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ORIGINAL RESEARCH

# Acute Coronary Syndrome: Treatment Strategies and Outcomes in Patients Admitted to a Tertiary Care Hospital in Palestine

Abdallah Damin Abukhalil, Shahd Hamad*, Zain Khalid Swaileh*, Aseel Wasel Ghanem*, Sarah Abumadi*, Raed Madia, Ni'meh Own Al-Shami

Pharmacy Department, Faculty of Pharmacy, Nursing and Health Professions, Birzeit University, Birzeit, West Bank, Palestine

*These authors contributed equally to this work

Correspondence: Abdallah Damin Abukhalil; Raed Madia, Pharmacy Department, Faculty of Pharmacy, Nursing and Health Professions, Birzeit University, Birzeit, West Bank, Palestine, Email Adkhalil@birzeit.edu; Rmadia@birzeit.edu

**Background:** Acute coronary syndrome (ACS) is the leading cause of death worldwide despite advances in treatment and prevention measures. This study aimed to explore ACS treatment strategies (ischemia-guided vs early invasive) and risk factors among patients diagnosed with ACS in a tertiary care hospital in Palestine and to evaluate related outcomes regarding future events and standard clinical guidelines.

**Methods:** This retrospective cohort study reviewed patient data from a Palestinian medical hospital. The study included 255 patients ≥ 18 years who were hospitalized between January 2021 and December 2021 and diagnosed with ACS. The data were analyzed using the Statistical Package for Social Science (SPSS).

**Results:** 71% of the participants were males. The mean age was 59.59±11.56 years. Smoking, diabetes, and hypertension were the most common risk factors. Unstable angina (UA) was the most prevalent ACS type, accounting for 43.1% (110) of cases, whereas NSTEMI accounted for 39.2% (100) and STEMI accounted for 17.6% (45) of cases. An ischemic-guided strategy approach was used in 71% (181) of the patients. Upon discharge, the most prescribed medication classes were antiplatelets (97.6%), statins (87.1%), PPIs (72.5%), and antihypertensives (71.8%). Treatment strategies were selected according to the clinical guidelines for most ACS types.

**Conclusion:** ACS management in Palestine continues to evolve to overcome barriers, decrease patient mortality, and decrease hospital stay. UA and NSTEMI were the most common ACS diagnoses at admission, and the ischemic strategy was the most common modality. The findings of this study call for an increased awareness of CVD risk factors, resource availability, and adherence to clinical guidelines to improve patient outcomes and community health.

**Keywords:** acute coronary syndrome, ST-elevation myocardial infarction, non-ST-elevation myocardial infarction, unstable angina, ischemia-guided strategy, early invasive strategy

## Introduction

Acute coronary syndrome (ACS) refers to a group of disorders that includes ST-elevation myocardial infarction (STEMI), non-ST-elevation myocardial infarction (NSTEMI), and unstable angina (UA). ACS is characterized by episodes of chest pain, often with dynamic ECG changes due to a dramatic reduction in the blood supply to the myocardium. [1] This is caused by atherosclerosis, leading to partial or near-complete coronary artery occlusion, causing ischemia to the myocardium and potentially infarction.[2] Risk factors for ACS include age, family history, obesity, hypertension, hyperlipidemia, diabetes mellitus, male sex, smoking, unhealthy diet, and physical inactivity.[3] Despite significant advancements in the diagnosis and management of ACS, it remains the primary cause of mortality worldwide.[4] For example, ACS accounts for one-third of the total deaths among people aged > 35 years old.[3] According to statistics from the American Heart Association (AHA), from 2005 to 2014, the estimated yearly incidence of myocardial infarction was 605,000 new and 200,000 recurrent attacks. It is



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expected that 170,000 of these 805,000 first and recurring incidents will be silent.[5] In Palestine, ACS accounted for 20% of all reported fatalities in the age range 20–59 years in 2012.[6]

The medical management of ACS depends on the patient presentation, clinical assessment, cardiac biomarkers, type of ACS, and availability of primary percutaneous coronary intervention (PCI) hospitals. Primary PCI and optimal medical management can improve patient outcomes after MI.[7]

The American Heart Association (AHA) recommends emergent catheterization and percutaneous intervention (PCI) with a door-to-procedure time of less than 90 minutes for STEMI patients with fibrinolysis reserved for individuals who do not have access to early primary PCI.[8] Traditional treatment for NSTEMI/UA involves an ischemia-guided strategy, which includes initial rapid treatment with aspirin and heparin followed by non-invasive testing for further risk stratification to determine the necessity of urgent catheterization or revascularization.[3] However, an early invasive strategy is coronary angiography with or without revascularization within 48–72 hours of admission to detect blocked arteries in the heart. Revascularization is a procedure that can open blocked veins or arteries to allow blood flow by coronary artery bypass graft surgery (CABG) or PCI.[9]

The management of ACS in Palestine can be challenging because of many factors associated with the lack of resources and access to healthcare services.[10] This observational retrospective cohort study aimed to explore the treatments (ischemia-guided vs early invasive strategies) applied to different ACS types (NSTEMI, STEMI, and UA) in the Palestine Medical Complex, a tertiary care hospital in Palestine, and to evaluate risk factors as well as the related outcomes concerning future events and standard clinical guidelines.

# Methodology

## Study Design

A retrospective cohort study was conducted by retrieving patients' medical records data. This study included all patients aged > 18 years who were diagnosed with ACS at the Palestine Medical Complex between January 2021 and December 2021. The patients were followed-up for 12 months. A data collection form was created by reviewing several articles and literature related to ACS management.[11,12]

The data collection form included five sections. The first section included demographic information, including patient hospital I.D., age, sex, obesity, and smoking status, in addition to the diagnosis and admission date. The second section, comorbidities, and medical/clinical history comprised common diseases such as hypertension, diabetes, hypercholesterolemia, and chronic kidney disease, as well as a family history of CAD, and a clinical history of PCI, CABG, or MI. The third section consisted of the ACS type (UA, NSTEMI, or STEMI), the treatment strategy applied (ischemia-guided or early invasive), the revascularization procedure type (PCI or CABG), and the date on which it was performed. The fourth section includes discharge dates and medications. The fifth section, follow-up, focused on the development of future cardiac events and the date of their occurrence.

## Data Collection, Assessment, and Analysis

The data collection form was double-checked by PharmD students and professionals from the Faculty of Pharmacy at Birzeit University to ensure accuracy and completeness before collecting patient information. A random sample of patients' medical records was chosen, and the data were collected by four 5th-year PharmD students between March 7 and March 30, 2023, then added to Microsoft Excel 356 spreadsheet, separated, cleared, and imported to the Statistical Package for Social Science (SPSS) version 28. Recoding of data was done to recategorize variables as needed. Data analysis was performed using descriptive statistics, where the mean ± standard deviation (SD) was calculated for normally distributed data and the median with interquartile range (IQR) for non-normally distributed data. In contrast, frequencies and percentages were used for categorical data. Chi-squared and Fisher's exact tests were performed to determine the association between the patient's demographics and medical and clinical history (age, sex, obesity, smoking status, family history of CAD, comorbidities, clinical history of PCI, CABG, and MI) and ACS type (NSTEMI, STEMI, and UA). A second bivariate analysis was performed to measure the association between the treatment strategy and the possibility of developing future cardiac events. A third bivariate analysis was performed to

determine the association between the possibility of developing future cardiac events and discharge medications. Statistical analysis was performed with 95% confidence intervals (CIs) and 5% margin of error.

## Ethical Considerations

The IRB committee approved the study design at Birzeit University (reference number: BZUPNH2205). The requirement for written informed consent from each patient was waived because this was an observational retrospective study. Patients were anonymized. The study complied with the ethical guidelines of the Declaration of Helsinki.

# Results

A total of 263 medical records of patients diagnosed with ACS were retrieved, and eight patients were excluded because they were transferred to other hospitals (Figure 1). Table 1 shows the patients' data and characteristics. Of the study participants, 68.2% were aged ≤ 64 years. 71% of the participants were male, and 79.6% were not obese. In addition, 54.2% and 75.8% of the patients were smokers and had no family history of CAD, respectively. The most common comorbidity was hypertension (63.1%), followed by diabetes (53.7%). Most participants were diagnosed with neither hypercholesterolemia (87.85%) nor chronic kidney disease (92.5%). Furthermore, 19.2% of the participants had no reported comorbidities and most had no clinical history of ACS.

Figure 2A shows the distribution of patients according to ACS type. A total of 43.1% of patients were diagnosed with UA, 39.2% with NSTEMI, and 17.6% with STEMI. Figure 2B shows the distribution of the study sample according to the treatment strategy applied, where the ischemia-guided strategy was applied to 71% of the patients.

The treatment selection adhered to standard practices for managing acute coronary syndrome, as shown in Figure 1. NSTEMI and UA (69% and 87.3%, respectively) underwent an ischemic strategy. STEMI patients (64.4%) were treated using an early invasive strategy,[13] and 16 patients (35.6%) underwent an ischemia-guided strategy; however, only 5 (11.1%) of them were given proper medications as recommended by the guidelines.[14]

In addition, cross-tabulation results revealed that STEMI (41.7%) was significantly more common among patients with a history of MI than in patients with no previous MI (16.5%), while UA was less common among them (16.7%, p= 0.047). However, No significant associations were found between the ACS type, neither the patients' demographics nor the comorbidity they suffered from, including a history of CAD. Table 2 shows the chi-square and Fisher exact test results for future events. A significant association was found between the treatment strategy and the possibility of developing future events within 6 months and one year (P=0.018 and 0.035, respectively), indicating that patients who

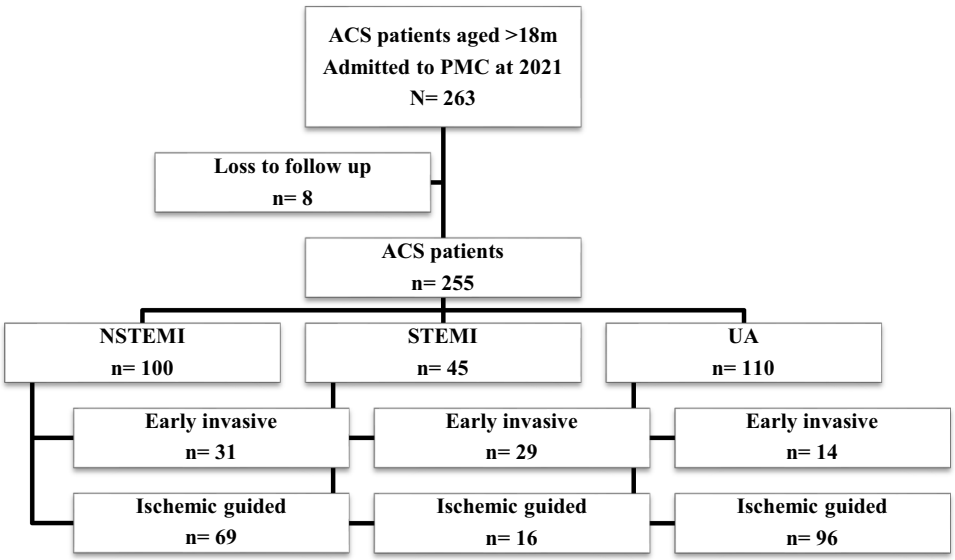


**Figure 1** Flow chart of inclusion and exclusion criteria, and distribution of treatment strategies applied to different ACS types.

**Table 1** Risk Factors Associated with Acute Coronary Syndrome Development (N=255)

| Variable | Category | Total n (%) | ACS Type | | | P-value |
|---|---|---|---|---|---|---|
| | | | NSTEMI n (%) | STEMI n (%) | UA n (%) | |
| **Age** | 64 or less | 174 (68.2%) | 68 (39%) | 33 (19%) | 73 (42%) | 0.698 |
| | 65 or more | 81 (31.8%) | 32 (39.5%) | 12 (14.8%) | 37 (45.7%) | |
| **Gender** | Female | 74 (29%) | 30 (40.5%) | 8 (10.8%) | 36 (48.6%) | 0.170 |
| | Male | 181 (71%) | 70 (38.7%) | 37 (20.4%) | 74 (40.9%) | |
| **Obesity (n=225)** | Yes | 46 (20.4%) | 25 (54.3%) | 5 (10.9%) | 16 (34.8%) | 0.078 |
| | No | 179 (79.6%) | 65 (36.3%) | 32 (17.9%) | 82 (45.8%) | |
| **Smoker (n=240)** | Yes | 129 (54.2%) | 50 (38.5%) | 27 (20.8%) | 52 (47.3%) | 0.116 |
| | No | 111 (45.8%) | 46 (41.8%) | 12 (10.9%) | 53 (40.8%) | |
| **Family History of CAD (n=227)** | Yes | 55 (24.2%) | 20 (36.4%) | 6 (10.9%) | 29 (52.7%) | 0.231 |
| | No | 172 (75.8%) | 71 (41.3%) | 31 (18%) | 70 (40.7%) | |
| **Comorbidities** | | | | | | |
| **Hypertension** | Yes | 161 (63.1%) | 71 (44.1%) | 25 (15.5%) | 65 (40.4%) | 0.103 |
| | No | 94 (36.9%) | 29 (30.9%) | 20 (21.3%) | 45 (47.9%) | |
| **Diabetes** | Yes | 137 (53.7%) | 58 (42.3%) | 24 (17.5%) | 55 (40.1%) | 0.509 |
| | No | 118 (46.3%) | 42 (35.6%) | 21 (17.8%) | 55 (46.6%) | |
| **Hypercholesterolemia** | Yes | 31 (12.2%) | 13 (41.9%) | 4 (12.9%) | 14 (45.2%) | 0.760 |
| | No | 224 (87.8%) | 87 (38.8%) | 41 (18.3%) | 96 (42.9%) | |
| **Chronic kidney disease** | Yes | 19 (7.5%) | 9 (47.4%) | 4 (21.1%) | 6 (31.6%) | 0.568 |
| | No | 236 (92.5%) | 91 (38.6%) | 41 (17.4%) | 104 (44.1%) | |
| **Diseases** | Yes | 206 (80.8%) | 86 (41.7%) | 35 (17%) | 85 (41.3%) | 0.236 |
| | No | 49 (19.2%) | 14 (28.6%) | 10 (20.4%) | 25 (51%) | |
| **CAD Clinical History** | | | | | | |
| **PCI** | Yes | 55 (21.6%) | 17 (30.9%) | 8 (14.5%) | 30 (54.5%) | 0.155 |
| | No | 200 (78.4%) | 83 (41.5%) | 37 (18.5%) | 80 (40%) | |
| **CABG** | Yes | 49 (19.2%) | 23 (46.9%) | 8 (16.3%) | 18 (36.7%) | 0.459 |
| | No | 206 (80.8%) | 77 (37.4%) | 37 (18%) | 92 (44.7%) | |
| **MI** | Yes | 12 (4.7%) | 5 (41.7%) | 5 (41.7%) | 2 (16.7%) | 0.047 |
| | No | 243 (95.3%) | 95 (39.1%) | 40 (16.5%) | 108 (44.4%) | |
| **No CAD clinical history** | Yes | 151 (59.2%) | 60 (39.7%) | 26 (17.2%) | 65 (43%) | 0.968 |
| | No | 104 (40.8%) | 40 (38.5%) | 19 (18.3%) | 45 (43.3%) | |

**Abbreviations**: NSTEMI, Non-ST-Elevation Myocardial Infarction; STEMI, ST Elevation Myocardial Infarction; UA, Unstable Angina; CAD, coronary artery disease; PCI, Percutaneous Coronary Intervention; CABG, Coronary Artery Bypass Graft surgery; MI, myocardial infarction.

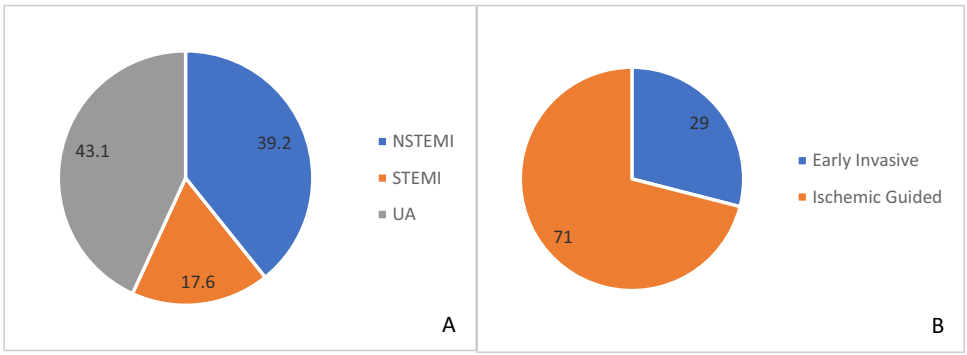


**Figure 2** Distribution of patients (N=255). (**A**) ACS type; (**B**) Treatment strategy applied.

had undergone an early invasive strategy were more likely to develop future events within 6 months and one year 25 (33.8%) and 30 years (40.5%), respectively, compared to patients who underwent an ischemic-guided procedure 36 (19.9%) and 49 (27.1%), respectively).

Heart failure (HF), acute coronary syndrome (ACS), death, other CV events, and other potential future events were examples of potential future events considered in our study. After analyzing the data, no conclusive evidence was found to support a relationship between the chosen treatment approach and the incidence of these future events. The relevant p-values for these variables are 0.240, 0.418, 0.127, 0.208, and 0.675, respectively. There was no significant difference in the number of events that developed during admission between the two therapy groups (P-value = 0.061). Only two patients (1.1%) in the ischemic-guided group experienced future events during their hospital stay compared to four patients (5.4%) in the invasive group.

Figure 3 shows the classes of medications prescribed during discharge. The most prescribed medication classes were antiplatelets (97.6%), followed by statins (87.1%), proton pump inhibitors (PPIs) (72.5%), and antihypertensives (71.8%).

**Table 2** Treatment Strategy Applied and Possible Development of Future Events. (N=255)

| Variable | Category | Treatment | | P-value |
|---|---|---|---|---|
| | | Invasive | Ischemic Guided | |
| **Future events** | None | 38 (51.4%) | 109 (60.2%) | 0.193 |
| | HF | 6 (8.1%) | 8 (4.4%) | 0.240 |
| | ACS | 9 (12.2%) | 16 (8.8%) | 0.418 |
| | Death | 5 (6.8%) | 4 (2.2%) | 0.127 |
| | Other CV events* | 6 (8.1%) | 7 (3.9%) | 0.208 |
| | Other events** | 19 (25.7%) | 42 (23.2%) | 0.675 |
| **Events developing during admission** | Yes | 4 (5.4%) | 2 (1.1%) | 0.061 |
| | No | 70 (94.6%) | 179 (98.9%) | |
| **Developing future events within 6 months** | Yes | 25 (33.8%) | 36 (19.9%) | 0.018 |
| | No | 49 (66.2%) | 145 (80.1%) | |
| **Developing future events within a year** | Yes | 30 (40.5%) | 49 (27.1%) | 0.035 |
| | No | 44 (59.5%) | 132 (72.9%) | |

**Notes**: *Other CV events included hypotension, bradycardia, tachycardia, atrial fibrillation, ventricular aneurysm, revascularization, and stroke. **Other future events include acute kidney injury, chronic kidney disease, muscle weakness, and developing infections.
**Abbreviations**: HF, Heart Failure; ACS, Acute Coronary Syndrome.

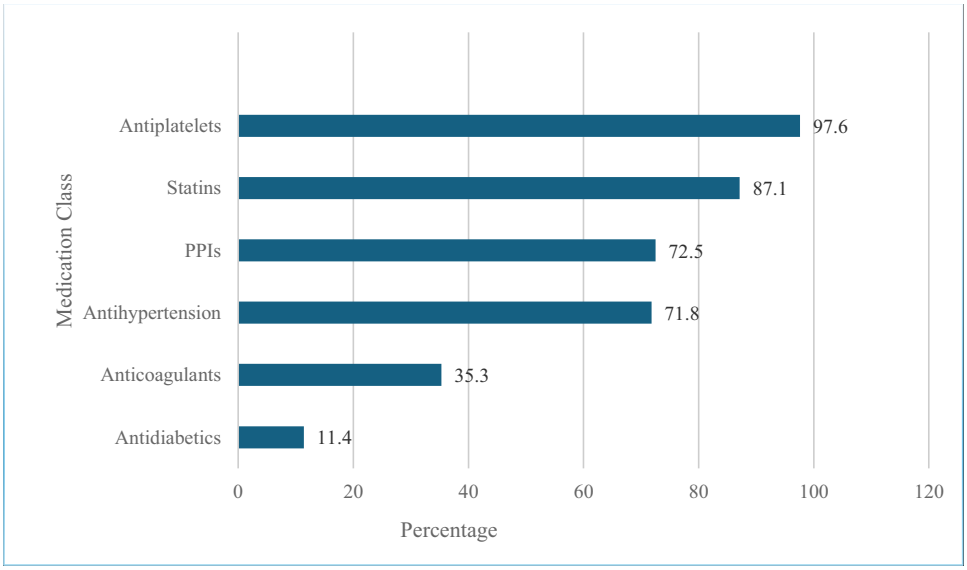


**Figure 3** Sample Percentage and Medication Group Analysis (N=255).

Bivariate analysis was performed between the administered drugs at discharge and the development of future events; however, there were no significant associations between the administered medications at discharge and the possibility of increasing the risk of developing future events within a year.[13,14]

## Discussion

This observational retrospective cohort study was the first to explore the characteristics of patients presenting with ACS symptoms at a tertiary hospital in Palestine and address their management strategies. Furthermore, this study evaluated the appropriateness of the treatment strategy selection of ischemia-guided versus early invasive strategies according to clinical guidelines and the outcomes associated with the treatment modality.

This study had several interesting findings. First, most patients diagnosed with ACS were male, around 60 years old, non-obese, and had no family history of CVD. This finding resembles that of an Asian study, in which ACS was more common in males of the same age range.[15] The American Heart Association (AHA) reported that the incidence of cardiovascular diseases (CVD) in US men and women is approximately 40% from 40 to 59 years, 75% from 60 to 79 years, and approximately 86% in those above the age of 80.[16] The protective effect of sex steroid hormones, especially estrogen, has been linked to lower age-specific CVD rates in women.[17]

Another interesting finding was that most patients in this study did not have traditional risk factors for CVD such as family history and obesity.[18] According to the CDC, a family history of heart disease is more likely to lead to the development of heart disease, which could be linked to familial hypercholesterolemia.[19] Obesity also leads to the development of cardiovascular disease and cardiovascular disease mortality independent of other cardiovascular risk factors.[20] The development of CVD among Palestinians may be influenced by the living situation in a conflict zone, where stress and insecurity have been identified as major risk factors for increased risk of CVD.[21]

Other risk factors for ACS were evident in the study, including smoking history and multiple comorbidities such as hypertension and diabetes. Similar findings were reported in another study conducted in Greece, where the majority of patients had hypertension, diabetes, or a smoking history.[22] Smoking is globally recognized as a risk factor for CVD as it is associated with atherosclerosis and stroke.[23] Common CVD comorbidities included hypertension and type 2 diabetes mellitus. Hypertension and diabetes are associated with similar risk factors such as endothelial dysfunction, vascular inflammation, arterial remodeling, atherosclerosis, dyslipidemia, and obesity.[24]

The second observation is related to the ACS clinical diagnosis, where the chi-square test results revealed that there were no significant associations with age, sex, obesity, smoking, and family history the type of ACS diagnosis on admission, and

most patients were diagnosed with UA (43%) and NSTEMI (39%). This Finding differs significantly from that of a study in India in which most patients presented with STEMI.[25] These finding might be related to the health care practice in Palestine, the increased diagnoses of NSTEMI in this sample may an indication for better health care management of UA, furthermore UA patient is an opportunity for management at urgent care clinic with available diagnostic resources as an outpatients without the need hospital admission.[26] Furthermore, regarding CVD, the majority of patients presenting with STEMI had a prior MI, whereas patients presenting with UA were the least likely to have a prior MI history. Similar to the findings of Shen et al, in which STEMI was less prevalent among patients with no prior MI.[27] Other studies also illustrated contrary findings, where STEMI was more prevalent among patients with no history of MI than among those with prior MI.[28,29] Moreover, UA was more prevalent among patients with previous MI in other study which is contrary to the result of this study.[29]

Although many other studies have primarily focused on patients with non-ST-segment elevation myocardial infarction (NSTEMI), our comprehensive analysis examined a broader ACS population, thereby providing valuable insights into the management of various ACS types. A study conducted in the US analyzed individual patient data from the FRISC-II, RITA-3, and ICTUS trials and found that patients who received a routine invasive strategy had a lower primary outcome of death and myocardial infarction than those who received a delayed or conservative approach. The primary outcome was achieved in 14.7% of patients using the routine invasive strategy versus 17.9% using delayed intervention.[30] Regarding the mortality rate, a Swedish study investigating one-year mortality following the diagnosis of acute coronary syndrome showed a mortality rate of 3.9% within one year of discharge compared to 3.5% in this study.[31]

In this study, there was a significant correlation between the treatment method and the likelihood of experiencing future events. Statistically significant outcomes were observed within six months and a year when comparing the two treatment strategies (P-values = 0.018 and 0.035, respectively). For patients who underwent an early invasive strategy, the likelihood of experiencing future events was 33.8% within 6 months and 40.5% within a year. In contrast, those who received ischemic-guided therapy had a decreased incidence of future events, with 19.9% having them after six months and 27.1% within a year.[32] In a meta-analysis early invasive treatment modalities for NSTSE had greater benefits in reducing all causes of mortality with increased rate of revascularization.[33] Furthermore the most common management strategy was ischemic-guided. Many factors may affect the outcomes of treatment modalities, access to care, time to intervention, admission hours day or night, and resource availability which might be different among different countries, lack of health care resources, staff, and equipment has also been reported in by Palestinian physicians.[21,34]

In this study, prescribed medications at discharge provided valuable insights into the treatment patterns and priorities in managing acute coronary syndrome. The data revealed that the most prescribed medication at discharge was antiplatelet therapy (97.6%). This Finding indicates the importance of antiplatelet therapy in preventing platelet aggregation and reducing the risk of cardiovascular events in patients with acute coronary syndrome. Antiplatelets such as aspirin and clopidogrel are widely recommended and have proven efficacy in reducing the risk of recurrent ischemic events.[35]

Following antiplatelet therapy, statins were the second-most prescribed medication class (87.1%). Statins play a crucial role in managing dyslipidemia and reducing cholesterol levels, thereby preventing the progression of atherosclerosis and lowering the risk of cardiovascular events.[36] The high percentage of statin prescriptions reflects the emphasis on lipid management and recognition of its significant impact on long-term outcomes in patients with acute coronary syndrome.

The distribution of medication classes at discharge highlights adherence to evidence-based guidelines and standard practices for managing acute coronary syndrome. This finding is similar to that of a Vietnamese study, in which physicians were very adherent to prescribing medications for the management of ACS.[37] The high utilization of antiplatelet agents and statins in patients with ACS to prevent recurrent cardiovascular events, optimize long-term outcomes, and reflect the adherence of healthcare providers to clinical guidelines for the secondary prevention of ACS. These findings align with the established treatment recommendations and emphasize the importance of guideline-directed medical therapy in managing acute coronary syndrome.

## Strengths

This is the first study to explore the characteristics of patients presenting with ACS symptoms at a tertiary care hospital in Palestine and explore the treatment strategies followed in their care process. This study could be the core of a more

extensive scale study to assess cardiovascular patients' medication management, adherence, access to care, and long-term complications associated with their treatment strategies.

## Limitations

While efforts were made to collect and analyze data from a diverse patient population, the relatively small sample size (N=255) may restrict the generalizability and statistical power of the findings. Furthermore, because of the retrospective design of this study, there are inherent limitations associated with relying on pre-existing patient data. This reliance introduces the potential for bias and a lack of control over variables, which can impact the validity of the findings.

Additionally, the absence of randomization in retrospective studies presents challenges in establishing causal relationships, as confounding variables may influence the observed associations. Selection bias arises because patients are not randomly assigned to treatment groups and decisions regarding strategies may be influenced by various factors, potentially biasing the results.[38]

## Conclusions

This study offers insights into the risk factors, management, and outcomes of ACS in Palestine. ACS management continues to evolve to overcome barriers, decrease patient mortality, and decrease hospital stay. Most ACS cases recorded in Palestine were males with a mean age of approximately 60 years. UA and NSTEMI were the most common ACS diagnoses at admission, and the ischemic strategy was the most common modality. The findings of this study call for an increased awareness of CVD risk factors, resource availability, and adherence to clinical guidelines to improve patient outcomes and community health.

## Disclosure

The authors report no conflicts of interest in this work.

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