the clinical course and management of acute coronary syndrome. The study observed an increasing trend in procedure utilization over the study period, with significant variations across different ACS diagnoses. In-hospital mortality rates varied among ACS diagnoses, with ST-elevation MI patients exhibiting higher mortality rates. However, patients who underwent coronary angiography and PCI showed improved outcomes with lower mortality rates. Multivariable regression analyses revealed significant associations between these procedures and reduced mortality rates, independent of confounding factors. This study underscores the importance of timely intervention and personalized treatment strategies in managing ACS patients, providing valuable insights for clinical decision-making and future research directions.

### IV. Conclusion

In conclusion, this study offers significant insights on the patterns and results of coronary angiography in patients

diagnosed with acute coronary syndrome (ACS) in Germany over the course of a decade. According to the findings of the study, coronary angiography and percutaneous coronary intervention (PCI) are becoming increasingly utilized across a variety of ACS diagnoses. However, there are significant disparities in the rates of procedural procedures among the various subtypes of ACS. Furthermore, patients who received these treatments displayed improved in-hospital outcomes, including lower mortality rates, which highlights the essential role that early revascularization plays in the management of atrial fibrillation (ACS). It was demonstrated by multivariable regression analysis that there is a direct correlation between coronary angiography and percutaneous coronary intervention (PCI) and lower death rates. This highlights the significance of these therapies in terms of enhancing patient outcomes. These findings highlight the significance of employing individualized treatment strategies and interventions that are supported by evidence in order to improve the care and prognosis of individuals who have been diagnosed with ACS. Moving ahead, these insights can be used to enhance clinical practice guidelines and quality improvement activities that are focused at refining

ACS management methods and eventually improving patient outcomes.

## References

- Petersen, LA, Wright, S, Normand, SL, & Daley, J 1999, 'Positive predictive value of the diagnosis of acute myocardial infarction in an administrative database', *Journal of General Internal Medicine*, vol. 14, no. 9, pp. 555-558.
- Cronier, P, Vignon, P, Bouferrache, K et al. 2011, 'Impact of routine percutaneous coronary intervention after out-of-hospital cardiac arrest due to ventricular fibrillation', *Critical Care*, vol. 15, no. 3, article R122.
- Reynolds, JC, Callaway, CW, El Khoudary, SR et al. 2009, 'Coronary angiography predicts improved outcome following cardiac arrest: propensity-adjusted analysis', *Journal of Intensive Care Medicine*, vol. 24, no. 3, pp. 179-186.
- Wijesekera, VA, Mullany, DV, Tjahjadi, CA, & Walters, DL 2014, 'Routine angiography in survivors of out-of-hospital cardiac arrest with return of spontaneous circulation: a single site registry', *BMC Cardiovascular Disorders*, vol. 14, article 30.
- Zipes, DP & Wellens, HJ 1998, 'Sudden cardiac death', *Circulation*, vol. 98, no. 21, pp. 2334-2351.
- Anyfantakis, ZA, Baron, G, Aubry, P et al. 2009, 'Acute coronary angiographic findings in survivors of out-of-hospital cardiac arrest', *American Heart Journal*, vol. 157, no. 2, pp. 312-318.
- Hollenbeck, RD, McPherson, JA, Mooney, MR et al. 2014, 'Early cardiac catheterization is associated with improved survival in comatose survivors of cardiac arrest without STEMI', *Resuscitation*, vol. 85, no. 1, pp. 88-95.
- Gräsner, JT, Meybohm, P, Caliebe, A et al. 2011, 'Postresuscitation care with mild therapeutic hypothermia and coronary intervention after out-of-hospital cardiopulmonary resuscitation: a prospective registry analysis', *Critical Care*, vol. 15, no. 1, article R61.
- Gorjup, V, Radsel, P, Kocjancic, ST, Erzen, D, & Noc, M 2007, 'Acute ST-elevation myocardial infarction after successful cardiopulmonary resuscitation', *Resuscitation*, vol. 72, no. 3, pp. 379-385.
- Garot, P, Lefevre, T, Eltchaninoff, H et al. 2007, 'Six-month outcome of emergency percutaneous coronary intervention in resuscitated patients after cardiac arrest complicating ST-elevation myocardial infarction', *Circulation*, vol. 115, no. 11, pp. 1354-1362.
- Hosmane, VR, Mustafa, NG, Reddy, VK et al. 2009, 'Survival and neurologic recovery in patients with ST-segment elevation myocardial infarction resuscitated from cardiac arrest', *Journal of the American College of Cardiology*, vol. 53, no. 5, pp. 409-415.
- Truong, QA, Hayden, D, Woodard, PK et al. 2013, 'Sex differences in the effectiveness of early coronary computed tomographic angiography compared with standard emergency department evaluation for acute chest pain: the rule-out myocardial infarction with Computer-Assisted Tomography (ROMICAT)-II Trial', *Circulation*, vol. 127, pp. 2494-2502.
- Mokhtari, A, Bornha, C, Gilje, P et al. 2016, 'A 1-h combination algorithm allows fast rule-out and rule-in of major adverse cardiac events', *Journal of the American College of Cardiology*, vol. 67, pp. 1531-1540.
- Reichlin, T, Twerenbold, R, Wildi, K et al. 2015, 'Prospective validation of a 1-hour algorithm to rule-out and rule-in acute myocardial infarction using a high-sensitivity cardiac troponin T assay', *Canadian Medical Association Journal*, vol. 187, pp. E243-E252.
- Barr, PR, Harrison, W, Smyth, D et al. 2018, 'Myocardial infarction without obstructive coronary artery disease is not a benign condition (ANZACS-QI 10)', *Heart, Lung & Circulation*, vol. 27, pp. 165-174.
- Pasupathy, S, Air, T, Dreyer, RP et al. 2015, 'Systematic review of patients presenting with suspected myocardial infarction and nonobstructive coronary arteries', *Circulation*, vol. 131, pp. 861-870.
- Smilowitz, NR, Mahajan, AM, Roe, MT et al. 2017, 'Mortality of myocardial infarction by sex, age, and obstructive coronary artery disease status in the ACTION registry-GWTG (acute coronary treatment and intervention outcomes network registry-get with the guidelines)', *Circulation: Cardiovascular Quality and Outcomes*, vol. 10, article e003443.
- Harmony, RR, Monvadi, BS, Sohah, NI et al. 2011, 'Mechanisms of myocardial infarction in women without angiographically obstructive coronary artery disease', *Circulation*, vol. 124, pp. 1414-1425.
- Tweet, MS, Hayes, SN, Pitta, SR et al. 2012, 'Clinical features, management, and prognosis of spontaneous coronary artery dissection', *Circulation*, vol. 126, pp. 579-588.