An-Najah National University

Faculty of Graduate Studies

SIGNIFICANCE OF HEART SCORE IN CHEST PAIN PATIENTS AT EMERGENCY DEPARTMENT

By

Salam Mosa Abu Amer

Supervisors

Dr. Nizar Said

Dr. Mohamad Hayek

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This Thesis was Defended Successfully on 19/06/2025 and approved by

Dr. Nizar Said	
Supervisor	Signature
Dr. Mohamad Hayek	
Co-Supervisor	Signature
Dr. Imad Abu Khader	
External Examiner	Signature
Dr. Jamal Qaddumi	
Internal Examiner	Signature

Dedication

All praises to Allah.

Today, I fold away days of tiredness—days that were beautiful despite their challenges.

To the utmost guiding light of knowledge, our honored Prophet Muhammad (Peace Be Upon Him).

To my other soul, my life, and my eternal love, one who spent sleepless nights so I could become who I am today, my beloved husband.

To the one who strives tirelessly to bring comfort and blessings into my life, my first inspiration, my unwavering supporter, my beloved father.

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To the companions on this journey, the ones who always stood by me, the shining candles in my life, my dear friends and colleagues.

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Declaration

I, the undersigned, declare that I submitted the thesis entitled:

SIGNIFICANCE OF HEART SCORE IN CHEST PAIN PATIENTS AT EMERGENCY DEPARTMENT

I declare that the work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

Student's Name: **Salam Mosa Abu Amer**

Signature: Salam Abu Amer

Date: **19/06/2025**

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SIGNIFICANCE OF HEART SCORE IN CHEST PAIN PATIENTS AT EMERGENCY DEPARTMENT

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Abstract

Background: Chest pain is one of the most common symptoms of patients presenting to the Emergency Department (ED), and the diagnosis of chest pain poses significant challenges. This study evaluates the effectiveness of the HEART score in risk stratification of these patients according to the susceptibility of Acute Coronary Syndrome (ACS), compared to traditional clinical diagnosis, at an Emergency Department of Northwest Bank Central Hospital.

Methods: A retrospective cohort study was conducted in a central North West Bank hospital, involving 247 patients were complaining of chest pain as a presenting symptom, to assess the susceptibility of ACS. Patients were randomly assigned to either the HEART score group (n=124) or the control group (n=123). The primary outcome was the occurrence of Major Adverse Cardiac Events (MACE) within 6 weeks.

Results: The HEART score group demonstrated a significantly lower occurrence of MACE in comparison to the control group (2.4% vs 8.1%, p=0.044). The HEART score effectively stratified patients into low (54.8%), intermediate (22.6%), and high (22.6%) risk categories, guiding the selection of appropriate interventions. While the admission rates were higher in the HEART group, suggesting more precise risk-based hospitalization, and similar time for length of stay at the ED.

Conclusion: Introducing the use of the HEART score in classifying Emergency Department (ED) chest pain presenting patients will significantly reduce the occurrence of MACE (2.4% HEART group vs. 8.1% traditional clinical diagnosis, p=0.044), validating its use as a safer, more efficient risk-stratification tool. The implementation of the HEART score can regulate the care provided for chest pain patients in resource-limited settings. improving patient outcomes and potentially optimizing resource utilization.

Keywords: Chest Pain; HEART Score; Acute Coronary Syndrome (ACS); Major Adverse Cardiac Events (MACE).

Chapter One

Introduction

1.1 Introduction

Non-Communicable Diseases (NCDs), and Cardiovascular Disease (CVD) represent an essential cause of the global burden of disease and are known as the main cause of mortality globally. In 2019, the worldwide death rate reached approximately 56.5 million deaths globally, with (32.9%) of them (18.6 million deaths) being due to CVD (Safiri et al., 2022).

CVD and mortality in Palestine, IHD was the major cause of death in Palestine, accounting for 3,345 cases, which represent (22.2%) of all deaths in 2022. (MOH, 2023). This study proposes the first evaluation of the HEART score's efficacy in the Palestinian Emergency Department (ED), identifying a critical gap in standardized chest pain assessment in our healthcare system. As mentioned previously, CVD accounted for (22.2%) of all deaths in Palestine, with Ischemic Heart Disease (IHD) being the most common mortality cause according to the Palestinian Ministry Of Health (MOH) annual report 2022. (MOH, 2023).

The application of evidence-based risk stratification scores like the HEART score can significantly enhance the management of chest pain patients and reduce the burden of cardiovascular morbidity and mortality in our population. One of the most common symptoms for patients to seek health care is chest pain. Diagnosis of patient with chest pain for health care providers can be difficult because there are so many potential causes. These include potentially fatal conditions like acute myocardial infarction (AMI) and pulmonary artery embolism, as well as less serious but more common conditions like muscular chest pain (MCP), which is a type of chest wall syndromes, and gastrointestinal causes such as gastro esophageal reflux disease (GERD). (von Bezold, 2021)

Acute coronary syndromes (ACS) are characterized by an acute reduction in the blood flow to the myocardium and include ST-segment elevation myocardial infarction (STEMI), non- ST-segment elevation myocardial infarction (NSTEMI), and unstable angina (UA). (Bhatt, Lopes, & Harrington, 2022). Annually, an estimated over 7 million

patients globally are diagnosed with ACS, and more than 1 million patients require hospitalization in the United States (US) (Bhatt et al., 2022).

Primary assessment of patient arrives to ED complaining acute chest pain includes: complete physical examination, detailed past medical and surgical history, accompanied by further work up, such as a 12-lead electrocardiogram (ECG), and targeted laboratory diagnostics with point- of-care tests, including complete blood count (CBC), troponin level and D-dimer test. Diagnostic pathways and score systems, such as the Marburg Heart Score, have been particularly developed to rule out coronary artery disease through empowering patient assessment and providing orientation in the primary care situation. (von Bezold, 2021).

One of the essential components in the triage of chest pain patients demonstrating signs and symptoms indicative of coronary artery disease (CAD), is ECG interpretation. Reports of Acute MI or Acute Ischemia are critical, particularly during prehospital transfer when access to physician interpretation of the ECG is restricted. Even so, the relationship between automatic ECG interpreter statements and adjudicated clinical outcomes during hospitalization remains unclear. One of the most significant primary claims is the Among the most categorization of myocardial infarction (MI) and its potential territory (i.e., Anterior MI, Lateral MI). The primary statement is additionally supported with a modifier indicating the severity of the event (i.e. Acute, Recent). Also, a top emergency case with the statement label AMI requires particular steps to be implemented across the continuum of care to manage the condition quickly. In cases when health care providers, less experienced ECG readers, depend on these developed statements, as proficient ECG interpreters are not readily accessible for an over read (Faramand et al., 2021).

Patients who present with ischemic symptoms such as severe left sided chest pain, diaphoresis, and ECG ST-segment elevation should be transported immediately to the cardiac catheterization laboratory to do primary percutaneous coronary intervention (PPCI). However, the ECG frequently contains in many patients confusing factors that make the ST-Elevation Myocardial Infarction (STEMI) diagnosis a challenge may cause to improper Cath-lab activation (Fakhri et al., 2021).

The elderly population is predisposed to have atypical ACS symptoms, which may make it difficult to obtain the diagnosis and delay the treatment. The potential mechanisms for those atypical symptoms could be the cognitive limitations, age-related communication impairment or reduction of pain perception. The advanced age doesn't appear to impact the typical clinical presentation of ACS, theorizing the symptoms should be investigated and interpreted regardless of the age of patients. (Filgueiras et al., 2021).

Risk factors of cardiovascular disease (CVD) involve: hypertension, diabetes, obesity, hyperlipidemia, tobacco use, sedentary lifestyle, and lack of physical activity, as saw by the Framingham study. The identification and assessment of risk factors that precede cardiovascular disease (CVD) are essential for recognizing individuals at increased risk for developing CVD, so that interventional strategies can be utilized to address these risk factors and control or prevention of these factors could reduce CVD risk. (Teo & Rafiq, 2021)

The most recent guidelines, according to the European Society of Cardiology recommend using serial high-sensitivity cardiac troponin (hs-cTn) measurements with the 99th percentile upper reference limit as the cutoff for triaging patients with suspected ACS in the ED. (Collet et al., 2020)

The troponin is a commonly used cardiac biomarker in assessing chest pain patients is troponin. The early use of troponin level with chest pain patients who are suspected to have an AMI, but troponin measurement is can also be used in other acute and non-acute settings. The troponin is essential for decision making with chest pain patients suspected of having an AMI, providing immediate treatment and further examination. A rapid approach in ACS diagnosis is use of troponin assays with very low cut-off concentrations, which has been reported to improve the rapid ED diagnosis. Furthermore, the high sensitivity troponin level can improve patients' risk stratification in conditions other than CAD and chronic testing of troponin assays, for instance, they could be used as a biomarker in patients with congestive heart failure, pulmonary embolism, or stable coronary artery disease. (Westermann, Neumann, Sörensen, & Blankeaawnberg, 2017).

There are many methods are used to classify patients with chest pain in emergency departments. Currently, the most often use for acute chest pain risk stratification is the History, Electrocardiogram, Age, Risk factors, and Troponin (HEART) immediately after

its founding in 2008, several validation studies on the HEART score demonstrated it to be Morea current than Thrombolysis in Myocardial Infarction (TIMI) and Global Registry of Acute Coronary Events (GRACE) scores and at least comparable in accuracy to other current scores for predicting short-term Major Adverse Cardiac Events (MACE). (Aung & Roongsritong, 2022). Another scale Vancouver chest pain (VCP) demonstrated early discharge for chest pain patients who are at low risk of developing ACS, and so can be safely discharged within 2 hours of presentation at the ED (Ong et al., 2017).

MACE includes AMI, Percutaneous Coronary Intervention (PCI), Coronary Artery Bypass Grafting (CABG) surgery, or mortality from any cause. (Poldervaart et al., 2016)

In a situation where there is currently a lack of clarity and direction from medical literature, the heart score assists to make reliable diagnostic and treatment decision. The chest pain patients can be triaged by utilizing the Heart score it is a simple, fast, and accurate predictable predictor of the result. HEART score facilitate communication between health care provider. At least ten lines of description and recommendation regarding patients with chest pain are summarized by a single figure. It would be simple and quick to formulate guidelines using the heart score as a guideline. A policy of early discharge is supported when the score is between 0-3 as this represents a (2.5%) risk of reaching an endpoint. Considering this extremely low risk percentage, it is unclear if further diagnostic test performed at the outpatient clinic will provide useful result.an immediate discharge cannot be considered when the heart score is between 4- 6, as this indicates a (20.3%) risk of an adverse outcome. Patient in this situation should be admitted to the hospital for close observation as an ACS while recognizing an accurate diagnosis. They should also indicate to noninvasive investigations, such as exercise testing, serial troponin and the possibility of detecting advance ischemia. Patients with a heart score of 7 point or higher, representing a risk of (72.7%), require early aggressive treatment, include invasive procedures, without waiting for result from noninvasive tests (Six, Backus, & Kelder, 2008).

1.2 Problem statement

CVDs represent the primary common causes of death globally. In the year 2019, it is estimated that 17.9 million people died in CVDs, accounting for (32.%) of all deaths globally. (WHO, 2021). In Palestine, IHD formed as the most common cause of mortality, accounting for 3.345 cases and representing (22.2 %) of total deaths according to the 2022 statistics report. (MOH, 2022). The EDs in Palestine are experiencing a notable rise in patients reporting chest pain, in addition to a rise in the frequency of these visits and an increased mortality rate associated with CVD and sudden cardiac arrest, especially after discharge.

Patients reporting with chest pain can be classified by using a variety of evaluation methods, that including non-threatening conditions such as musculoskeletal pain, psychosomatic issues, and gastroesophageal reflux, as well as serious conditions including AMI, aortic dissection, or pulmonary embolism. The effectiveness of current methods in emergency sittings to distinguish between benign and severe causes of chest pain remains unreliable, which may impact optimal patient outcomes. It is essential to addressing this diagnostic gap, an accurate and prompt diagnosis can greatly diminish the mortality and morbidity linked to cardiovascular diseases. moreover, the use of enhanced diagnostic protocols guided by our findings has the potential to affect national health policies and promote more economical healthcare delivery, possibly establishing a guideline serving as a model for similar regions facing healthcare challenges.

1.3 Objectives

The study objectives are:

1. Evaluate the performance of the HEART score and compare its performance with the current protocol on patients with chest pain presenting to the ED in North West Bank hospitals.
2. Evaluate the influence of the HEART score on resource operation, such as hospital admissions, interventional treatments, and length of stay, and accurately estimate MACE in patients who arrived at the ED complaining of nonspecific chest pain.
3. Compare the effectiveness of the HEART score as a risk stratification instrument for chest pain patients in North West Bank emergency departments with traditional clinical diagnosis.

4. Assess the appropriate level of care required for each patient according to their risk profile. The study
5. Compares the accuracy and predictive value of the HEART score in identifying patients at high risk for adverse cardiac events, including myocardial infarction or death, with traditional clinical diagnosis. The study looked to
6. Assess if the application of the HEART score could facilitate more appropriate and efficient utilization of resources, including decisions about admission to a coronary care unit or discharge with outpatient follow-up.
7. The impact of the HEART scores on resource use, including hospital admissions, interventional treatments, and length of stay.

1.4 Importance of study

Palestinian emergency departments are still missing a consistent methodology for the early assessment of risk, regardless of the high incidence of cardiac-related events. The implementation of the HEART score system may enhance evaluation accuracy, thus enhancing patient outcomes and optimizing the use of healthcare resources.

This study in Palestine introduces the HEART score system for chest pain evaluation, covering an essential gap in standardized, quick risk assessment within emergency departments. This system's implementation can set a new standard for emergency care, potentially impacting future healthcare policies and practices. The HEART score is used as a predictive instrument for outcomes in patients with chest pain, which enhances treatment strategies and the distribution of healthcare resources.

Shortly after the patient's presentation at the ED, based on already available clinical data and without the need for computerized calculations, the HEART score has demonstrated a good to excellent ability to classify among all-cause chest pain patients based on their risk of MACE occurrence, includes AMI, PCI, CABG surgery, or mortality. Which happens during 6 weeks after the visit.

1.5 Study hypothesis

H1: HEART score has higher performance compared to traditionally used protocol in chest pain patients.

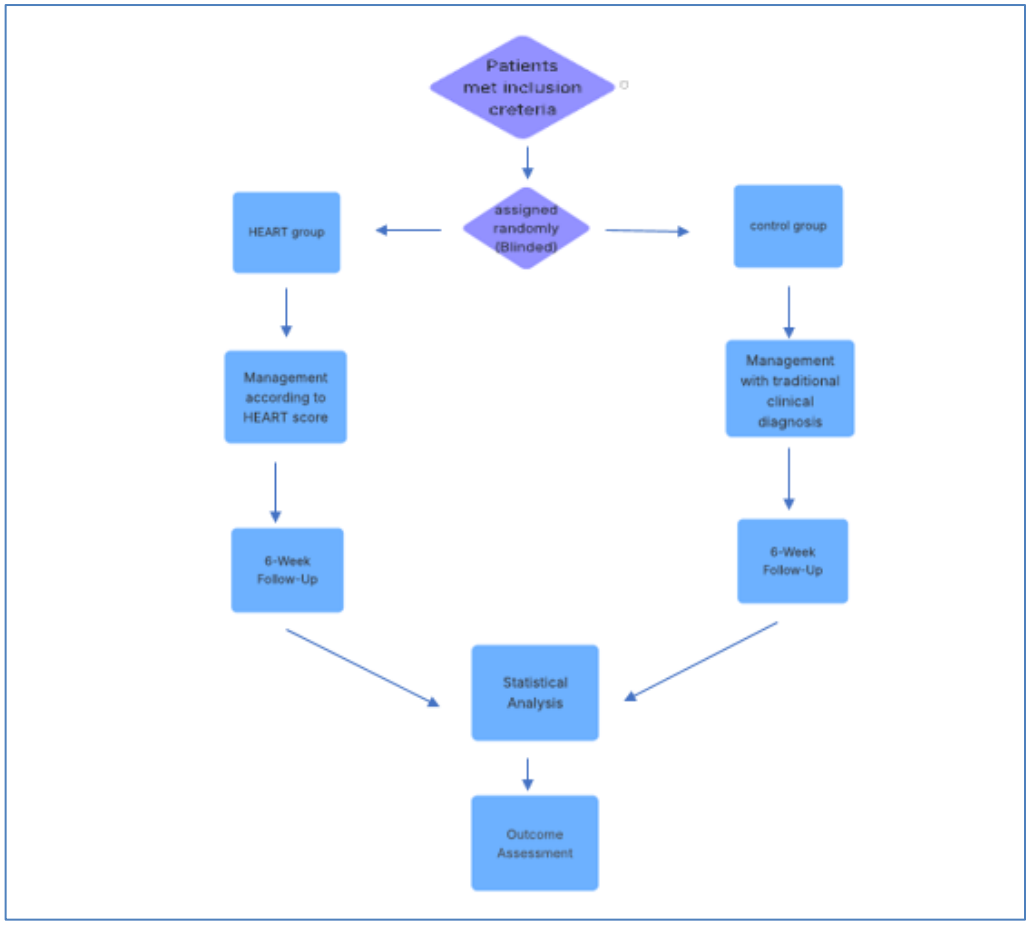
H1: HEART score predicts Major Adverse Cardiovascular Event (MACE) compared to the traditionally used protocol in chest pain patients.

1.6 Conceptual Framework:

The study employed a single-blinded randomized comparative design. After the patient met the inclusion criteria, patients were randomized to either the HEART protocol or the traditional care group. The HEART group received care based on standardized score categories, while the control group followed the clinician's clinical diagnosis. All patients underwent a 6-week follow-up for MACE. Primary analysis compared outcomes using the chi-square test and the T-test.

Figure 1

Showed the Conceptual Framework



1.7 Literature review Introduction:

Many different tools are currently used to classify patients with chest pain in the ED. History, ECG, age, risk factors, and troponin (HEART) score has been a commonly used tool for stratifying the risk of relatively soon after it's found in 2008 (Six et al., 2008). According to Several validation studies on the HEART score demonstrate that it is superior performance to Thrombolysis in Myocardial Infarction (TIMI) and Global Registry of Acute Coronary Events (GRACE) scores and is at least as reliable as other existing scores for predicting short-term MACEs. (Aung & Roongsritong, 2022).

1.7.1 Impact of coronary risk scores on disposition decision in emergency patients with chest pain

A study conducted in 2019, by Tzu-Yun Liu and others, at Kaohsiung Chang Gung Memorial Hospital, Taiwan. Their research was aimed to assess the influence of Coronary risk scores (CRS) on the management of patients presenting with symptoms indicative of acute coronary syndrome in the emergency department. Their design was a retrospective cohort study with 3660 adult patients who presented to the ED with chest pain. The inclusion criteria for the study were patient age > 18 years and a diagnosis of angina pectoris or chronic ischemic heart disease as verified by the treating ED physician. If the treating ED physician completed the electronic structured variables for the calculation of CRS to aid in disposition planning, then the patient would be classified as the CRS group, otherwise, the patient was included in the control group. Their results showed between 2676 patients, 746 were categorized into the Coronary risk scores group, while only 1930 were classified into the control group. There was no notable variation observed in sex, age, initial vital signs, and ED length of stay between the two groups. The coronary risk factors were comparable between the two groups, with the exception of a higher percentage of smokers in the CRS group (19.6% vs. 16.1%, p=0.031). In comparison to the control group, a large number of patients were discharged (70.1% vs. 64.6%) directly from the ED, while fewer of them were hospitalized (25.9% vs. 29.7%). MACE and mortality rate at 60 days between the two groups were not significantly different. In conclusion elevated ED discharge rate of the group utilizing CRS suggests that ED physicians have more confidence in discharging low-risk patients based on CRS. (Liu et al., 2021).

A study with prospectively collected data from nine Dutch hospitals Netherlands aimed to compare the ability of the GRACE, HEART and TIMI scores in detecting the

probability of MACE between chest pain patients reporting at the emergency department (ED), particularly focusing on their capacity to detect patients at low risk. The result demonstrates that the HEART score superior the GRACE and TIMI scores in differentiating between those with and without MACE in those reporting with chest pain, while also identifying the greatest cohort of low-risk patients at the equivalent level of safety (Poldervaart et al., 2017).

A Systematic Review and Meta-Analysis study was conducted to assessed the diagnostic of reliability a low-risk, History, ECG, Age, Risk Factors, and Troponin (HEART) score for predicting major adverse cardiac events in ED patients ,the study included four group analyses: by geography the utilization of a modified low-risk HEART score (traditional HEART score [0 to 3] along with negative troponin results), the comparison of conventional versus high- sensitivity troponin assays within the HEART score, and an analysis of various follow-up intervals for patients post-ER discharge. This meta-analysis indicates that, regardless of patients' demographics, troponin type, and follow-up duration, a low-risk HEART score demonstrate high sensitivity, negative predictive value, and negative likelihood ratio for prediction short-term major adverse cardiac events, regardless of significant risk of bias and high statistically heterogeneity. (Laureano-Phillips et al., 2019).

This retrospective cohort study conducted in the Mid-Atlantic region of the United States, aimed to evaluate whether sex or race independently expects recording of patients' HEART scores in chest pain patients. Result showed Women and non-white patients are more unlikely to receive HEART score risk stratification while reporting with nonspecific chest pain, even after adjusting for patient age. (Check et al., 2022).

A further analysis of a prospective observational research conducted in the United States, in 2022. The purpose of the Study objective was to evaluate whether Clinical decision tools can reduce healthcare gaps. The HEART score is a clinical decision tool that evaluates ED patients for cardiac risk. They aimed to investigate the impact of patient and physician genders on the HEART scores. The study results were, all 336 clinician–patient pairs from the original study were included. A total of (47%) (158/336) of patients were female, while (52%) (174/336) received treatment from a female physician. So the Patient and physician gender may influence HEART scores. (Soares et al., 2021).

1.7.2 Risk Stratification

A study was done to examine consecutive patients reporting with a primary chest pain complaint seen in the ED, at Mercy Philadelphia Hospital, Philadelphia, from January 2012 to December 2014. Researchers in this study aimed to determine whether the HEART score and TIMI scores which take into account patient history, electrocardiogram, age, risk factors, and initial troponin (HEART) is a better predictor of MACE in patients with a low risk of cardiovascular disease (CVD), their study design was retrospective. The result indicates that, in non-high CV risk patients, the HEART score is a superior predictive tool for 6-week MACE when compared to the TIMI score. Additionally, for patients who report to the emergency department with chest pain, the best policy for a (2% to 4%) miss rate limit possibility would be to discharge these patients from the ED. (Bhattacharya et al., 2019).

Differentiating among urgent and non-urgent causes can be difficult, this study attempted to do just that in a primary care institution in the Netherlands using a retrospective, observational cohort design. If troponin is absent ('simplified HEART') or changed by the so-called 'sense of alarm' (HEART-GP), then an alternative of the heart score that does not include troponin could be useful for risk stratification. primary care providers without regular access to troponin assays may utilize the heart score adjustments, which include the physician's 'sense of alarm' to classify patients' risk for chest pain. (Harskamp et al., 2021).

Another prospective observational cohort study in the Netherlands by Van Dongen et al. was performed in 2017. The original goal of the triage project was to assess paramedics' risk stratification accuracy in patients predicted to have NSTEMI. The result showed risk stratification based on the HEART-score. Possibly in the future, pre-hospital risk stratification will take the role of hospital risk stratification. (van Dongen et al., 2020).

1.7.3 Admission Rate

A study was conducted in 2013 in Sweden, by Melki et al. The total sample number was 410 consecutive patients who were complaining of chest pain but without ST-segment elevations, they were selected and followed for three months for the combined end point of cardiovascular death, myocardial infarction, or unexpected revascularization. The study aim was to determine whether the HEART score is valid and, if so, to what degree it can lower the admission rate. According to the result of the study, the HEART score may be an effective tool for the assessment of patients with chest pain and for recognizing a low-risk group, suggesting that admission and additional investigations may not be required. But maybe all that is necessary is a history, troponin level, and ECG findings. (Melki & Jernberg, 2013)

Another study was done in 2018 by Brandon et al, in Florida. The purpose of their study was to safely reduce the admissions rate through a retrospective observational pre/post study design. They integrated the updated HEART score computation instrument 'into the electronic medical record system. There was a notable rise in discharges of low-risk chest pain patients (relative increase of 21%; $p < 0.0001$) in the post-implementation, in their period of the observation was no notable change in the rates of MACE within the pre- and post-periods. There was a reduction in the number of followed up patients with readmission for 30 days (4.65% fewer; $p = 0.009$) and 60 days (3.78% fewer; $p = 0.020$). According to the length of ED stay was no notable change was noted for patients who were discharged. A (64%) reduction in monthly coronary computed tomography angiograms was noted in the post period ($p < 0.0001$). These outcomes support the growing agreement in the literature that the implementation of the HEART method or others protocols in ED, particularly in large and high-volume medical centers, can significantly improve patient care and decrease related health care costs. (Brandon et al., 2018)

1.7.4 MACE Rate

In the years 2013-2014, researchers in the Netherlands conducted a randomized controlled trial, by Poldvaart et al 2013. The purpose of their study was to detect if the HEART score facilitates management of chest pain patients, in specifically in recognizing low-risk patients who may be discharged early than usual. The total population sample 3,648 patients. 1,827 patients received the traditional care, whereas 1,821 had been managed according to the HEART score. The MACE rate was (18.9%) in the HEART

score group and (22.3%) in the traditional care group. In addition, the mortality rate (0.3%) in the HEART group, compared to (0.5%) in the traditional care group.

In 2022, a cohort study was done in Pennsylvania by Vaskas et al. The total study population was 11,232, including chest pain patients. Their study aimed to validate the influence of an automated best practice alert, utilizing high sensitivity troponin cut points, that showed capture of the HEART score on ED discharge decision making. HEART score had a higher rate of ED discharge rate. Patients with low (≤3) risk HEART score demonstrate essentially a decrease in 30-days MACE, and the patients with high-risk scores demonstrate greatly higher (1.6% vs. 6.6%, $p < 0.001$) rates of 30-day MACE. (Vaskas et al., 2024)

In summary of the literature review, the HEART score demonstrated superiority to other CRS, and clinical diagnosis. The studies showed lower MACE rates, lower admission rate, and improved resources utilization.

1.8 Validity and Reliability

The HEART score has been widely validated across in different populations and healthcare settings, demonstrating its reliability and generalizability as a risk stratification tool for chest pain patients. Studies conducted in high-income countries, such as the Netherlands and the United States, have consistently shown that the HEART score outperforms other risk assessment tools, such as the TIMI and GRACE scores, in predicting short-term Major Adverse Cardiac Events (MACE) (Poldervaart et al., 2017; Six, Backus, & Kelder, 2008). Likewise, research in middle- and low-income countries, including Taiwan and Brazil, has established the HEART score's effectiveness in resource-constrained settings, where access to advanced diagnostic tools and follow-up care may be inadequate (Liu et al., 2021; Soares et al., 2021). These studies highlight the HEART score's compliance to different healthcare structures and patient demographics, making it a versatile tool for global use.

Chapter Two

Methods

2.1 Methodology

Patients were blinded and randomly assigned to either the HEART score group or the control group based on their presentation to the emergency department (ED). An assigned random allocation method was implemented due to logistical constraints specific to the ED setting.

All participating physicians underwent a comprehensive 2-hour training session on the application of the HEART score. This training included a theoretical overview of the HEART score components, practical case studies, and a competency assessment to ensure consistent application.

To maintain consistency in HEART score application, 10% of cases were randomly selected for review by a senior physician not involved in the initial assessment. Any discrepancies were discussed and resolved to ensure the standardized implementation of scores throughout the study period.

2.2 Study design: Single-blind, randomized, comparative Retrospective analysis of a prospective cohort study

2.3 Site and sitting

The study was conducted in the emergency department of Al-Watani Hospital, a high-volume central hospital located in the North West Bank. The Emergency Room (ER) at Al-Watani Hospital is the first line of urgent medical care in the area. It's work for 24 hours daily, seven days a week, to treat medical illnesses and other situations quickly and effectively, saving lives. The hospital capacity to 62 beds, and 251 employees, an occupancy rate is 90%. As a busy central hospital, our emergency room is ready to handle large groups of people hurt badly and complicated medical situations with care and accuracy.

2.4 Sample and sampling

The sample included the patients who presented complaining of chest pain, and their ages were above than 18 years. Simple random sampling was used.

2.5 Sample size

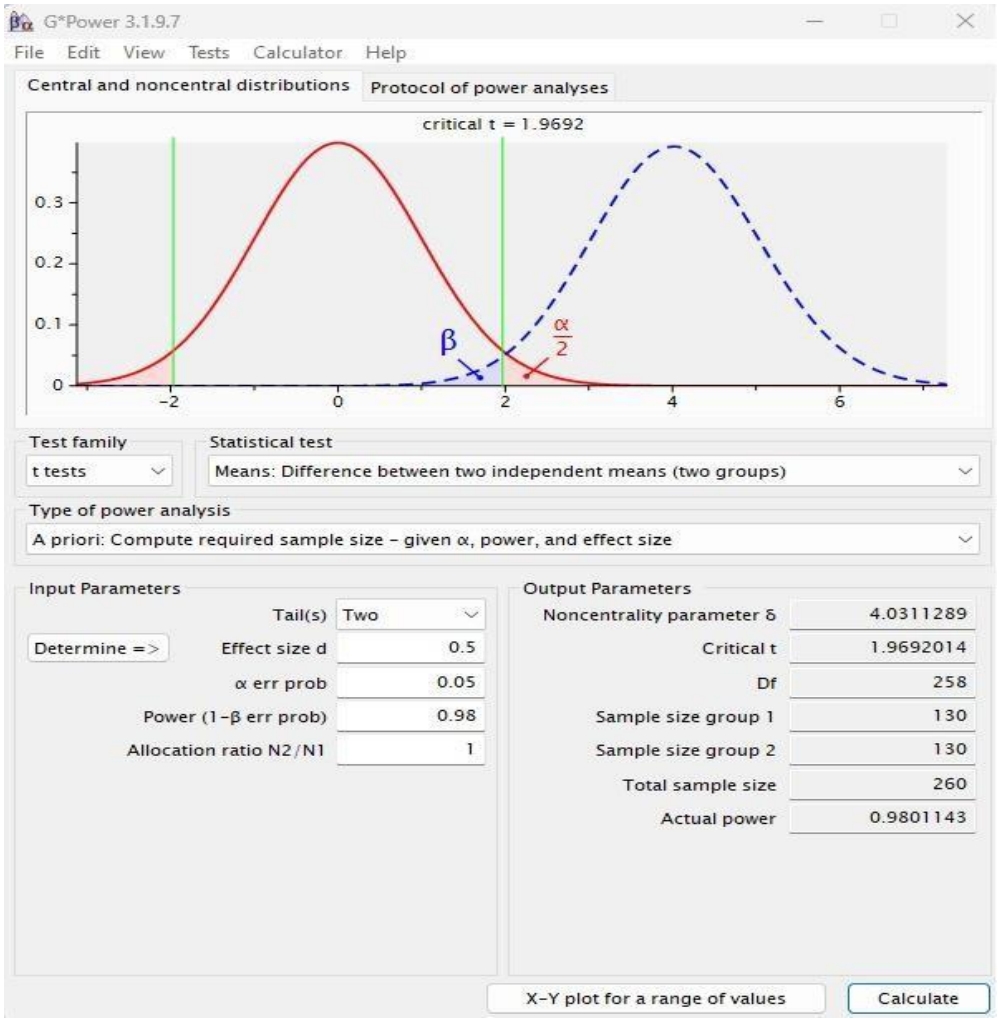
The sample size was calculated by G-power with a confidence interval of 95%, the total sample size was 260 patients, as appear in figure-2.

Control group: The Sample size of control group was 130 patients as calculated by G-power, 130 patients.

HEART group: The Sample size of HEART group was 130 patients, as calculated by G-power.

Figure 2

Sample Size, Calculated by G-Power



2.6 Inclusion Criteria

Patients admitted to the ED during the research period with chest pain are eligible for inclusion in the study, who are above 18 years old and have experienced chest pain that can be related to ACS.

2.7 Exclusion criteria

Patients reporting with ECG ST-segment>1mm, elevation myocardial infarction (STEMI), requiring primary percutaneous coronary intervention (PCI), patients required admission for another medical diagnosis, and hypotensive patients were excluded.

2.8 Study instrument

HEART score was used for the experiment group the HEART score components were assembled including: History, Electrocardiograph, Age, Risk factors, and Troponin, as shown in the following Table-1, required completion of these five components. This information was used to calculate the HEART score risk group.

The presenting chest pain history, characteristics, and associated factors were used to determine the typical chest pain that relate to acute myocardial ischemia, or angina. Typical anginal chest pain that is described by retrosternal central pressure, tightness, and heaviness given a maximum of 2 points. Non-cardiac pain features, such as pain reducible during motion or body positions, sharp or fleeting, give 0 points, and a mixture of typical anginal and non-cardiac pain features gives 1 point.

According to ECG, the highest score 2 points given for those who had ECG ST-depression “defined as ST-segment down-sloping or horizontal depression ≥0.05 mV in two or more contiguous leads in the appropriate clinical context present on the ECG” (Collet et al., 2020).

For those patients who had non-specific repolarization disturbances or a left bundle branch block (LBBB) were given 1 point. Zero point for normal ECG pattern with normal, and regular sinus rhythm, no defined ST-segment changes.

The HEART score and the probability of ACS according to clinical diagnosis were assessed as soon as the first lab results and ECG were obtained. ECGs were saved for all patients for evaluation purposes.

High sensitivity Troponin assay was done for all study patients, initially at presentation, with results being available within 60 minutes, Roche Modular E170, Roche Diagnostics Mannheim, Germany; 99th centile 14 ng/L. (Suthahar, 2020). For those patients who have chest onset more than 6 hours before the presentation, with a normal initial troponin result, no serial troponin measurement is required. Otherwise, the serial troponin was checked after 6 hours from the initial read according to European Society of Cardiology (ESC) guideline recommendations (Hamm et al., 2011). Patients' data were followed up for 6 weeks to determine the occurrence of any MACE.

The patient's age at admission was considered. The patients aged less than 45 years get zero points; they are considered the lowest risk age group. For those who fell between 45 and 65 years, one point was given. In cases where the patient was 65 years or older, two points were awarded, which those the higher risk age group.

The evaluation of risk factors for CAD involved, for patients who have no risk factors they got zero points, for patients who have one or two risk factors they got one point, and for who have three or more risk factors were awarded two points. The CAD risk factors are: currently treated diabetes mellitus, current or recent smoking, diagnosed hypertension, diagnosed hypercholesterolemia, a family history of coronary artery disease, and obesity. Additionally, a history of coronary revascularization, myocardial infarction, stroke, or peripheral arterial disease resulted in two points.

Table 1

HEART score

HEART score		
History	Highly suspicious	2
	Moderately suspicious	1
	Slightly suspicious	0
ECG	Significant ST-segment depression	2
	Nonspecific repolarization disturbance/LBBB/PM	1
	Normal	0
Age	≥ 65 years	2
	> 45 and <65 years	1
	≤ 45 years	0
Risk factors*	≥ 3 risk factors or history of atherosclerotic	2
Troponin**	≥ 3x normal limit	2
	1-2 x normal limit	1
	Normal limit or lower	0
Total		

*Risk factors: Hypercholesterolemia, hypertension, diabetes mellitus, cigarette smoking, family history of atherosclerotic disease, Body mass index (BMI) 30 kg/m2. **Troponin Results of hospital troponin will be scored according to this table ECG = electrocardiogram; HEART = History, ECG, Age, Risk factors, and initial Troponin; LBBB = left bundle branch block; PM = pacemaker

2.8.1 HEART Score Interpretation

Patients who calculated HEART score between 0-3 points, which mean they have a (2.5%) risk of reaching an endpoint, or MACE, which means that early discharge should be considered. It is uncertain if further diagnostic test at the outpatient clinic will be more beneficial considering this very low risk ratio. For patients who have HEART score 4-6 points, reflect there is a (20.3%) risk of adverse outcome therefore, immediate discharge is not an option as this figure indicates a risk of (20.3%) for an adverse outcome. These patients were admitted for close observation, treated as ACS awaiting definitive diagnosis. They were also subjected to noninvasive investigations, such as serial troponin, exercise tolerance testing, and possibly advanced ischemia detection like Coronary computed tomography angiography.A HEART score ≥7 points, with a risk of (72.7%) of MACE, implies early aggressive treatment, including invasive strategies without preceding noninvasive testing.(Six et al., 2008)

2.8.2 Data Collection

The patients who were selected by our study criteria underwent ED treatment by their health care providers, and they were categorized blindly into the control group, or HEART group (experimental group), while receiving treatment at the ED. The treating physicians were either emergency medicine consultants, internal medicine residents, or general practitioners.

The data collection forms were case reports that had information about the physician, such as demographic data, age, gender, level of training of the physician, and medication administration in the ED. All accessible visit information history, physical exam, ECG, and laboratory results were used by the physician to determine clinical diagnosis. Physicians were asked about the patient's clinical diagnosis as related to the patient's presenting symptoms or clinical signs.

2.9 Follow-up

After 6 weeks, follow-up data, including discharge reports, revascularization reports, or documentation from follow-up visits in the outpatient clinics, were reclaimed from the electronic patient records.

2.10 Ethical Approval

The study adhered to the ethical guidelines outlined in the Declaration of Helsinki, which ensures the protection of human subjects in research. These guidelines include safeguarding participant privacy and confidentiality, as well as minimizing potential harm or risks. To protect participant identities, anonymity was maintained by assigning unique identification numbers instead of using personal identifiers. Confidentiality was ensured by storing data securely and restricting access to authorized researchers only.

Ethical approval was obtained from the Institutional Review Board (IRB) with reference number: Mas.May.2024/8 at An-Najah National University, an independent committee responsible for reviewing research protocols to ensure compliance with ethical standards.

Also, the Ethics and Research Committee of the Ministry of Health (MOH) obtained approval for data collection at the MOH hospital setting. These approvals confirm that the study design upholds the rights, safety, and welfare of all participants.

2.11Working Plan

A prospective, single-blind, randomized comparative study was conducted at a central governmental hospital in the North West Bank between May and October 2024. Participants were randomly allocated to one of two groups using a sealed-envelope randomization method with blinded assignment: (1) the HEART score group (n=124), where risk stratification was guided by the HEART score protocol, and (2) the control group (n=123), where patients received standard evaluation based on traditional clinical assessment by treating physicians. Data collection was conducted through electronic medical records and direct assessments by a trained researcher. Data was randomly collected from the two groups of participants using structured data collection forms designed to capture demographic information, medical history, specific metrics used for the HEART score, and clinical outcomes.

The data collection was done for the two groups after obtaining Ministry of Health (MOH) approval. The control group was treated traditionally, with the clinical diagnosis, and the experimental group was treated according to the HEART score.

The Variables Collected were Demographics, medical history, HEART score components (history, ECG, age, risk factors, troponin). Outcomes were Admission, discharge rates, interventions, MACE (death, AMI, PCI, CABG), and ER treatment time. The Follow-up was done for Six weeks post-discharge to track MACE.

MACE and treatment outcomes were followed up for six-week period for Participants in both groups to assess the occurrence of MACE. The need for interventional management, admission rates and discharge rates, and MACE were compared. The treatment time consumed by each one in the ED was assessed.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS). After reviewing and coding, the data collected were entered into SPSS version 20 for analysis. SPSS Version 22 is used for data analysis. Descriptive statistics (Frequencies, Percentages, Means, and Standard Deviations) were computed. The following statistical tests and methods were used to analyze the results, assuming that the statistical test with the P-value less than or equal to 0.05 is significant.

Chi-Square test was used to test the differences in percentages between the control group and the heart group for the qualitative variables such as: Patient Age, Gender, Smoking, and Characteristics of Presenting chest pain, Medical History, Physical Examination, Intervention data, and the Follow up data.

Two independent samples T-test was used to test the differences in means between the control group and the heart group for the quantitative variables such as: Weight, Height, and BMI,

Packs of cigarettes smoked per day, Years the patient has smoked, Pack years, and the Laboratory Findings.

Overall, this study aimed to contribute to the existing body of knowledge on the management of chest pain and the use of the risk stratification tool, HEART score. By adhering to ethical guidelines and obtaining approval from the IRB, the study ensured the protection and well- being of participants while generating valuable evidence to inform clinical practice.

Chapter Three

Results

3.1 Sample Demographics

The study sample composed of 247 patients who were above 18 years old and presented to the ER complaining of chest pain. The patients were distributed into two groups: 123 patients in the control group and 124 in the heart group. Most of the patients in the sample are males (about 78%), while about 22% are females. About 56% of the patients in the study sample are from the age group (30-44 years), about 24% from the age group (25-29 years), and about 20% from the age group (45 or above). The average of the weights of the patients in the sample is about 87 kg, the average of the heights is about 170 cm, and the average of the BMI is 30.1.

About 44% of the patients in the study sample are smokers and the average of their Packs of cigarettes smoked per day is about 1.5, and the average of their smoking years is about 30 years, and the average of their Pack years is about 46, (the results are shown in the next table- 2).

3.2 Comparisons between the traditional group and the heart group according to the Patients' demographic data and characteristics

Table 2

*Patient demographic data (N=247) **

Variable	Category	Control (N=123)	Heart (N=124)	Total (247)	Test Statistics	P-value
	25-29	29(23.6%)	30(24.2%)	59(23.9%)		
	30-44	65(52.8%)	73(58.9%)	138(55.9%)		
Patient Age	45 or above	29(23.6%)	21(16.9%)	50(20.2%)	1.757	0.415
	Male	98(79.7%)	94(75.8%)	192(77.7%)		
Gender	Female	25(20.3%)	30(24.2%)	55(22.3%)	0.534	0.465
Weight		86.72±15.51**	87.12±12.53	86.92±14.06	-0.226	0.822
Height		169.67±5.27	170.21±5.85	169.94±5.56	-0.774	0.439
BMI		30.16±5.44	30.05±3.8	30.1±4.68	0.191	0.849
Smoker patients		53(43.1%)	55(44.4%)	108(43.7%)	0.040	0.841
Packs of cigarettes smoked per day		1.48±0.58	1.54±0.66	1.51±0.62	-0.458	0.648
Years the patient has smoked		29.77±11.68	29.55±11.45	29.66±11.51	0.095	0.924
Pack years		45.06±24.39	46.32±28.45	45.7±26.42	-0.248	0.805

*Some of the Chi-square p-values were computed based on the adjusted exact test for low frequency categories and some of the T-test p-values were adjusted for non-homogeneous variances.
**Standard Deviation

The results in the table-2 above show that there are no significant differences at 0.05 level between the control group and the heart group in all the Patients' demographic data and characteristics; the p-values of the test for these variables are higher than 0.05.

Figure 3

Sample gender distribution

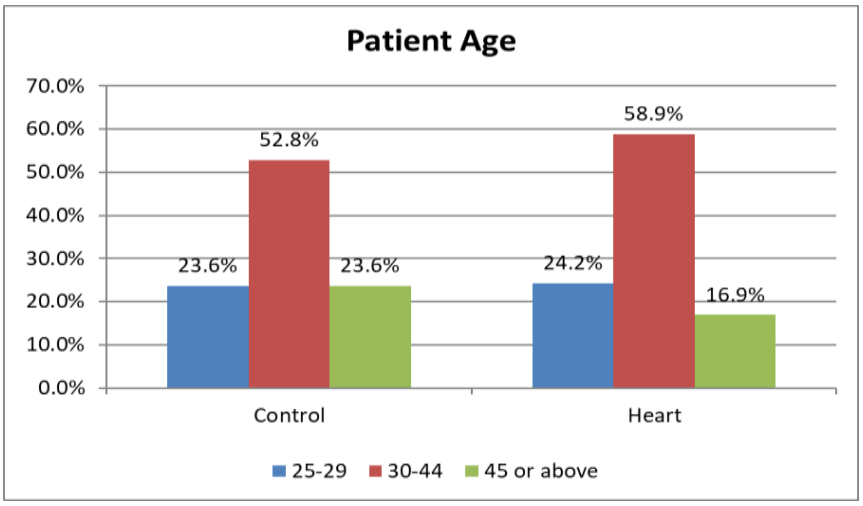


Figure 4

Show patients' age distribution

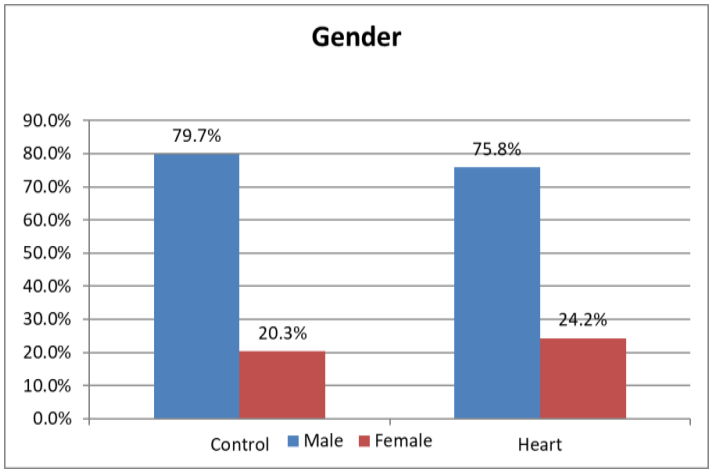
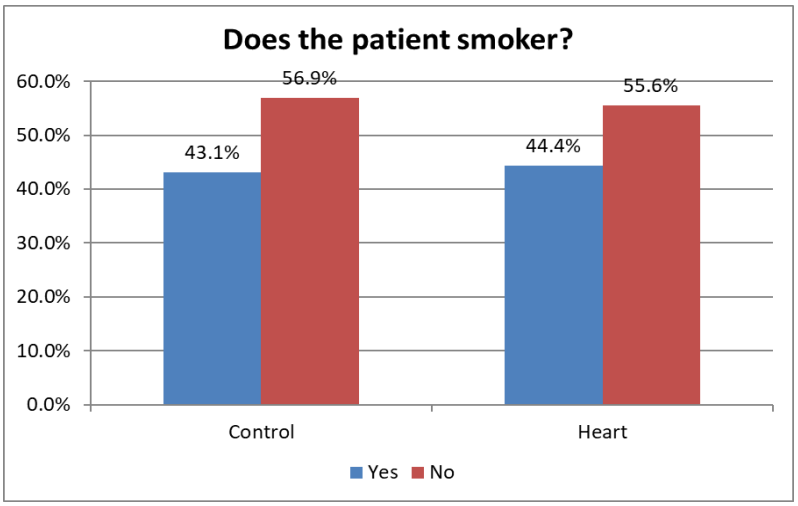


Figure 5

Shows sample smoking comparison



3.3 Comparisons between the control group and the heart group according to the Characteristics of presenting chest pain.

Table 3

*Characteristics of presenting chest pain (N=247) ***

Variable	Category	Control (N=123)	Heart (N=124)	Total (247)	Test Statistics	P-value
Does the patient have typical chest pain?	Yes	53(43.1%)	62(50%)	115(46.6%)		
	No	70(56.9%)	62(50%)	132(53.4%)	1.185	0.276
If no, specify*	Chest discomfort	32(45.7%)	29(46.8%)	61(46.2%)		
	Shortness of breath	6(8.6%)	4(6.5%)	10(7.6%)		
	Localized chest tenderness	16(22.9%)	20(32.3%)	36(27.3%)		
If no, specify*	Epigastric pain	11(15.7%)	7(11.3%)	18(13.6%)		
	Central chest pain	2(2.9%)	2(3.2%)	4(3%)	4.156	0.552
	Palpitations	3(4.3%)	0(0%)	3(2.3%)		
Onset	Sudden	56(45.5%)	52(41.9%)	108(43.7%)		
	Gradual	67(54.5%)	72(58.1%)	139(56.3%)	0.324	0.569
Episode duration	Less than one minute	0(0%)	1(0.8%)	1(0.4%)		
Episode duration	1-5 minutes	6(4.9%)	13(10.5%)	19(7.7%)		
	6-20 minutes	1(0.8%)	5(4%)	6(2.4%)	5.256**	0.026
	More than 20 minutes	116(94.3%)	105(84.7%)	221(89.5%)		
Quality	Dull	14(11.4%)	7(5.6%)	21(8.5%)		
	Heavy	32(26%)	38(30.6%)	70(28.3%)		
	Crushing	4(3.3%)	7(5.6%)	11(4.5%)		
	Sharp	20(16.3%)	26(21%)	46(18.6%)		
Quality	Stabbing	17(13.8%)	15(12.1%)	32(13%)	4.943	0.423
	Burning	36(29.3%)	31(25%)	67(27.1%)		
Radiated to left arm or neck:	Yes	24(19.5%)	38(30.6%)	62(25.1%)		
	No	99(80.5%)	86(69.4%)	185(74.9%)	4.071*	0.044
Associated with sweating:	Yes	25(20.3%)	28(22.6%)	53(21.5%)		
	No	98(79.7%)	96(77.4%)	194(78.5%)	0.186	0.666
Associated with palpitations:	Yes	18(14.6%)	20(16.1%)	38(15.4%)		
	No	105(85.4%)	104(83.9%)	209(84.6%)	0.106	0.745
Increased with exercise:	Yes	40(32.5%)	44(35.5%)	84(34%)	0.242	0.623
	No	83(67.5%)	80(64.5%)	163(66%)		

*Specified atypical symptoms of chest pain

** The chi-square test is significant at the level of significance 0.05.** Some of the Chi-square p-values were computed based on the adjusted exact test for low-frequency categories.

The results in the table-3 above show that there are significant differences at 0.05 level between the control group and the heart group in Episode duration, the p-value of the test is 0.026. The results show that the percentage of the Episode duration (1-5 minutes) for the HEART group (n= 13, 10.5%) is significantly higher than the percentage for the Control group (n= 6, 4.9%). In addition, the results show that the percentage of the Episode duration (6-20 minutes) for the Heart group (n= 5, 4%) is significantly higher than the percentage for the Control group (n= 1, 0.8%). On the other hand, the results show that the percentage of the Episode duration (More than 20 minutes) for the Heart group (n= 105, 84.7%) is significantly lower than the percentage for the Control group (n= 116, 94.3%).

The results also indicate that 46.6% of the study sample presented with typical chest pain, while 53.4% reported atypical symptoms. The atypical symptoms were further categorized into six categories, as detailed in Table 3: Chest discomfort (46.2%), shortness of breath (7.6%), localized chest tenderness (27.3%), epigastric pain (13.6%), central chest pain (3%), and palpitations (2.3%). As explained their percentages the table-3. Among these, chest discomfort was the most prevalent atypical symptom, accounting for 46.2% of all atypical complaints.

The results in the table-3 above also shows 43.7% of chest pain patients were have sudden onset, while 56.3% with gradual onset. The distribution (43.7% sudden vs. 56.3% gradual) suggests that gradual-onset chest pain is slightly more common in this patient population. However, the high percentage of sudden onset cases (43.7%), confirm the importance of rapid assessment to rule out life-threatening conditions.

Episode duration of chest pain was classified into four categories: less than one minute (0.4%), 1-5 minutes (7.7%), 6-20 minutes (2.4%), and more than 20 minutes (89.5%). The most

common of the sample reported experiencing chest pain lasting for more than 20 minutes, representing a prevalence of prolonged chest pain episodes in the study population. This prolonged duration may indicate a higher risk of severe cardiovascular events. Figure-6 illustrates the distribution of chest pain episode duration across these categories.

The results, as detailed in the table -3 above, show the following descriptors for chest pain quality as reported by the participants: dull (8.5%), heavy (28.3%), crushing (4.5%),

sharp (18.6%), stabbing (13%), and burning (27.1%). The most commonly reported descriptor was heavy, suggesting that a significant portion of patients experienced this sensation, which could be related to an acute cardiovascular event.

The results in the table-3 above also show the incidence of sweating associated with their presenting chest pain: 25 (20.3%) in the control group and 28 (22.6%) in the HEART group. Overall, 53 (21.5%) of the study sample reported sweating associated with their presenting chest pain.

The results in the table-3 above also show the incidence of palpitations in control group 18(14.6%), and 20(16.1%) in the HEART group. generally, 15.4% (38 participants) of the study sample reported palpitations with their chest pain.

The results in the table-3 above also indicate the prevalence of chest pain increasing with exercise: 40 (32.5%) in the control group and 44 (35.5%) in the HEART group. Overall, 84 participants (34%) in the study sample reported chest pain that worsened with exercise.

The results in the table-3 above also show that there are significant differences at 0.05 level between the control group and the HEART group in the Radiated to left arm or neck, the p- value of the test is 0.044. The results show that the percentage of the Radiated to left arm or neck for the Heart group (n=38, 30.6%) is significantly higher than the percentage for the Control group (n= 24, 19.5%). The following figure-7 Show the differences the two groups regarding to chest pain that radiated to left arm or neck.

Finally, the results in the table-3 above show that there are no significant differences at 0.05 level between the control group and the heart group in the remaining characteristics of presenting chest pain (having typical chest pain, Onset, Quality, associated with sweating, associated with palpitations, and increased with exercise), the p-values of the test for these characteristics are higher than 0.05.

Figure 6

Show episode duration of presenting chest pain

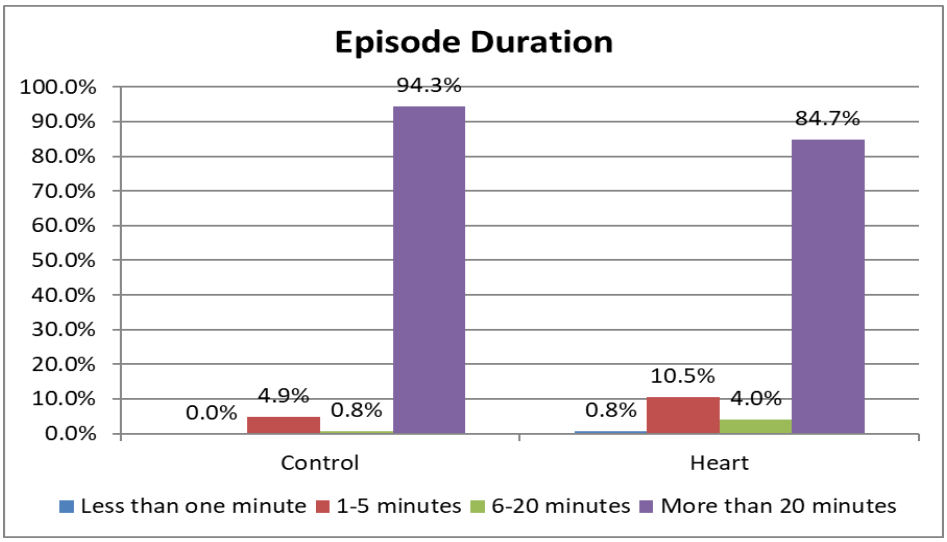
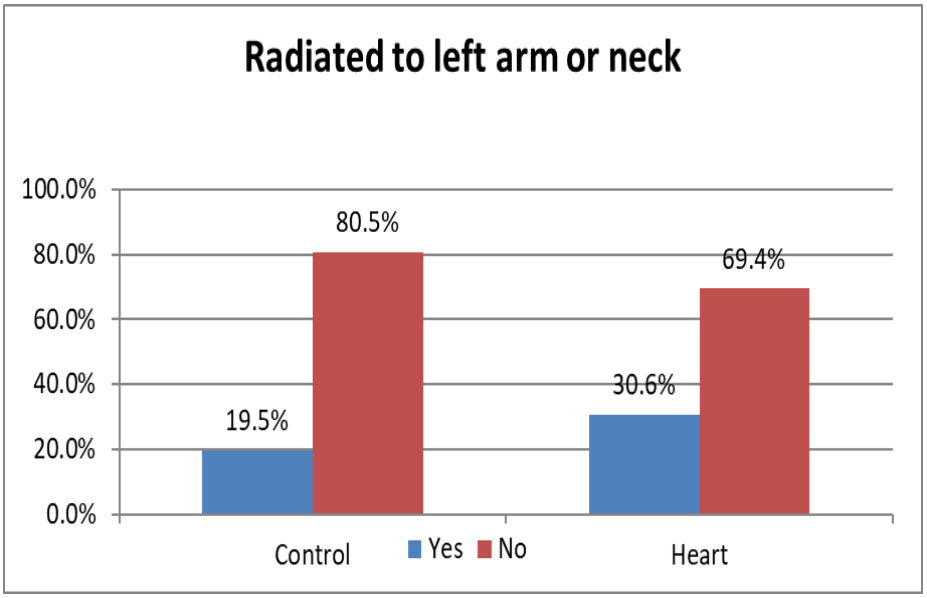


Figure 7

Show percentage of chest pain that's radiated to left arm or neck.



3.4 Comparisons between the control group and the heart group according to the Medical History

Table 4

*Medical History (N=247) ***

Variable	Group Control	Heart	Total (247)	Test Statistics	P-value
Hypertension	64(52%)	65(52.4%)	129(52.2%)	0.004	0.951
Diabetes	43(35%)	49(39.5%)	92(37.2%)	0.549	0.459
Dyslipidemia	12(9.8%)	22(17.7%)	34(13.8%)	3.317	0.069
Coronary artery disease	17(13.8%)	25(20.2%)	42(17%)	1.759	0.185
Previous percutaneous	22(17.9%)	29(23.4%)	51(20.6%)	1.140	0.286
Previous coronary artery	8(6.5%)	7(5.6%)	15(6.1%)	0.080	0.777
Previous transient	4(3.3%)	3(2.4%)	7(2.8%)	0.155	0.722
Family history of IHD	11(8.9%)	17(13.7%)	28(11.3%)	1.396	0.237
Others**	8(6.5%)	18(14.5%)	26(10.5%)	4.209*	0.040
Does the patientYes	64(52%)	53(42.7%)	117(47.4%)		
compliant with hisNo	16(13%)	17(13.7%)	33(13.4%)	2.308	0.315
prescribed Not	43(35%)	54(43.5%)	97(39.2%)		

* Chi-square test is significant at the level of significance 0.05. ** Some of the Chi-square p-values were computed based on the adjusted exact test for low-frequency categories.
** Others past medical history include (congestive heart failure (CHF), Atrial fibrillation (AF), peripheral vascular disease (PVD), and chronic kidney disease (CKD).

The results in the table-4 above also show the prevalence of hypertension: 64 (52%) in the control group and 65 (52.4%) in the HEART group. Overall, 129 participants (52.2%) in the study sample had a history of hypertension as a comorbid condition.

The results in Table-4 above also show the prevalence of diabetes: 43 (35%) in the control group and 49 (39.5%) in the HEART group. Overall, 92 participants (37.2%) in the study sample had a history of diabetes as a comorbid condition.

The results in Table-4 above also show the patients who have previous percutaneous coronary intervention (PCI): 22 (17.9%) in the control group and 29 (23.4%) in the HEART group, with 51 participants (20.6%) in the study sample having a history of PCI. For previous coronary artery bypass graft (CABG): 8 (6.5%) were in the control group and 7 (5.6%) in the HEART group, totaling 15 participants (6.1%) of study sample have history of CABG. Regarding family history of ischemic heart disease (IHD): 11 (8.9%)

were in the control group and 17 (13.7%) in the HEART group, resulting in 28 participants (11.3%) in the study sample reporting a family history of IHD.

The study also showed the compliance rate to prescribed medications: 64 (42%) in the control group and 53 (42.7%) in the HEART group. Overall, 78% of the total 150 participants with a history of previously prescribed medications were compliant.

The results in the table-4 above show that there are significant differences at 0.05 level between the control group and the heart group in the other medical histories ((congestive heart failure (CHF), Atrial fibrillation (AF), peripheral vascular disease (PVD), chronic kidney disease (CKD), the p-value of the test is 0.040. The results show that the percentage of the patients who have other medical histories for the Heart group (n= 18, 14.5%) is significantly higher than the percentage for the Control group (n= 8, 6.5%). And the patient compliance to prescribed medications was assessed, revealing that 60.8% of participants had a medication history, while 39.2% did not. Among those with a medication history, 117 participants (78%) were compliant with their prescribed medications, whereas 33 participants (22%) were non- compliant. Overall, the compliance rate was 78%.

On the other hand, the results in the table-4 above show that there are no significant differences at 0.05 level between the control group and the heart group in the remaining medical histories (Hypertension, Diabetes, Dyslipidemia, Coronary artery disease, Family history of IHD, Previous coronary artery bypass graft (CABG), Previous transient ischemic attack (TIA), Previous percutaneous coronary intervention (PCI)) and also if the patient is compliant to his prescribed medications, the p-values of the test for these medical histories and variables are higher than 0.05.

3.5 Comparisons between the control group and the heart group according to the Physical Examination

Table 5

*Physical Examination (N=247) ***

Variable	Category	Control (N=123)	Heart (N=124)	Total (247)	Test Statistics	P-value
General Appearance	Normal	122(99.2%)	122(98.4%)	244(98.8%)		
	Abnormal	1(0.8%)	2(1.6%)	3(1.2%)	0.329	1.000
Cardiovascular	Normal	123(100%)	123(99.2%)	246(99.6%)		
	Abnormal	0(0%)	1(0.8%)	1(0.4%)	0.996	1.000
Respiratory	Normal	116(94.3%)	118(95.2%)	234(94.7%)		
	Abnormal	7(5.7%)	6(4.8%)	13(5.3%)	0.090	0.764
Abdomen	Normal	122(99.2%)	121(97.6%)	243(98.4%)		
	Abnormal	1(0.8%)	3(2.4%)	4(1.6%)	1.000	0.622
Skin	Normal	123(100%)	123(99.2%)	246(99.6%)		
	Abnormal	0(0%)	1(0.8%)	1(0.4%)	0.996	1.000
Eyes, Ears, Nose & and Throat	Normal	123(100%)	124(100%)	247(100%)		
	Abnormal	0(0%)	0(0%)	0(0%)	0.000	1.000
Head, Neck & Thyroid	Normal	123(100%)	124(100%)	247(100%)		
	Abnormal	0(0%)	0(0%)	0(0%)	0.000	1.000
Extremities	Normal	120(97.6%)	121(97.6%)	241(97.6%)		
	Abnormal	3(2.4%)	3(2.4%)	6(2.4%)	0.000	1.000
Neurological	Normal	122(99.2%)	123(99.2%)	245(99.2%)		
	Abnormal	1(0.8%)	1(0.8%)	2(0.8%)	0.000	1.000
Electrocardiograph (ECG)	Normal	93(75.6%)	78(62.9%)	171(69.2%)		
	Abnormal	30(24.4%)	46(37.1%)	76(30.8%)	4.680*	0.031
If an abnormal Electrocardiograph (ECG), description	ST-segment depression	7(23.3%)	13(28.3%)	20(26.3%)		
	T-Wave inversion	7(23.3%)	12(26.1%)	19(25%)		
	Atrial fibrillation	2(6.7%)	5(10.9%)	7(9.2%)		
	Left Bundle Branch Block	8(26.7%)	5(10.9%)	13(17.1%)		
	Right Bundle Branch Block	1(3.3%)	1(2.2%)	2(2.6%)		
	Early repolarization	4(13.3%)	7(15.2%)	11(14.5%)		
	Premature ventricular contractions	1(3.3%)	1(2.2%)	2(2.6%)	4.828	0.732
	Sinus bradycardia	0(0%)	2(4.3%)	2(2.6%)		

* The chi-square test is significant at the level of significance 0.05. ** Some of the Chi-square p-values were computed based on the adjusted exact test for low-frequency categories.

The results in the table-5 above show there are significant differences at 0.05 level between the control group and the heart group only in the Electrocardiograph (ECG) Physical Examination; the p-value of the test is 0.031. The results show that the percentage of patients who have a normal Electrocardiograph (ECG) in the Heart group (n= 78, 62.9%) is significantly lower than the percentage for the Control group (n= 93, 75.6%). Hence, the percentage of patients who have abnormal Electrocardiograph (ECG) in the Heart group (n= 46, 37.1%) is significantly higher than the percentage for the Control group (n= 30, 24.4%) In the following figure-8, the normal physical examination findings are shown.

The results in table-5 above also show that the most common ECG abnormality was ST-segment depression, occurring in 23.3% of the traditional group and 28.3% of the HEART group, accounting for 26.3% of abnormal ECG findings in the study sample. This was followed by: T-wave inversion (25%), Atrial fibrillation (9.2%), Left Bundle Branch Block (LBBB) (17.1%), Right Bundle Branch Block (RBBB)' (2.6%), Non-specific early repolarization (14.5%), Premature ventricular contractions (2.6%) and Sinus bradycardia (2.6%). The following figure-9 shows the percentages of abnormal physical examination findings.

On the other hand, the results in the table-5 above show that there are no significant differences at 0.05 level between the control group and the heart group in the remaining Physical Examinations(General Appearance, Cardiovascular, Respiratory, Abdomen, Skin, (Eyes, Ears, Nose & Throat), Neurological, Extremities, (Head, Neck & Thyroid)), and in the descriptions of the abnormal Electrocardiograph (ECG), the p-values of the test for these Physical Examinations and variables are higher than 0.05.

Figure 8

Show the percentage of normal physical exam

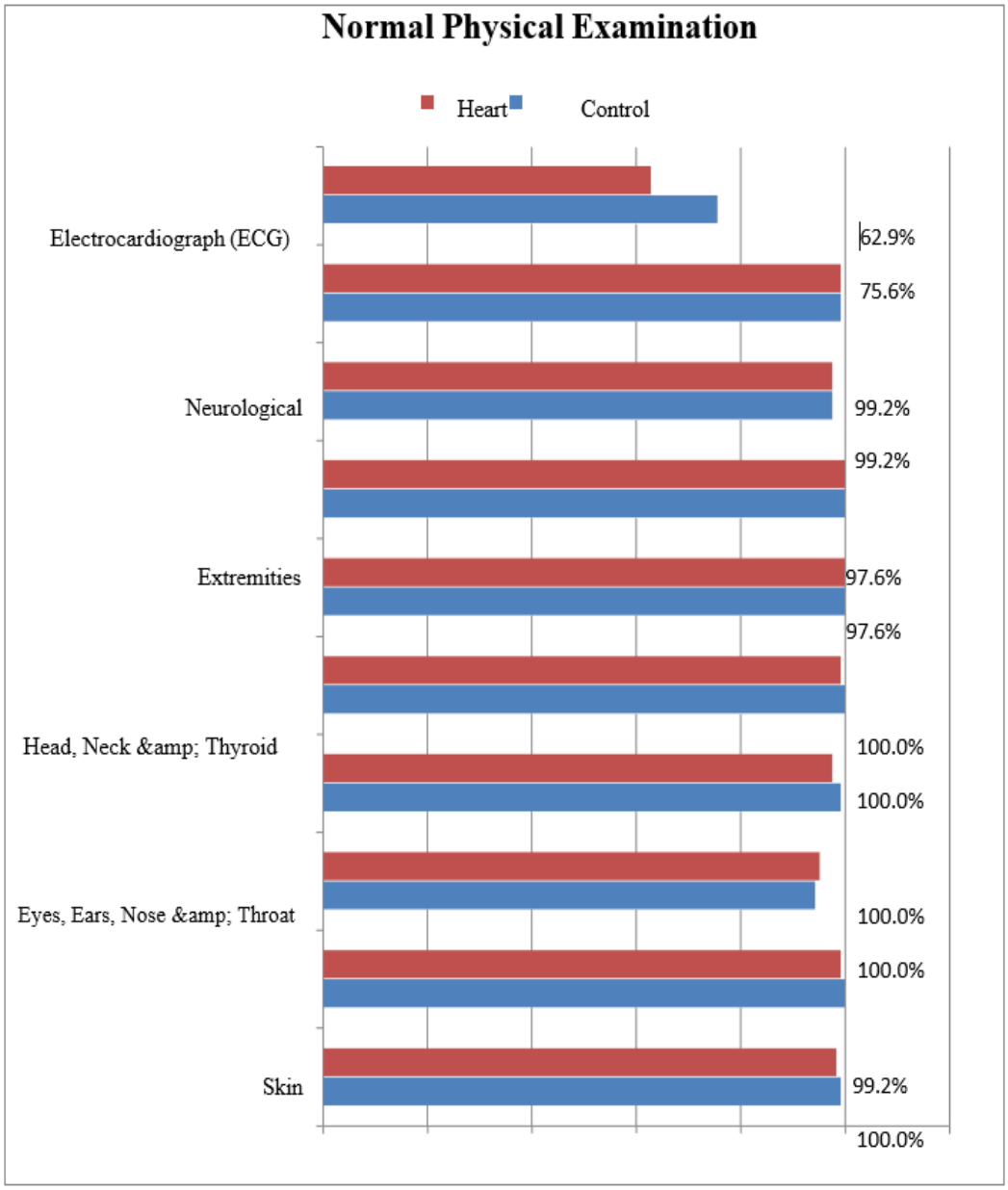
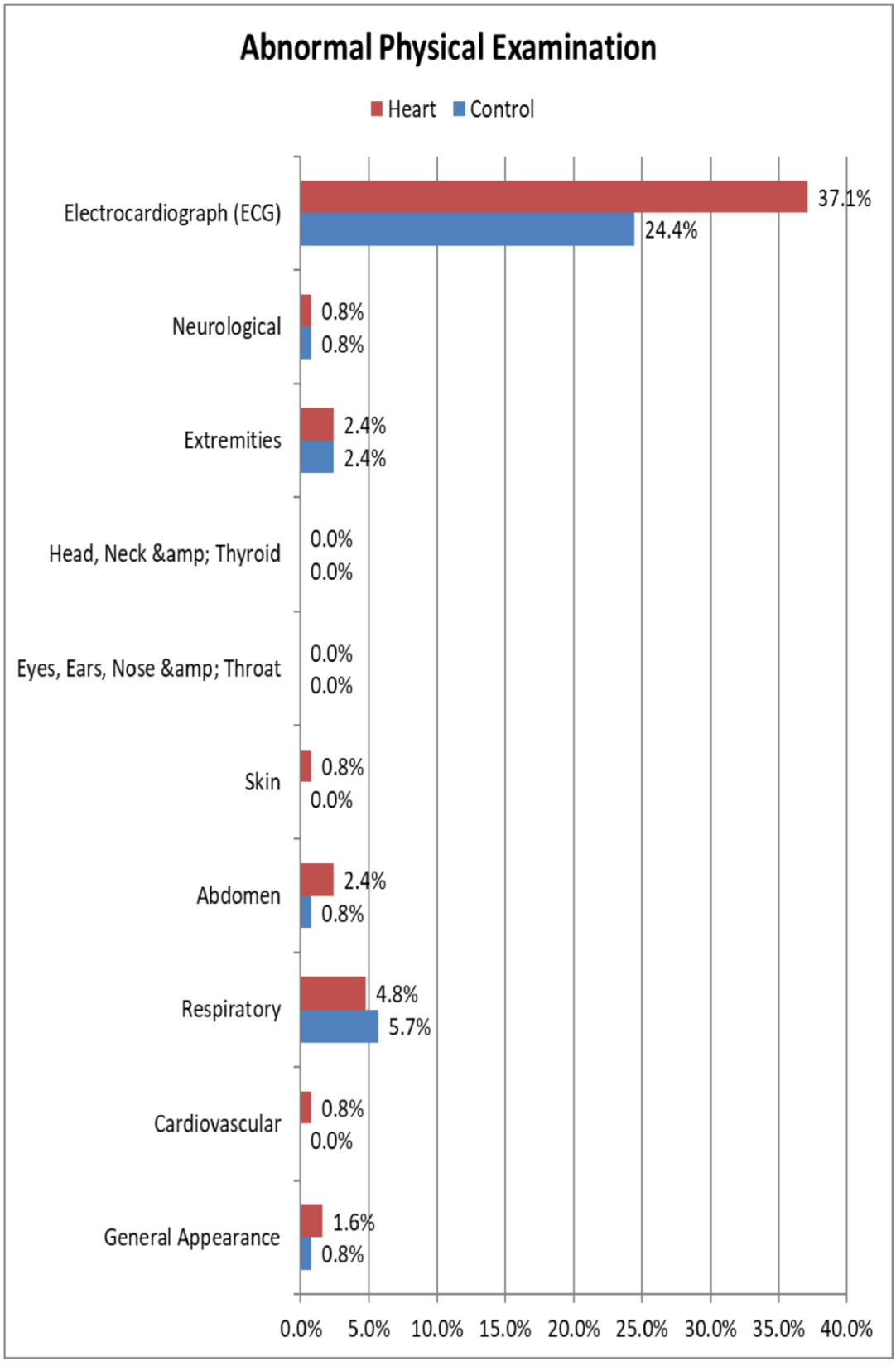


Figure 9

Show the percentage of abnormal physical exam



3.5.1 Comparisons between the control group and the heart group according to the Laboratory Findings

Table 6

*Laboratory Findings (N=247) **

Variable	Category	Group		Total (247)	Test Statistics	P-value
		Control (N=123)	Heart (N=124)			
Troponin initial		0.17±1.17**	0.05±0.24	0.11±0.84	1.115	0.267
Frequency of serial troponin		12(9.8%)	17(13.7%)	29(11.7%)	0.862	0.353
Troponin serial		0.04±0.06	0.11±0.39	0.08±0.3	-0.675	0.505
Creatinine		0.87±0.31	0.98±0.9	0.92±0.67	-1.288	0.200
Hemoglobin		15.25±12.77	13.59±2.25	14.41±9.17	1.412	0.159
White blood cells		9.29±5.38	8.46±2.58	8.87±4.21	1.420	0.157
CRP		1.05±1.01	0.58±0.38	0.8±0.76	1.238	0.248
Lipase		45±0	29.67±5.13	33.5±8.74	-----	-----
D-dimer		0±0	0.8±0	0.8±0	2.588	0.122

* Some of the T-test p-values were adjusted for non-homogeneous variances. ** Standard Deviation.

The results in the table-6 above show that there are no significant differences at 0.05 level between the control group and the heart group in all the Laboratory Findings, the p-values of the test for these Laboratory Findings are higher than 0.05.

The results in the table-6 above show that serial troponin was done for (N=12,9.8%) participant in the control group, and (N=17,13.7%) participant, in HEART group.

The mean of creatinine was 0.87 mg/dL in the control group, and 0.98 mg/dL in the HEART group. Hemoglobin mean was 15.25 g/dL in the control group and 13.59 g/dL in the HEART group.

Table 7

Troponin result interpretation (N=247) **

			Group						Test Statistics	P-value
	Troponin		Control		Heart		Total			
			N	%	N	%	N	%		
Gender	Male (N=98)	Normal	86	87.8%	76	80.9%	162	84.4%	1.735	0.188
		Positive	12	12.2%	18	19.1%	30	15.6%		
		Total	N=98		N=94		N=192			
	Female (N=)	Normal	20	80.0%	24	80.0%	44	80.0%	0.000	1.000
		Positive	5	20.0%	6	20.0%	11	20.0%		
		Total	N=25		N=30		N=55			

*High sensitivity quantitative troponin was used with reference range Male: <0.001-0.028 ng/ml, Female:<0.001-0.014 ng/ml.

The results in Table-7 show that 12 participants (12.2%) from the male population in the control group had positive troponin results (including both initial and serial troponin testing), while 18 participants (19.1%) in the HEART group had positive troponin results. On the other hand, 5 female participants (20%) from the female sample in the control group had positive troponin results, while 6 participants (20%) from the female sample in the HEART group also had positive troponin results (including both initial and serial troponin testing). Additionally, the results in Table-7 indicate that there were no significant differences at the 0.05 significance level between the control group and the HEART group in terms of troponin findings. The p- values for the statistical tests comparing troponin findings were greater than 0.05, indicating that the observed differences were not statistically significant.

3.5.2 Comparisons between the control group and the heart group according to the Intervention data.

Table 8

*Intervention data (N=247) ***

Variable	Category	Group Control (N=123)	Heart (N=124)	Total (247)	Test Statistic s	Pvalue
Clinical diagnosis (only for control group)	Muscular Chest Pain (MCP)	27(22%)	0(0%)	27(22%)	-----	-----
	NSTEMI	12(9.8%)	0(0%)	12(9.8%)		
	Stable Angina	46(37.4%)	0(0%)	46(37.4%)		
	Unstable Angina	23(18.7%)	0(0%)	23(18.7%)		
	Anxiety Disorders	8(6.5%)	0(0%)	8(6.5%)		
	GERD	7(5.7%)	0(0%)	7(5.7%)		
	No	112(91.1%)	104(83.9%)	216(87.4%)		
Any treatment given at the visit?	Paracetamol	4(3.3%)	8(6.5%)	12(4.9%)	5.793	0.277
	Aspirin and/or Plavix	3(2.4%)	9(7.3%)	12(4.9%)		
	Bisoprolol	1(0.8%)	1(0.8%)	2(0.8%)		
	Furosemide	2(1.6%)	2(1.6%)	4(1.6%)		
	Nitroglycerin	1(0.8%)	0(0%)	1(0.4%)		
Intervention	Discharge	76(61.8%)	68(54.8%)	144(58.3%)	6.509*	0.039
	Admission for observation	13(10.6%)	28(22.6%)	41(16.6%)		
	Early intervention	34(27.6%)	28(22.6%)	62(25.1%)		
Time lasting in emergency department:	Less than 1h	90(73.2%)	90(72.6%)	180(72.9%)	0.073	1.000
	2-6 hours	28(22.8%)	29(23.4%)	57(23.1%)		
	More than 6 hours	5(4.1%)	5(4%)	10(4%)		

* Chi-square test is significant at the level of significance 0.05. ** Some of the Chi-square p-values were computed based on the adjusted exact test for low frequency categories. GERD: Gastroesophageal reflux disease

The results in the table-8 above indicate the distribution of clinical diagnoses in the control group. The most common diagnosis was Stable Angina with 46 cases (37.4%), followed by Muscular Chest Pain (MCP) with 27 cases (22%). Other diagnoses included Unstable Angina (23 cases, 18.7%), NSTEMI (12 cases, 9.8%), anxiety disorders (8 cases, 6.5%), and GERD (7 cases, 5.7%).

The table-8 indicates the distribution of drug treatments administered to patients in the ED. The results show the majority 216 patients (87.4%) did not receive any drug treatment. Among those who received medications: the most commonly administered drugs Paracetamol was administered to 12 patients (4.9%), equally to Aspirin/Plavix

(antiplatelet therapy) was given to 12 patients (4.9%), Bisoprolol (a beta-blocker) was administered to 2 patients (0.8%), Furosemide (a diuretic) was given to 4 patients (1.6%), and Nitroglycerin (anti anginal) was administered to 1 patient (0.4%). This distribution highlights that most patients weren't required to undergo an immediate pharmacological intervention.

The results in the table-8 above also show significant differences at the 0.05 level between the Control group and the HEART group in terms of intervention (discharge, admission for observation, or early intervention), with a p-value of 0.039. Specifically, the percentage of patients admitted for observation in the HEART group (n=28, 22.6%) was significantly higher than in the Control group (n=13, 10.6%), while the percentage of patients discharged in the HEART group (n=68, 54.8%) was lower than the Control group (n=76, 61.8%). Additionally, the percentage of patients transferred to early intervention in the HEART group (n=28, 22.6%) was lower than in the Control group (n=34, 27.6%).

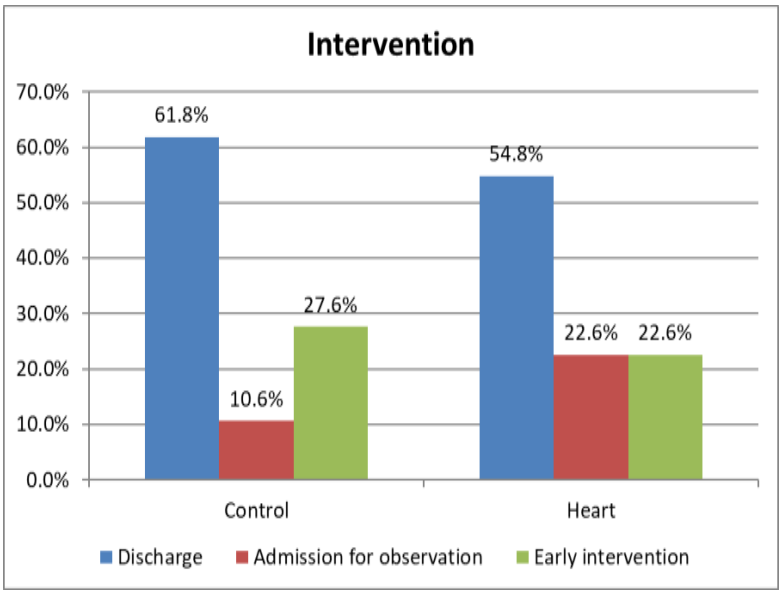
The significant differences in intervention outcomes highlight that patients in the HEART group were more likely to be admitted for observation, while those in the Control group were more likely to be discharged or transferred to early intervention, with fewer admissions for observation. The interventions that the patients received at the ED are clarified in Figure-10.

The table-8 also showed the results indicate that the distribution of time spent in the emergency department (ED) was classified into three categories: Less than 1h (Control 73.2%, 72.6% HEART), 2-6 hours (Control 22.8%, 23.4% HEART), and more than 6 hours (Control 4.1%, 4% HEART) the results were similar between the two groups, with no statistically significant differences observed.

On the other hand, the results in the table-8 above show that there are no significant differences at 0.05 level between the control group and the heart group in the treatments given at the visit, or in the time lasting in emergency department, the p-values of the test for these intervention variables are higher than 0.05.

Figure 10

Show the distribution of interventions done for the HEART group and control group



3.5.3 Comparisons between the three intervention categories in the HEART group

Table 9

Intervention data for Heart group (N=124)

Variable	Category	Heart Group (N=124)	Test Statistics	P-value
Intervention	Discharge (Low Score)	68(54.8%)	25.806*	0.000
	Admission for observation (Intermediate Score)	28(22.6%)		
	Early intervention (High Score)	28(22.6%)		

* The chi-square test is significant at the level of significance 0.05.

The results in the table-9 above show that there are significant differences at 0.05 level between the three intervention categories in the heart group, the p-value of the test is 0.000, and the results show that the percentage of the patients with low heart scores in the Heart group (n= 68, 54.8%) is significantly higher than the percentages of the patients with intermediate or high heart scores in the Heart group (n= 28, 22.6%) for both of them.

Figure 11 in Appendix E following shows the distribution levels of the HEART score.

3.5.4 Comparisons between the control group and the heart group according to the Follow- up data

Table 10

*Follow-up data (N=247) ***

Variable	Category	Group		Total (247)	Test Statistics	P-value
		Control (N=123)	Heart (N=124)			
Does the patient have a reoccurrence visit during the next six weeks? /(MACE occurrence)	Yes	10(8.1%)	3(2.4%)	13(5.3%)	4.039*	0.044
	No	113(91.9%)	121(97.6%)	234(94.7%)		
Major Adverse Cardiac Events (MACE)	AMI	6(4.9%)	2(1.6%)	8(3.2%)	2.101	0.172
	PCI	4(3.3%)	2(1.6%)	6(2.4%)	0.700	0.446
	CABG	1(0.8%)	0(0%)	1(0.4%)	1.012	0.498
	Cardiopulmonary Resuscitation	0(0%)	0(0%)	0(0%)	0.000	1.000
	Death	1(0.8%)	0(0%)	1(0.4%)	1.012	0.498
	Other***	1(0.8%)	1(0.8%)	2(0.8%)	0.000	1.000

* Chi-square test is significant at the level of significance 0.05. ** Some of the Chi-square p-values were computed based on the adjusted exact test for low-frequency categories. ***Other: Acute decompensated heart failure (ADHF) due to ST-elevation Myocardial Infarction Note: the same patient could be counted for multiple MACE items

The results in the table-10 indicate significant differences at the 0.05 level between the control group and the HEART group, specifically in the incidence of recurrence visits within the next six weeks, with a p-value of 0.044. The percentage of patients who experienced any recurrence visit (defined as the incidence of Major Adverse Cardiac Events, or MACE) within six weeks was significantly lower in the HEART group (n=3, 2.4%) compared to the control group (n=10, 8.1%). This suggests that patients in the HEART group had a lower occurrence of MACE within six weeks than those in the control group, as clarified in figure-12. The MACE occurrence in the HEART group was as follows: Low score: 1 participant (1.5%), Intermediate score: 2 participants (7%). On the other hand, the results in the table-10 above show that there are no significant differences at 0.05 level between the control group and the heart group in the Major Adverse Cardiac Events (MACE), the p-values of the test for these MACEs are higher than 0.05.

Also, the table-10 shows that the occurrence of Major Adverse Cardiac Events (MACE) was generally lower in the HEART group compared to the control group.in particular, the HEART group demonstrates lower rates of Acute Myocardial Infarction (AMI) (1.6% vs. 4.9%), Percutaneous Coronary Intervention (PCI) (1.6% vs. 3.3%), and Coronary Artery Bypass Grafting (CABG) (0% vs. 0.8%). Additionally, there were no recorded deaths in the HEART group, whereas the control group had a 0.8% mortality rate. The incidence of Acute Decompensated Heart Failure (ADHF) due to non-ST-elevation myocardial Infarction (NSTEMI) was the same in both groups (0.8%).

Chapter Four

Discussions and Conclusions

4.1 Discussion

This study, conducted at an emergency department (ED) in a central North West Bank governmental hospital in Palestine, aimed to evaluate the effectiveness of the HEART score as a risk stratification tool for patients presenting with chest pain, compared to traditional clinical diagnostic methods. The study aimed to determine whether the HEART score may improve patient outcomes by increasing risk stratification accuracy, estimating MACE rates, and maximizing resource usage.

The study population consisted of 247 patients, who were separated into two groups: a control group (n=123) managed using traditional clinical diagnosis and an experimental group (n=124) evaluated, and managed according to the HEART score results interpretations. The main finding was the significantly lower incidence of recurrence visits within six weeks, indicative of MACE, in the HEART score group (2.4%) compared to the control group (8.1%) (p=0.044). This result emphasizes the predictive superiority of the HEART score in spotting patients at greater risk of negative outcomes, hence allowing for more precise and individualized management plans. The HEART score, for example, helped to ensure more suitable observation admissions (22.6% vs 10.6% in the control group), hence possibly maximizing resource allocation in the limited Palestinian healthcare system.

According to the Palestinian MOH 2022 statistical report, cardiovascular disease (CVD) was the most common mortality cause in Palestine, accounting for 22.2% of all deaths. (MOH, 2022). The results of the study represent major consequences for emergency care there.

The study's limitations, including its single-center design, and possible future directions, such as a multi-center validation study, are discussed. We also explore the findings' implications for clinical practice in Palestine, such as the potential for standardized chest pain evaluation protocols, and contextualize these within the larger body of works on risk stratification in emergency medicine.

The problem statement concerns mortality and morbidity, particularly sudden cardiac events following discharge. The HEART score's demonstrated ability to reduce the recurrence of Major Adverse Cardiac Events (MACE) suggests its potential to address the high burden of CVD.

By accurately identifying low-risk patients (0-3 points) suitable for safe discharge, the HEART score could help alleviate emergency department (ED) overcrowding, a critical issue in resource-constrained healthcare settings. Additionally, the capacity of the HEART score to identify the intermediate risk group and high-risk group who require observation or early intervention, as to maximize patient safety and increase the quality of care.

On the other hand, there is a significant difference in the intervention decisions between the two research groups (p=0.039), ensuring the HEART score's capability to provide standardized clinical care. So, it minimizes the inconsistency in the traditional clinical diagnosis approaches. The research revealed the possible clinical diagnoses found in the control group ranged from Stable Angina (37.4%), MCP (22%), Unstable Angina (18.7%), NSTEMI (9.8%), anxiety disorders (6.5%), and GERD (5.7%), showing the subjectivity nature of the clinical diagnosis, which could miss important risks.

Contrary to the HEART score's objective criteria, which incorporate with patient's past medical history, patient age, risk factors, and troponin level, providing a well-structured and evidence-based practice framework for risk assessment. So this structured approach provides patient-centered, consistent diagnosis across healthcare providers, a benefit supported by (Soares et al., 2021), who emphasized the HEART score's effectiveness in reducing disparities in clinical care.

4.2 Summary of main findings

The study revealed the potential of the HEART score to enhance chest pain patients' outcomes in the ED settings, through optimizing resource employment, and improving chest pain risk stratification. By providing a consistent and beneficial tool in risk assessment, the HEART score exposed the limitations of the traditional chest pain clinical diagnosis, mainly in resource-limited settings. The study findings ensure that the evidence-based practice was used (HEART score) in assessing chest pain patients decreases the occurrence of MACE, thereby improving overall patient outcomes.

4.3 HEART Score Performance

The HEART score confirmed prominent efficacy in chest pain patients' stratification, categorizing the patient into three subgroups: low-risk, intermediate-risk, and high-risk groups. So directly influences the patients' clinical judgement and disposition.

The demographic profile of our study population was reflective of patients who complain of chest pain; the mean age of those patients was 45 years, and the majority of the participants were male (77.7%). 89% of these patients reported that their chest pain persisted for more than 20 minutes, so reflecting a higher risk of acute coronary syndrome.

A subsequent validation study, such as those by (J. M. Poldervaart et al., 2017), they confirmed that the HEART score has a higher performance in chest pain risk stratification compared to other risk assessment tools, such as GRACE and TIMI scores, in identifying low-risk patients while maintaining safety. Correspondingly, (Aung & Roongsritong, 2022) reported that the HEART score was superior to TIMI and GRACE in predicting short-term MACE.

Our study found that the HEART score established greater prognostic performance in MACE compared to traditional protocols in Palestinian emergency departments. This aligns with findings from prior research. (Six et al., 2008). The developers of the HEART score verified its ability to stratify patients into low-risk (0-3 points, 2.5% MACE risk), intermediate-risk (4- 6 points, 20.3% MACE risk), and high-risk (≥7 points, 72.7% MACE risk) categories, as validated by (Six et al., 2008) . Our results showed similar risk stratification, with 1.5% low- risk and 7% intermediate-risk.

In the Low-risk (0–3 points) patients in the HEART group were more likely to be discharged early, with only a 1.5% probability of experiencing MACE. This supports the safety of early discharge for this group and aligns with findings from previous studies such as (Backus et al., 2013), and (Six et al., 2008), which have validated the HEART score's reliability as a risk assessment tool for patients presenting with chest pain.

The intermediate risk group (4-6 points) had a risk of MACE occurrence 7%, and the high-risk group (≥7 points), was kept for observation, or transferred for early intervention.

This stratification provides more resource optimization in emergency departments, ensuring that patients' safety is maintained, and they receive appropriate treatment needed to their risk level. These findings have significant practical implications for ED, particularly in resource- constrained settings like Palestine.

The HEART score also increased effective use of available resources, as our study results, 22.6% of participants in the HEART group were admitted for observation, compared to control group 10.6%, reporting that the HEART score identified the patients who need closer observation. This intervention ensured the risky patients received the appropriate care, so the HEART score can decrease unnecessary admissions. Additionally, the percentage of patients transferred to early intervention in the HEART group was 22.6%, fewer than the Control group, 27.6%. However, the HEART score lowers financial costs with low-risk populations by decreasing the need for additional diagnostic tests, potentially leading to cost savings and a more valuable use of healthcare resources.

4.4 HEART Score's Impact on Risk Stratification

There are 5 components offered by the HEART score: patient History, Electrocardiogram (ECG) findings, Age, Risk factors, and Troponin values. These clinical parameters are used to categorize chest pain patients into the three classification groups: low-risk, moderate-risk, and high-risk.

In our study, the HEART score exhibited a notable effectiveness in patients' risk stratification. The low-risk scores (0-3) were associated with a low rate of MACE (1.5%), supporting the safety of early discharge. This finding aligns with existing evidence, such as (Laureano- Phillips et al., 2019), which has consistently shown that low HEART scores can reliably guide safe discharge decisions.

On the other hand, patients classified as moderate-risk (4-6) and high-risk (≥7) were appropriately directed toward admission for observation or early intervention, respectively. This highlights the HEART score's ability to accurately identify patients requiring closer monitoring or immediate treatment, guiding for reducing the likelihood of adverse outcomes.

Furthermore, this risk stratification approach minimizes unnecessary hospital admissions and optimizes the allocation of limited healthcare resources, a critical consideration in

settings like Palestine, where healthcare infrastructure is often strained by high patient volumes and resource constraints.

The implementation of the HEART score significantly influenced ‘clinical decision-making in our ED. Although in our study the overall discharge rate was slightly lower in the HEART score group (54.8% vs 61.8% in the control group), the distribution of interventions more closely aligned with objective risk stratification. That suggestion implies the HEART score might be promoting a more suitable distribution of treatment, therefore lowering the under- triage of high-risk patients as well as the over-triage of low-risk patients.

The higher rate of observation admissions in the HEART score group reflects a more judicious approach to intermediate-risk patients. This cautious strategy may be particularly valuable in our resource-limited setting, where reliable outpatient follow-up is often challenging. By optimizing risk assessment, the HEART score appears to enhance clinical decision-making while balancing efficiency and patient safety.

4.5 Length of Emergency Department Stay

In our study, the patient's length of ED stay was: Less than 1h (Control 73.2%, 72.6% HEART), 2-6 hours (Control 22.8%, 23.4% HEART), and more than 6 hours (Control 4.1%, 4% HEART) the results were similar between the two groups, with no statistical significant differences observed. These comparisons between the HEART and control groups are inconsistent with previous studies, such as (Melki & Jernberg, 2013), which suggested that the HEART score could streamline patient management and reduce ED overcrowding. This finding may be explained by systemic factors specific to our setting, such as delays in getting troponin results or organizing admissions, which were not alleviated by the HEART score alone. The failure to reduce ED length of stay reflects the necessity of a systems-based framework for deploying new risk stratification tools.

We recommend future studies to examine specific bottlenecks in patient flow in Palestinian EDs, and this could be studied on correlation with the implementations of the HEART score.

4.6 Pharmacological interventions and laboratory

In our result showed, there were no statistically significant differences in pharmacological interventions, between the two groups, this finding similarly corresponds with (Priyanka T. Bhattacharya et al., 2019), they found the primary outcome of the HEART score will be in risk stratification rather than influencing the acute treatment protocols. These findings emphasize the significance of contextual factors in influencing the implementation and outcomes of risk stratification tools such as the HEART score.

Also, the laboratory findings troponin levels, creatinine, and hemoglobin results, showed no significant differences between the two groups ($p>0.05$). So, the consistency we found in the laboratory parameters supports the comparability of the patients' characteristics between the two groups, with no statistically significant differences in the initial patient presentation or clinical status. Leads to confirm the observed variance in the clinical outcomes are likely due to the risk stratification method, specifically the use of the HEART score.

These findings ensure to maintenance of consistency in the immediate clinical management of chest pain patients, and enhance the decision-making process.

4.7 ECG and Troponin Findings Electrocardiogram (ECG)

In our study, the electrocardiogram (ECG) has an essential role in the HEART score's ability to classify the chest pain patients who presented with chest pain to the ED. The ECG is one of the five components of the HEART score it's providing a sensitive indicator for the possibility of ACS, also the ECG guiding clinical decision making.

The ECG abnormalities were classified and scored as follows: 0 points for a normal ECG, 1 point for non-specific repolarization disturbances or left bundle branch block (LBBB), and 2 points for significant ST-segment depression. Allowed with this classification for the researcher to identify the patient, mainly those with significant ST-segment changes who are at high risk to have MACE, and they are categorized to intermediate or high risk with the HEART score.

Our findings revealed that 37.1% of patients in the HEART group had abnormal ECG findings, compared to 24.4% in the control group. The observed difference the ECG comparison between the two groups illustrates the HEART score's ability to detect

patients with more serious cardiac conditions, such as ischemia or infarction, who are at higher risk of adverse outcomes. The most common observed ECG abnormality finding was ST-segment depression, occurring in 26.3% of abnormal ECGs, followed by T-wave inversion (25%) and left bundle branch block (LBBB) (17.1%). Our findings align with previous studies, such as those by (Six et al., 2008)and (J. M. Poldervaart et al., 2017) , they have demonstrated the strong predictive value of ECG changes for short-term MACE in chest pain patients.

The ECG interpretations were challenging, access to expert ECG interpreters may be limited in resource-limited settings, particularly in busy ED where physicians must make rapid decisions. So, the standardized training of healthcare providers in ECG interpretations is crucial, and the potential role of a reliable automated ECG analyzer to minimize the variations in the ECG interpretations. Additionally, the patient's past medical history must be combined with ECG and troponin levels, to avoid the ECG misclassification. For example, patients with non-specific repolarization disturbances or pre-existing ECG abnormalities (e.g., LBBB) may be incorrectly classified as high-risk without considering other factors.

In conclusion, in our study findings, the ECG interpretations were a key element in stratifying the patients to identify high-risk patients who require early intervention, and low-risk patients who could be discharged early. The higher observation of abnormal ECG findings in the HEART group confirms the ability to detect patients with significant cardiac conditions.

We recommend for future training to improve ECG interpretation skills in ER healthcare providers and exploring the use of automated tools to enhance the accuracy and consistency of ECG-based risk assessment.

4.7.1 Troponin level

Troponin level was a key factor of the HEART score in our study, suggestively improving the accurate risk stratification of patients complaining of chest pain in the ED. Troponin, a biomarker of myocardial injury, is a well-established predictor of ACS, and its inclusion in the HEART score aligns with international chest pain evaluation guidelines. In our study findings, the initial troponin level was scored based on its elevation relative to the upper reference limit: 0 points for normal levels, 1 point for levels 1-2 times the limit, and 2

points for levels ≥3 times the upper reference limit. Particularly for those with notably raised troponin levels, who were more often categorized as intermediate- or high-risk, this scoring system eases the identification of patients at higher risk of MACE.

Conversely, patients with normal initial troponin levels were more likely to be categorized as low-risk and safely discharged, supporting the HEART score's utility in reducing unnecessary admissions. That lines up with previous studies, such as those by (Six et al., 2008) and (J. M. Poldervaart et al., 2017) , which have consistently shown that troponin is a strong predictor of short-term MACE in chest pain patients. However, it is crucial to recognize that early that the initial troponin levels alone cannot conclusively exclude ACS. Troponin level may not rise immediately since the onset of chest pain, particularly in patients with very recent onset of symptoms (<3 hours). To address this limitation, serial troponin measurements after 6 hours were performed in 11.7% of our study population, following ESC guidelines (Hamm et al., 2011), confirming that patients with ongoing myocardial injury were not missed.

Although troponin initial result is clinically significant, obtaining the troponin constraint was confronted in our study. The problem we met with the troponin test was the timing to get the result, the delay in obtaining the result may impair the accuracy of risk stratification used with the HAERT score. This challenge leads to recommending support for the laboratory structure and timing for results in Palestinian EDs.

Moreover, there are many medical causes of elevated troponin levels other than ACS, such as heart failure, pulmonary embolism, or chronic kidney disease. Therefore, obtaining combined troponin results with ECG findings and clinical history is essential to prevent misclassification.

In conclusion, initial troponin level played a crucial role in the HEART score's ability to categorize patients and guide clinical decision-making. Their inclusion enhanced the identification of high-risk patients requiring urgent intervention and low-risk candidates for safe discharge, improving patient outcomes and optimizing resource utilization. Future studies should explore the implementation of strategies to minimize testing delays, further enhancing the HEART score's effectiveness in resource-limited settings.

4.7.2 Impact on Clinical Decisions and Resource Use

The study results showed a statistically significant variation between the HEART group, and the control group in the interventional outcomes (p=0.039). The HEART score group had a higher rate of admission for observation (22.6% vs. 10.6%) and a lower discharge rate (54.8% vs. 61.8%) compared to the control group. According to these findings, the HEART group suggests to providing more targeted management, especially for the patients classified as intermediate-risk, potentially minimizing the risk of discharging patients who might later experience an occurrence of MACE.

Starting with the HEART score group, the patients' intervention is assigned accordingly to the risk stratification category, among patients with low-risk scores (0-3), 54.8% were discharged, while 22.6% of those with intermediate-risk scores (4-6) were admitted for observation, and 22.6% of patients with high-risk scores (≥7) received early intervention (p=0.000).

The HEART score empowers the health care providers to adjust the interventions according to individual patient risk assessment. The configuration between risk categories and the clinical decisions highlights the HEART score's effectiveness in guiding evidence-based management strategies. The demonstrated HEART score's ability to improve patient care and reduce cardiac adverse outcomes emphasizes its utility as a clinical practice tool for optimizing clinical decision-making in ED settings. However, our finding according to the admission rate observed in the HEART group was contrasts with some studies suggesting that the HEART score reduces unnecessary admissions. For example, (B. R. Allen et al., 2018) reported a 21% relative increase in the discharge of low-risk patients following the implementation of the HEART score, without an increase in MACE rates. This discrepancy may be attributed to contextual differences, particularly in resource- limited settings, where healthcare providers may adopt a more conservative approach due to limited outpatient follow-up capabilities.

According to the discharge rate findings, our results are inconsistent with (Liu et al., 2021) who observed a higher ED discharge rate in the coronary risk score group versus the control group (70.1% vs. 64.6%) with the use of coronary risk scores, indicating that ED physicians may gain greater confidence in discharging low-risk patients when supported by objective risk

stratification tools. According to the discharge rate within the HEART group (54.8% versus 61.8%), it was lower than the control group, which may be recognized to careful interpretation of intermediate-risk scores (4-6 points), preferring the observation over immediate discharge to alleviate potential adverse outcomes.

These findings ensure important issues for the application of the HEART score in the Palestinian ED. A higher admission rate indicates that more resources could be allocated to observation units. However, if it lowers missed MACE cases, this strategy could be cost- effective; this is a hypothesis that deserves more research. Although the admission rate is higher, the HEART score's more effective consistency and accuracy have notable implications for ED, especially in resource-limited settings.

The MACE rate could potentially decrease by optimizing the resource allocation by providing the patient who requires admission, to ensure the high-risk patients receive their suitable treatment. And the others who require early intervention or close monitoring, they provided their appropriate treatment, the standardized approach could enhance overall patient outcomes.

There a further workup may continue for the intermediate risk group to optimize the available resources, and maintain patients' safety, without worsening health care system constraints. One potential solution is the integration of structured outpatient follow-up protocols, as suggested by(Six et al., 2008), who questioned the utility of additional diagnostic procedures for intermediate-risk patients, such as exercise testing and advanced ischemia detection.

Future research may investigate the decision-making processes of Palestinian emergency physicians on the application of the HEART score, including their interpretation of intermediate-risk scores. A cost-benefit analysis comparing the increased observation rate with potential decreased in MACE could provide significant insights for resource allocation in this setting.

4.7.3 Impact on Major Adverse Cardiac Events (MACE)

Reducing the frequency of MACE is one of the main goals in the evaluation and treatment of patients presenting with chest pain. Overall MACE incidence, which includes AMI, PCI, and death. The lower MACE rate was observed in our study, in the HEART group (2.4%) compared to the control group (8.1%). These results are consistent with (Poldervaart et al., 2016) RCT they founded the 6-week occurrence of MACE was (18.9%) among HEART group and (22.3%) in the control group. Also aligns with (Laureano-Phillips et al., 2019). The HEART score has a well-established, strong negative predictive value for MACE, and the data revealed a safer risk profile for patients released under the HEART protocol.

The HEART score's predictive validity and capability to accurately stratify patients according to their risk of adverse outcomes were highlighted by the findings that most of the MACE events in the HEART group happened among patients who were categorized as moderate- or high-risk.

The occurrence of several MACE cases among patients discharged based on traditional clinical diagnosis underlines the possibility for misclassification when depending on exclusively subjective physician assessment. Markedly, the occurrence of several MACE cases was 8.1% among patients discharged based on traditional clinical diagnosis. This accurate prediction tool can enhance patients' outcomes, by offering a more accurate risk assessment tool and adapted management strategies.

The HEART score provides a superior efficacy compared to traditional clinical diagnosis in predicting MACE and optimizing patient management. The lower MACE with the HEART group recorded a P-value of 0.044. This significantly highlights the HEART score's utility in facilitating precise risk evaluation and enhancing patient outcomes.

Further analysis revealed that the HEART score group showed lower rates of specific MACE components, including mortality rate (0% vs. 0.8%), AMI (1.6% vs. 4.9%), and PCI (1.6% vs. 3.3%). However, these differences didn't reach statistical significance, likely due to the comparatively low event rates in the study population. Despite this limitation, the trend toward reduced adverse outcomes in the HEART score group aligns with the broader evidence supporting its utility in risk stratification and clinical decision-making.

4.7.4 Mortality Rate

In our study, no death was reported in the HEART group, but the control group had a mortality rate of (0.8%). these findings are consistent with (Poldervaart et al., 2016), they found that the mortality rate was (0.3%) in the HEART group, compared to (0.5%) in the traditional care group. The capability of HEART score to categorize patients into low-, intermediate-, and

high-risk categories have a notable effect in reducing mortality and morbidity associated with CVD.

The high-risk group (≥7 points) who were identified with HEART score, require early aggressive intervention, and should receive timely access life-saving treatments, such as PCI or CABG.

In the context of Palestine, CVD was the leading cause of death, accounting for (22.2%) of all fatalities in 2022 (MOH, 2023), the widespread adoption of the HEART score could contribute to a notable reduction in CVD-related mortality and morbidity

4.7.5 On the potential impact on healthcare provider confidence and patient satisfaction

Although we were not directly assessed in this study, employing an objective risk stratification tool such as the HEART score could improve patient satisfaction and the confidence of healthcare providers. A cohort done in 2022 by (Vaskas et al., 2024) evaluating the HEART score, the study established improved 30-day MACE rates, reinforcing healthcare providers' confidence. The HEART score offers a consistent framework for decision-making.

From a patient point of view. In 2016, a study by (Poldervaart et al., 2016) The HEART score was associated with higher patient acceptance, confidence, and general satisfaction.

A more methodical approach to risk assessment might result in more obvious communication about their condition and management strategy, therefore enhancing their whole emergency department experience. Future research should measure patients' satisfaction after implementing the HEART score.

4.7.6 On the implications for emergency medicine education and training

According to employing the HEART score in the Palestinian ED setting, we recommend conducting training sessions in continuing education and training programs in risk stratification tools like the HEART score. Leads to standardized management for chest pain patients across different providers or settings.

This could be particularly useful for less experienced clinicians or those working in more remote or resource-limited settings. Future research should explore the most effective methods for training healthcare providers for the application of the HEART score and similar risk stratification tools.

4.7.7 Validation in Different Populations

The studies were done to validate the HEART score previously in high-income countries, such as the Netherlands and the United States, which confirmed for reliability and generalizability as a chest pain risk stratification tool for ED patients. The HEART score also shows outperformance over other risk assessment tools, such as the TIMI and GRACE scores, in predicting short-term MACE. (Poldervaart et al., 2017; Six et al., 2008). Similarly, research in middle- and low-income countries, including Taiwan and Brazil, has established the HEART score's efficiency in resource-constrained settings, where access to advanced diagnostic tools and follow-up care may be limited (Liu et al., 2021; Soares et al., 2021).

According to previously shown studies, the HEART score has an adaptability in various settings, healthcare systems, and patient demographics, making it an adaptable tool for global use.

Our study contributes to this cumulative body of evidence by validating the HEART score in the Palestinian context, 'where cardiovascular disease is the leading cause of death and emergency departments face significant resource constraints. Our findings align with other international studies, indicating its capability to stratify chest pain patients. These further supports 'the HEART score's potential as a standardized tool for assessing chest pain in diverse populations, including those in low-resource settings as Palestine.

4.7.8 HEART Score Performance and Hypotheses

The study's hypotheses—(H1) the HEART score performs higher than traditional clinical protocols and (H2) the HEART score predicts Major Adverse Cardiac Events (MACE) more effectively were partially supported by the findings.

Our study results revealed a significant reduction in the MACE occurrence rate in the HEART group (p=0.044), strongly supporting H2, suggesting the HEART score has superior prediction for adverse cardiac outcomes. This finding is consistent with the meta-analysis conducted by (Laureano-Phillips et al., 2019), which reported high sensitivity and negative predictive value for the HEART score in predicting short-term MACE. Supporting this conclusion by the lower

occurrence of AMI and PCI in the HEART. Although the small sample sizes limited the statistical power to detect significant differences in individual MACE components.

The established ability of the HEART score to stratify patients effectively into low, intermediate, and high-risk categories (p=0.000 within the HEART group) and its influence on intervention decisions (p=0.039 between groups). Confirming HEART score outperforms the traditional clinical diagnosis, demonstrating H1. However, the lack of ED length of stay or treatment administration impact is limited by disposition decisions and prognostic accuracy rather than operational efficiency.

The HEART score is limited in affecting immediate care or reorganization workflows within the ED. The finding emphasized by (van Dongen et al., 2020), who suggested its potential utility in pre-hospital settings.

The findings partially support H1 hypothesis, the superior predictive accuracy for MACE, and its efficiency in risk stratification and disposition decisions. However, its limited impact on operational metrics such as ED length of stay and treatment administration suggests that its benefits are primarily confined to enhancing prognostic accuracy rather than improving broader aspects of ED efficiency. These results underscore the HEART score's value as a risk assessment tool while highlighting the need for complementary strategies to address operational challenges in emergency care settings.

4.7.9 Strengths of the HEART Score in the Palestinian Context

The gap in standardization of risk assessment for patients complaining of chest pain is crucial, the study represents a pioneering effort in Palestine as mentioned in the study's significance section.

The HEART score's free accessibility, simplicity requiring no computer-based calculations and depend on already available clinical data such as patient history ECG findings, and troponin levels—makes it highly feasible to implement in a resource-limited ED. It's single- figure summary, as highlighted by.(Six et al., 2008). The HEART score can facilitate clear and efficient communication among healthcare providers, a feature particularly valuable in busy EDs with varying levels of staff expertise.

The notable reduction in the occurrence of Major Adverse Cardiac Events (MACE) in the HEART group highlights its capacity to enhance clinical outcomes in a population with a high burden of CVD. Globally, CVD was responsible for (32.9%) of all deaths in 2019 (Safiri et al., 2022), and in Palestine, ischemic heart disease was the leading cause of death in 2022 (MOH, 2022). The HEART score's capacity to identify high-risk patients requiring early intervention (22.6%) offers potential promise for decreasing CVD-related death, while its capacity to safely discharge low-risk patients (54.8%) could improve the use of limited healthcare resources. This dual benefit aligns closely with the study's secondary objective of enhancing both patient outcomes and resource efficiency.

The HEART score simplicity, practicality, and effectiveness in risk stratification make the HEART score an especially suitable tool for use in the Palestinian healthcare system. Its ability to reduce MACE rates, improve patient outcomes, and maximize resource allocation addresses major issues in a setting with a high load of CVD and limited healthcare resources. These advantages highlight the relevance of the HEART score as a practical and powerful tool for improving emergency care delivery in Palestine and similar resource-limited environments.

4.7.10 Strengths of the Study

This study is the first in Palestine to evaluate the HEART score, addressing a critical gap in standardized chest pain assessment, a need emphasized in existing literature. By focusing on hospitals in the Northwest Bank, the research responds to local healthcare challenges, including the high burden of cardiovascular disease (CVD) and emergency

department (ED) overcrowding, both of which underscore the urgency for reliable risk stratification tools.

4.7.11 Limitations of the Study

Limitations Our study results provide important and valuable perceptions to acknowledge its limitation

Single-Center Study: Our study was conducted in a single central hospital ED, in north west bank, may limit the ability to generalize the findings to other settings. We recommend a multi-center study, in variable populations and settings to confirm HEART score effectiveness.

4.7.12 Implementation Considerations:

The successful implementation of the HEART score and associated follow-up protocols would require careful consideration of existing healthcare infrastructure and resources. According to MOH (2023)**,** Palestinian hospitals currently operate at 89.4% capacity, with an average of 1.34 beds per 1,000 population. Integrating the HEART score into this context would necessitate targeted training programs for emergency department staff and, potentially, the development of new outpatient follow-up systems. Such initiatives would require support from healthcare policymakers and administrators to ensure successful adoption and long-term sustainability.

4.7.13 Recommendations for Future Research

1. Conduct multicenter trials across different regions and hospital types to enhance generalizability.
2. Compare the HEART score with other tools like TIMI and GRACE in Palestinian populations.
3. Evaluate long-term outcomes (e.g., 1-year follow-up) to assess sustained benefits.
4. Cost-benefit analysis of implementing the HEART score in ED settings.
5. Educational interventions for health care professionals to improve HEART score application and assess the impact of tutoring on outcomes.
6. Patient-centered outcomes to understand satisfaction, anxiety levels, and understanding of risk following HEART score-based triage.
7. Studying the barriers and facilitators to implementing the HEART score in Palestinian ED.

8. Integrating the HEART score into electronic health records or developing a mobile app for easier implementation.

4.8 Conclusion

The study demonstrates that the HEART score provides significant advantages over traditional clinical diagnosis in the treatment and interventions with chest pain patients in emergency departments (EDs) in the Northwest Bank of Palestine. The primary aim of the study is to evaluate the performance of the HEART score and compare its performance with current protocol on patients who present complaining of chest pain to the ED in North West- Bank hospitals. Study design: retrospective analysis of a prospective cohort study.

Demonstrate HEART score ability to reduce the recurrence of Major Adverse Cardiac Events (MACE) by from (8.1% to 2.4%) *HEART group, control group respectively and guide evidence-based intervention decisions underscores its potential as a standardized risk stratification tool in resource-limited healthcare systems such as Palestine's. While certain challenges remain, including higher rates of admission for observation and contextual limitations related to resource constraints, the findings are constant with global evidence supporting the HEART score's efficacy in improving patient outcomes and optimizing resource utilization. While the HEART score shows promise for improving chest pain assessment and management in Palestinian EDs, careful planning and system-wide support will be crucial to overcome implementation challenges and fully realize its potential benefits. Future research should address the limitations of this study through larger, multi-center trials to further validate the HEART score's effectiveness in the Palestinian healthcare context.

Addressing these challenges through future research, tailored implementation strategies, and policy integration could further enhance the HEART score's impact. By doing so, it has the potential to improve patient outcomes, streamline resource allocation, and establish a benchmark for emergency care in similar low-resource settings. Future research should address the limitations of this study through larger, multi-center trials to further validate the HEART score's effectiveness in the Palestinian healthcare context

As a pioneering effort led by An-Najah National University, this study contributes to the field of emergency by demonstrating the feasibility and benefits of implementing standardized risk

assessment tools in resource-constrained settings. It provides valuable insights to both local and international discourse on the managing of chest pain in emergency care settings. These findings underscore the importance of adopting standardized, evidence-based tools to address the growing burden of cardiovascular disease and improve healthcare delivery in resource- constrained environments. We recommend to Conduct multicenter trials across different regions and hospital types to enhance generalizability. Also, to implement standardized HEART score training programs. Develop and conduct comprehensive training programs for ED staff on the use of the HEART score.

In conclusion, this research represents a significant step towards enhancing the quality and efficiency of emergency cardiac care in Palestine, with potential implications for similar healthcare systems worldwide.

List of Abbreviations

Abbreviation	Meaning
ED	Emergency Department
HEART	History, ECG, Age, Risk factors, Troponin
ECG	Electrocardiograph
MACE	Major Adverse Cardiac Event
ACS MI	Acute Coronary Syndrome Myocardial Infarction
AMI	Acute Myocardial Infarction
STEMI	ST-Segment Elevation Myocard
NSTEMI	Non-ST-Segment Elevation Myo
PCI	Percutaneous Coronary Intervention
PPCI	Primary Percutaneous Coronary Intervention
CV	Cardiovascular
CVD	Cardiovascular Disease
NCDs	Non-Communicable Diseases
TIMI	Thrombolysis in Myocardial Infarction
GRACE	Global Registry of Acute Coronary Events
VCP	Vancouver Chest Pain
CABG	Coronary Artery Bypass Grafting
WHO	World Health Organization
MOH	Ministry Of Health
CRS	Coronary Risk Scores
LBBB	Left Bundle Branch Block
RBBB	Right Bundle Branch Block
ESC	European Society of Cardiology
PM	Pacemaker
BMI	Body Mass Index
RCT	Randomized Controlled Trial
IRB	Institutional Review Board
SPSS	Statistical Package for the Social Sciences
IHD	Ischemic Heart Disease
TIA	Transient Ischemic Attack
CHF	Congestive Heart Failure
AF	Atrial fibrillation
PVD	Peripheral Vascular Disease

CKD	Chronic Kidney Disease
MCP	Muscular Chest Pain
GERD	Gastroesophageal Reflux Disease
CPR	Cardiopulmonary Resuscitation
ADHF	Acute Decompensated Heart Failure

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Appendices

Appendix A

IRB Approval Letter

An-Najah National University
Faculty of Medicine & Health Sciences
Institutional Review Board

جامعة النجاح الوطنية
كلية الطب وعلوم الصحة
لجنة اخلاقي البحث العلمي

Ref: Mas. May. 2024/8

IRB Approval Letter

Title of Research:

Significance of HEART score in chest pain patient at emergency department

Submitted by:
Salam Mosa Abu Amer

Supervisor:
Nizar Saeed , Mohammed al Hayek

Approved:
15th May h. 2024

Your Study Title "**Significance of HEART score in chest pain patient at emergency departmen.**" reviewed by An-Najah National University IRB committee and was approved on 15th May. 2024.

Hasan Fitian, MD

IRB Committee Chairman

IRB Institutional Review Board

Nablus - P.O Box :7 or 707 | Tel (970) (09) 2342902/4/7/8/14 | Faximile (970) (09) 2342910| E-mail : IRB@najah.edu

Appendix B

Facilitating a Research Task

State of Palestine
Ministry of Health
Education in Health and Scientific Research Unit

دولة فلسطين
وزارة الصحة
وحدة التعليم الصحي والبحث العلمي

Ref.: ………………
Date:………………

الرقـــم: ………
التـاريخ: ………

عطوفة الوكيل المساعد لشؤون المستشفيات والطوارئ المحترم،،،

تحية واحترام،،،

<u>الموضـــوع: تسهيل مهمة بحث</u>

يرجى تسهيل مهمة الطالبة: **سلام موسى ابو عامر– ماجستير تمريض الطوارئ– جامعة النجاح،**

لعمل بحث الماجستير بعنوان:

"أهمية استعمال مقياس هارت لمرضى ألم الصدر في قسم الطوارئ"

حيث ستقوم الطالبة باجراء قياس هارت لمرضى الم الصدر في قسم الطوارئ وبموافقة رئيس القسم، وذلك

في:

- **مستشفى الوطني**

مع العلم أن مشرف الدراسة: د. نزار سعيد ود. محمد الحايك.

على ان يتم الالتزام بالمحافظة على اخلاقيات البحث العلمي وسرية المعلومات، وعدم التعرض للمعلومات الشخصية.
على ان يتم تزويد الوزارة بنسخة PDF من نتائج البحث، التعهد بعدم النشر لحين الحصول على موافقة وزارة الصحة.

مع الاحترام،،،

د. عبد الله القواسمي
رئيس وحدة التعليم الصحي والبحث العلمي

نسخة: **نائب الرئيس للشؤون الاكاديمية المحترم / جامعة النجاح**

Telfax.:09-2333901 scientificresearch.dep@gmail.com 09-2333901 :تلفاكس

Appendix C

Data Collection Form HEART Group

Data Collection Form
HEART Group

Significance of HEART score in chest pain patient at emergency department

Dear participant health care provider our study aimed to compare the effectiveness of using the HEART score as a risk stratification tool, as a predictor of outcomes for chest pain patients, compared to traditional clinical diagnosis. The primary objective was to determine the appropriate level of care needed for each patient based on their risk profile and to classify chest pain patients: low risk can be discharged safely, moderate risk patients will be admitted for observation, high risk patients they requiring early interventional treatments.

Chest pain is a common presenting symptom in emergency departments, and accurately identifying patients who are at high risk for adverse cardiac events is crucial for providing timely and appropriate care. Traditionally, clinical diagnosis has relied on subjective assessments and individual physician judgment, which can lead to variability in patient management and potentially suboptimal outcomes.

The **HEART score**, on the other hand, is a validated risk stratification tool that incorporates several objective parameters, including History, Electrocardiogram findings, Age, Risk factors, and Troponin levels. By assigning points to each parameter, the HEART score provides a numerical value that corresponds to the patient's risk of a major adverse cardiac event within a certain timeframe.

The study aimed to compare the accuracy and predictive value of the HEART score in identifying patients at high risk for adverse cardiac events, such as myocardial infarction or death, compared to traditional clinical diagnosis. It also sought to determine if the use of the HEART score could lead to more appropriate and efficient allocation of resources.
To achieve these objectives, the study employed a prospective, observational design, enrolling of chest pain patients presenting to the emergency department. Each patient underwent traditional clinical evaluation or calculation of their HEART score. Follow-up data, including the occurrence of major adverse cardiac events and subsequent management decisions, will collect and analyzed.

In conclusion, this study aimed to compare the effectiveness of using the HEART score as a predictor of outcomes for chest pain patients, compared to traditional clinical diagnosis

Date:

Case number:

Researcher contact: Mosasalam43@gmail.com

Physician demographic
Age ……..
Gender: Male ☐ Female ☐
Specialty: General Practitioner ☐ Internal medicine ☐ Emergency medicine ☐ resident ☐ other ……
Years of experience: less than 2 years ☐ 2-5 ☐ 5-10 ☐ 10< ☐
If resident: Year of residency : first ☐ 2nd ☐ 3rd ☐ 4th ☐

Patient demographic data	
Patient registry number…….	
Patient Age ……	Gender ……..
Weight: …… Height: …… BMI:…….	
Does the patient a smoker: Yes No If yes: Packs of cigarettes smoked per day ……. Years the patient has smoked …….. Pack years ……	
Characteristics of Presenting chest pain	
Do the patient have typical chest pain Yes ☐ No ☐ If no specify…….	
Onset: Sudden ☐ Gradual ☐	Episode duration: ……..
Quality: Dull ☐ heavy ☐ crushing ☐ Sharp ☐ stabbing ☐ burning ☐	
Radiated to left arm or neck: Yes ☐ No ☐	
Associated with sweating: Yes ☐ No ☐	
Associated with palpitations: Yes ☐ No ☐	
Increased with exercise: Yes ☐ No ☐	

Laboratory findings		Result	Normal range	Comment if clinically significant
Troponin	Initial			
	Serial*			
Creatinine				
Hemoglobin				
White blood cells				
Others…… ……				

* serial troponin required for experimental group with chest pain onset less than 6 hours, initial troponin negative

Medical History		
Has the patient had any relevant medical history? No ☐ Yes ☐		
Condition/Illness / Surgical Procedure	Tick at ongoing illness	Start year
Hypertension	☐	
Diabetes	☐	
Dyslipidemia	☐	
Coronary artery disease	☐	
Smoking	☐	
Previous percutaneous coronary intervention (PCI)	☐	
Previous coronary artery bapass graft (CABG)	☐	
Previous transient ischemic attack (TIA)	☐	
Family history of IHD	☐	
Others: ……..		
Drugs history …… …….. ……..		
Does the patient compliant to his prescribed medications? Yes ☐ No ☐		

Physical Examination			
System	Normal	Abnormal	*If noted ABNORMAL, please provide brief description and comment if clinically significant or not
General Appearance	☐	☐	
Cardiovascular	☐	☐	
Respiratory	☐	☐	
Abdomen	☐	☐	
Skin	☐	☐	
Eyes, Ears, Nose & Throat	☐	☐	
Head, Neck & Thyroid	☐	☐	
Extremities	☐	☐	
Neurological	☐	☐	
Electrocardiograph (ECG)	☐	☐	

Others…… …… ……	

HEART score			
History*	Highly suspicious	2	☐
	Moderately suspicious	1	☐
	Slightly suspicious	0	☐
ECG	Significant ST-segment Depression	2	☐
	Nonspecific repolarization	1	☐
	disturbance/LBBB/PM		☐
	Normal	0	☐
Age	≥ 65 years	2	☐
	> 45 and <65 years	1	☐
	≤ 45 years	0	☐
Risk factors*	≥ 3 risk factors or history of atherosclerotic disease	2	☐
	1 or 2 risk factors	1	☐
	No known risk factors	0	☐
Troponin*	≥ 3x normal limit	2	☐
	1-2 x normal limit	1	☐
	Normal limit or lower	0	☐
Total			
HEART score Interpretation		**0-3** points **Discharge** **4-6** points **Admission for observation** **HEART score ≥7 points** Early **intervention**	

***History**: In the absence of specific elements in terms of pattern of the chest pain, onset and duration, relation with exercise, stress or cold, localization, concomitant symptoms, the history was classified as 'nonspecific', granted 0 point.
If the patient history contained both nonspecific and suspicious elements, the history was classified as 'moderately suspicious' and granted 1 point.
If the history contained primarily specific elements, the history was classified highly suspicious and granted 2 points.

***Risk factors**: Hypercholesterolemia, hypertension, diabetes mellitus, cigarette smoking, family history of atherosclerotic disease, Body mass index (BMI) 30 kg/m2

ECG = electrocardiogram; HEART = History, ECG, Age, Risk factors, and Troponin; LBBB = left bundle branch block; PM = pacemaker

***Troponin**: serial troponin required for experimental group with chest pain onset less than 6 hours, initial troponin negative

HEART score Interpretation:

Score of **0-3** points holds a risk of 2.5% of reaching an endpoint and therefore supports a policy of **early discharge**. **Therefore, supports a policy of early discharge**.
HEART score of 4-6 points, immediate discharge is not an option indicates a risk of 20.3% for an adverse outcome. These patients **should be admitted for clinical observation**, treated as an ACS awaiting final diagnosis and subjected to noninvasive investigations, such as repeated troponin, exercise testing and possibly advanced ischemia detection
HEART score ≥7 points, with a risk of 72.7%, implies early aggressive treatment(**early intervention**) including invasive strategies without preceding noninvasive testing, requiring ca.(Six et al., 2008)

Intervention.

1. Discharge 2. Admission for observation 3. Early intervention

Any treatment received at the visit:

Time lasting in emergency department:

1. Less than 1h 2. 2-6 hours 3. More than 6 hours

Follow up

Does the patient have any follow up, or recurrence visit during next six weeks?
Yes ☐ No ☐

If yes continue
Date……
Number of weeks? ……

Follow up in six weeks for Major adverse cardiac events (MACE)
1. Acute myocardial infarction (AMI)
2. Percutaneous Coronary Intervention (PCI)
3. Coronary Artery Bypass Grafting (CABG)
4. Cardiopulmonary Resuscitation (CPR)
5. Death
Other ……

Thanks

and subjected to noninvasive investigations, such as repeated troponin, exercise testing and possibly advanced ischemia detection

HEART score ≥7 points, with a risk of 72.7%, implies early aggressive treatment**(early intervention)** including invasive strategies without preceding noninvasive testing, requiring ea.(Six et al., 2008)

Intervention:

1. Discharge **2**. Admission for observation **3**. Early intervention

Any treatment received at the visit:

……

Time lasting in emergency department:

1. Less than 1h **2**. 2-6 hours **3**. More than 6 hours

Follow up

Does the patient have any follow up, or recurrence visit during next six weeks?

Yes ☐ No ☐

If yes continue

Date…….

Number of weeks? ……

Follow up in six weeks for Major adverse cardiac events (MACE)

1. Acute myocardial infarction (AMI)
2. Percutaneous Coronary Intervention (PCI)
3. Coronary Artery Bypass Grafting (CABG)
4. Cardiopulmonary Resuscitation (CPR)
5. Death

Other ……

Thanks

Appendix D

Data Collection Control Group

Data Collection Form
Control Group

Significance of HEART score in chest pain patient at emergency department

Dear participant health care provider our study aimed to compare the effectiveness of using the HEART score as a risk stratification tool, as a predictor of outcomes for chest pain patients, compared to traditional clinical diagnosis. The primary objective was to determine the appropriate level of care needed for each patient based on their risk profile and to classify chest pain patients: low risk can be discharged safely, moderate risk patients will be admitted for observation, high risk patients they requiring early interventional treatments.

Chest pain is a common presenting symptom in emergency departments, and accurately identifying patients who are at high risk for adverse cardiac events is crucial for providing timely and appropriate care. Traditionally, clinical diagnosis has relied on subjective assessments and individual physician judgment, which can lead to variability in patient management and potentially suboptimal outcomes.

The **HEART score**, on the other hand, is a validated risk stratification tool that incorporates several objective parameters, including History, Electrocardiogram findings, Age, Risk factors, and Troponin levels. By assigning points to each parameter, the HEART score provides a numerical value that corresponds to the patient's risk of a major adverse cardiac event within a certain timeframe.

The study aimed to compare the accuracy and predictive value of the HEART score in identifying patients at high risk for adverse cardiac events, such as myocardial infarction or death, compared to traditional clinical diagnosis. It also sought to determine if the use of the HEART score could lead to more appropriate and efficient allocation of resources.
To achieve these objectives, the study employed a prospective, observational design, enrolling of chest pain patients presenting to the emergency department. Each patient underwent traditional clinical evaluation or calculation of their HEART score. Follow-up data, including the occurrence of major adverse cardiac events and subsequent management decisions, will collect and analyzed.

In conclusion, this study aimed to compare the effectiveness of using the HEART score as a predictor of outcomes for chest pain patients, compared to traditional clinical diagnosis

Date:
Case number:
Researcher contact: Mosasalam43@gmail.com

Physician demographic
Age ……..
Gender: Male ☐ Female ☐
Specialty: General Practitioner ☐ Internal medicine ☐ Emergency medicine ☐ resident ☐ other…..
Years of experience: less than 2 years ☐ 2-5 ☐ 5-10 ☐ 10< ☐
If resident: Year of residency : first ☐ 2nd ☐ 3rd ☐ 4th ☐

Patient demographic data	
Patient registry number……	**Date……**
Patient Age ……	Gender ……..
Weight: …… Height: …… BMI:…….	
Does the patient a smoker: Yes No If yes: Packs of cigarettes smoked per day …… Years the patient has smoked …… Pack years ……	
Characteristics of Presenting chest pain	
Do the patient have typical chest pain Yes ☐ No ☐ If no specify…….	
Onset: Sudden ☐ Gradual ☐	Episode duration: ……..
Quality: Dull ☐ heavy ☐ crushing ☐ Sharp ☐ stabbing ☐ burning ☐	
Radiated to left arm or neck: Yes ☐ No ☐	
Associated with sweating: Yes ☐ No ☐	
Associated with palpitations: Yes ☐ No ☐	
Increased with exercise: Yes ☐ No ☐	

Medical History		
Has the patient had any relevant medical history? No ☐ Yes ☐		
Condition/Illness / Surgical Procedure	Tick at ongoing illness	Start year
Hypertension	☐	
Diabetes	☐	
Dyslipidemia	☐	
Coronary artery disease	☐	
Smoking	☐	
Previous percutaneous coronary intervention (PCI)	☐	
Previous coronary artery bapass graft (CABG)	☐	
Previous transient ischemic attack (TIA)	☐	
Family history of IHD	☐	
Others: ……..		
Drugs history …… …….. ……..		
Does the patient compliant to his prescribed medications? Yes ☐ No ☐		

Physical Examination			
System	Normal	Abnormal	*If noted ABNORMAL, please provide brief description and comment if clinically significant or not
General Appearance	☐	☐	
Cardiovascular	☐	☐	
Respiratory	☐	☐	
Abdomen	☐	☐	
Skin	☐	☐	
Eyes, Ears, Nose & Throat	☐	☐	
Head, Neck & Thyroid	☐	☐	
Extremities	☐	☐	
Neurological	☐	☐	
Electrocardiograph (ECG)	☐	☐	
Others…… …… ……			

Laboratory findings		Result	Normal range	Comment if clinically significant
Troponin	Initial			
	Serial*			
Creatinine				
Hemoglobin				
White blood cells				
Others…… …… ……				

Control group

Clinical diagnosis :……..
Any treatment given at visit : ……
Intervention:……..……..

Time lasting in emergency department:

1. Less than 1h **2**. 2-6 hours **3**. More than 6 hours

Follow up

Does the patient have any follow up, or recurrence visit during next six weeks? Yes ☐ No ☐

If yes continue
Date…….
Number of weeks? ……

Follow up in six weeks for Major adverse cardiac events (MACE)

1. Acute myocardial infarction (AMI)
2. Percutaneous Coronary Intervention (PCI)
3. Coronary Artery Bypass Grafting (CABG)
4. Cardiopulmonary Resuscitation (CPR)
5. Death

Other ……

Thanks

Appendix E

Figures

Figure 11

Show the distribution of HEART score three levels

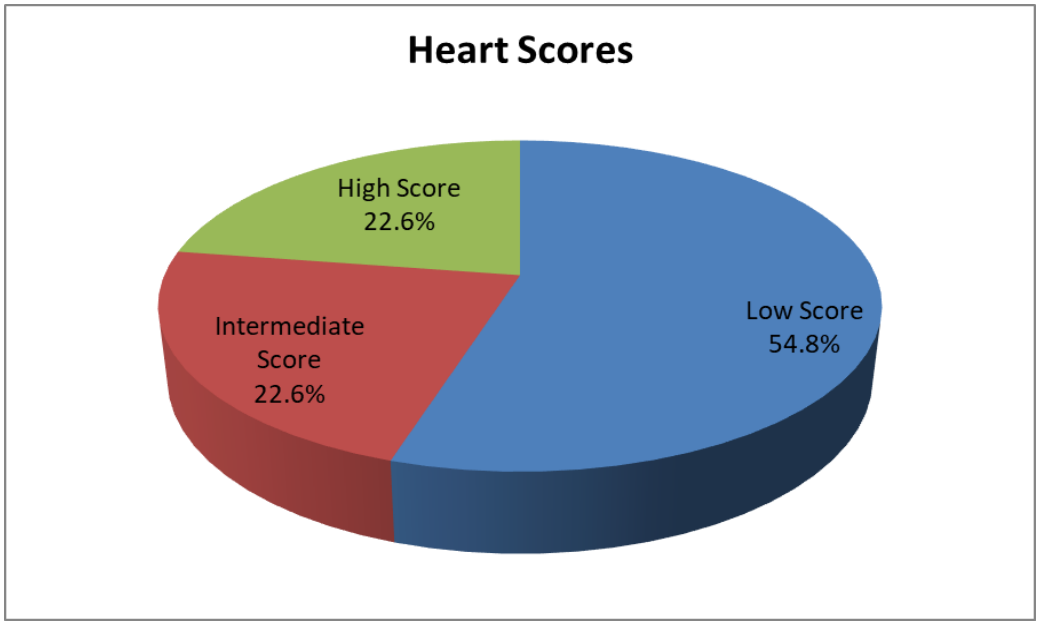
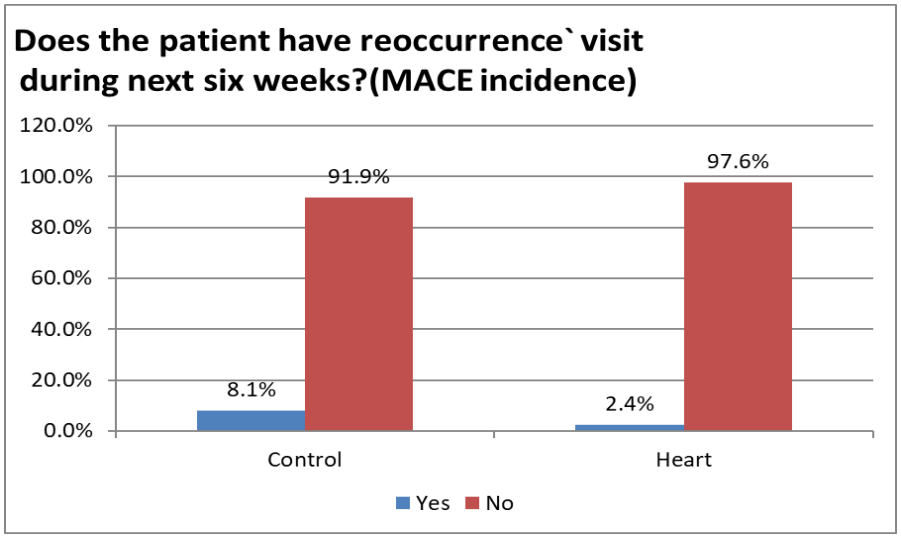


Figure 12

Show the percentages of MACE occurrences in control group, and HEART group



جـامعـــة النجاح الوطنية

كليـــة الدراســـات العليـــا

اهمية استعمال مقياس هارت لمرضى ألم الصدر في قسم الطوارئ

إعداد

سلام موسى سلامة ابوعامر

إشراف

د. نزار سعيد

د. محمد حايك

قدمت هذه الرسالة استكمالا لمتطلبات الحصول على درجة الماجستير في تمريض الطوارئ، من كلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس– فلسطين.

2025

اهمية استعمال مقياس هارت لمرضى ألم الصدر في قسم الطوارئ

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الملخص

خلفية الدراسة: ألم الصدر هو عرض شائع لحضور قسم الطوارئ، مما يطرح تحديات تشخيصية كبيرة. تقّيم هذه الدراسة فعاليه استعمال مقياس هارت في تصنيف مخاطر مرضى آلام الصدر وفقًا لمتلازمة الشريان التاجي الحادة, مقارنة بالتشخيص السريري التقليدي في قسم الطوارئ, في مستشفى مركزي بشمال الضفة ضا يعانون من ألم في

منهجية الدراسه: تم إجراء دراسة مستقبلية في مستشفى مركزي في شمال الضفة الغربية، شملت 247 مري الصدر. من أجل تقييم قابلية الإصابة بمتلازمة الشريان التاجي الحادة. تم توزيع المرضى

عشوائً يا إما إلى مجموعة هارت التجريبيه عددهم (124) او الى المجموعه المرجعيه وعددهم (123) كانت النتيجة الرئيسية هي حدوث الأحداث القلبية السلبية الكبرى (خلال ستة اسابيع).

النتائج: أظهرت مجموعة هارت انخفاضا في حدوث الأحداث القلبية الوعائية الكبرى مقارنةً بمجموعة (2.4% vs 8.1%, p=0.044) حيث قام نظام تقييم هارت بتصنيف المرضى بشكل فعال الى ثلاثه فئات: منخفضة (54.8%)، ومتوسطة (22.6%)، وعالية (22.6%)، مما ساعد في توجيه اختيار التدخلات المناسبة الخاتمة: يقلل نظام تقييم هارت بشكل كبير من حدوث الأحداث القلبية السلبية الكبرى, مقارنة مع التشخيص التقليدي السريري،(2.4%, 8.1 % p=0.044) مما يثبت فعالية استخدامه كأداة أكثر أماً نا

وكفاءة لتصنيف المخاطر في قسم الطوارئ.كما يمكن أن يؤدي تطبيقه إلى توحيد الرعاية في البيئات ذات الموارد المحدودة. تحسين نتائج المرضى وإمكانية تحسين استخدام الموارد.

الكلمات المفتاحية:(ACS), متلازمة الشريان التاجي الحادة، ألم الصدر، مقياس هارت، (MACE)، الأحداث القلبية السلبية الكبرى.

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