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The accuracy of The Emergency Severity Index Triage Score in Predicting Cardiac Events among Suspected Acute Coronary Syndrome Patients in The Emergency Department

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Abstract
Background: The Emergency Severity Index (ESI) triage score is a widely used tool in emergency departments (EDs) to prioritize patients based on the severity of their conditions. In the context of suspected acute coronary syndrome (ACS), accurate triage is crucial for timely intervention and optimal patient' outcomes. **Aim:** To evaluate the accuracy of the ESI triage score in predicting cardiac events among suspected ACS patients in the ED. **Design and Methods:** A prospective correlational observational study design was performed in cardiac ED. **Tools** Three tools were utilized to collect data pertinent to the study: **Tool l:** Patients' assessment (patients personal characteristics, vital signs) **Tool II:** ESI triage score sheet. **Tool III:** major adverse cardiac events (MACE) incidence among studied patients within 30 days. **Results:** Patients were triaged as (42.5%) ESI score 1, (41.0%) as ESI score 2 and (16.5%) as ESI score 3. ESI score ≤ 1 had sensitivity and specificity, positive, negative predictive value, and area under the curve of 53.52% and 84.48%, 89.4%, 42.6%, and 0.704, respectively. **Conclusion:** This study concludes that the ESI triage scores have a moderate accuracy in predicting cardiac events among suspected ACS patients at the cardiac ED. **The study recommended:** That enhanced training and possibly integrating additional diagnostic tools or biomarkers to improve the ESI score's sensitivity and overall predictive accuracy. Reapply this research on a large sample size acquired from different geographical areas in Egypt.

Keywords: Acute Coronary Syndrome, Emergency Department, Emergency Severity Index triage score & Major Adverse Cardiac Event.

Introduction
Emergency department (ED) overcrowding is a growing phenomenon that is associated with increased length of stay, worse patient outcomes, and high costs. Overcrowding is due to a number of factors that, in most cases, lead to an increase in the number of people within the ED, an increase in mortality and morbidity, and a decrease in the ability to provide critical services in a timely manner to patients suffering from acute coronary syndrome (ACS) **(Sartini et al., 2022).**

Chest pain is one of the most common, potentially serious presenting complaints for adult ED visits. The challenge of ACS identification with appropriate disposition is quite significant. Many of these patients are low risk and can be managed non-urgently in the outpatient environment; other patients, however, are intermediate to high risk for ACS and should be managed more aggressively, likely with inpatient admission and cardiology consultation **(Brady & de Souza, 2018).**

The challenge for clinicians is the dual danger of discharging patients at potential high risk and the clinical pressure of EDs crowded with low risk patients. In order to improve the quality of care and survival rates of cardiac patients, there is a worldwide impetus to develop and improve systems for emergency cardiac care. Current triage emphasizes rapid determination of the likelihood that the patient's clinical presentation represents high risk chest pain, such as acute coronary artery disease, and rapid assessment of the immediate risk for a Major Adverse Cardiac Event (MACE) **(Slankamenac et al., 2020)**.

Major Adverse Cardiac Event (MACE) was defined as a composite of all-cause death, sudden cardiac arrest, congestive heart failure, non-fatal myocardial infarction (MI), stress-induced cardiomyopathy, new-onset cardiac arrhythmias, severe hypotension requiring inotropic support, new-onset pulmonary edema, pulmonary hypertension, cerebrovascular accident, and pulmonary embolism within 30 days of admission at the cardiac ED **(Tandon & Hall, 2022).**

The Emergency Severity Index (ESI) is a widely used tool to triage patients in the ED. The ESI tool is used to assess all complaints and triage patients with suspected ACS. The accuracy of ESI triage score in predicting serious outcomes in suspected ACS has been evaluated in previous studies to assess and stratify suspected ACS patients. ED triage nurses assess and identify clinical conditions in order to prioritize those with the most significant risk of morbidity and mortality, such as ACS. This is

important because rapid recognition of time-sensitive clinical conditions can reduce negative patient outcomes while minimizing over-triage of patients who do not require immediate care **(Frisch et al., 2020).**

Rapid and accurate triage in EDs is a critical component of emergency nursing practice. The ESI scale has been reported as the most commonly used scale in the triage room worldwide. It is used to prioritize patients based on patients' vital signs and resource utilization in the ED **(Seyedhosseini-Davarani et al., 2018).**

The ESI triage scale stratifies patients according to the severity of their illness by providing a rough estimation of the level of resources that they require to cater to their ailments. Patients who are categorized as level one require urgent care, while those categorized as level two or three can be treated within a 15-minute window. Those with not-so-urgent needs belong to levels four or five and can be addressed within 30 minutes. Enhancing protocols for the classification of risks is a principal goal of emergency services, as it improves clinical outcomes and services **(Rashid et al., 2021).**

In the Emergency Severity Index (ESI) triage system, nurses play a crucial role in assessing patients' acuity levels and prioritizing care accordingly. They evaluate patients based on various factors, such as vital signs, chief complaints, and medical history, to determine the urgency of treatment. Nurses also ensure that resources are allocated efficiently by assigning appropriate triage categories to patients**(Ugbo, 2020)**.

Therefore, this study was conducted to evaluate the accuracy of the ESI triage score in predicting cardiac events among patients with suspected ACS in the cardiac ED.

Significance of the study

Chest pain is up to 6.3% of ED visits. An urgent question for these patients is whether they have acute coronary syndrome (ACS), as any delay in diagnosis and treatment can have a negative impact on their prognosis**(Cruz Rodriguez et al., 2022)**. On the other hand, mortality due to Cardio Vascular Disease (CVD) in Egypt is one of the highest compared to other countries in the region and worldwide **(Shaheen et al., 2020)**. Therefore, the rapid and accurate identification of these patients is paramount, as undiagnosed cases can lead to a high mortality rate and are the largest source of negligence claims in the ED. On the other hand, precise and efficient triage for chest pain presents a healthcare challenge. The primary objective of triage is the rapid identification of patients with critical conditions, time sensitivity, and prioritizing their care over individuals who can wait. In this context, the accuracy and reliability of triage in the emergency department are of utmost importance **(Mohammadi Sangsari et al., 2023)**. Also, according to patient records at Assiut University Heart Hospital, the number of patients' admissions in the cardiac emergency department is about 300 per month. Therefore, early risk detection for cardiac events is essential in guiding treatment and predicting the prognosis. This study will be conducted to evaluate the accuracy of the ESI triage score in predicting cardiac events among patients with suspected ACS in the cardiac ED.

Key words operational definitions:

The Emergency Severity Index (ESI): Is a tool for use in emergency department (ED) triage. The ESI triage algorithm yields rapid, reproducible, and clinically relevant stratification of patients into five groups, from level 1 (most urgent) to level 5 (least urgent). The ESI provides a method for categorizing ED patients by both acuity and resource needs.

Major Adverse Cardiac Events: Refer to the occurrence of any of the following within 30 days: cardiac arrest, emergency percutaneous coronary intervention, pulmonary embolus, acute heart failure, cardiogenic shock, arrhythmia, coronary artery bypass graft, and all-cause mortality. It has a significant effect on the patients' quality of life and can be predicted.

Aim of the study:

To investigate the accuracy of the emergency severity index triage score in predicting cardiac events among suspected acute coronary syndrome patients in the emergency department.

Research question:

What is the accuracy of the emergency severity index triage score in predicting cardiac events among suspected acute coronary syndrome patients in the emergency department?

Patients and Methods:

Research design:

A prospective correlational observational study design of suspected ACS patients was utilized in the present study.

Setting:

The study was conducted in the cardiac emergency department at Assuit University Heart Hospital, which contains 9 beds for inpatients in 3 separate rooms, 2 examination rooms for cardiac emergency patients, 1 physician, 3 head nurses, 15 staff nurses, 2 nurse assistants, and a flow rate of approximately 30 patients per day (nurse patient ratio of 1:3).

Sample:

- Patients who were admitted to the cardiac emergency department with suspected acute coronary syndrome (unstable angina, STEMI, or

NSTEMI) during six months (from February to July 2023) were 423 adult patients (Figure 1).

- They were randomly included in the study with the following matching criteria age group, sex, marital status, and level of education.

Inclusion criteria:

- Patients age > 18 years.
- A newly admitted patient to the cardiac ED with suspected acute coronary syndrome.
- -Male and female patients.

Exclusion criteria:

- Chest pain with an obvious non-cardiac cause (e.g., abdominal, pulmonary, trauma).
- Heart failure.
- Arrhythmia.
- Cardiogenic shock.
- Pregnancy
- Previously included in the study.
- Pulmonary embolism.

Study tools:

Three tools were used for this study.

Tool I: Patient assessment tool:

This tool consisted of two main parts.

Part (1): Patients' personal data: -

Include the patient's code, age, sex, marital status, level of education, telephone number, and diagnosis.

Part (2): Vital signs:

Includes pulse, mean arterial blood pressure, respiration, temperature, and blood glucose.

Tool II: Emergency Severity Index (ESI) triage score:

This tool was adopted from **(Gilboy et al.)2020** and **(Chmielewski & Moretz, 2022)** and used to triage suspected ACS patients in the cardiac emergency department and consists of a 5-level ESI score. The ESI algorithm tool helped to assign different levels based on a 1–5 scale:

Level 1, Patients admitted to the cardiac ED with one of the following and immediate life-saving interventions are required: unresponsiveness, cardiac arrest, apnea, ST elevation in the ECG, blood pressure ≥ 180⁄110, Spo2 < 90 %, severe bradycardia or tachycardia with signs of hypo-perfusion, hypotension with signs of hypo-perfusion, chest pain, pale, diaphoretic, systolic blood pressure 70 by palpation, weakness and dizziness, heart rate = 30 beats/minute, respiratory arrest, severe respiratory distress).

Level 2, patient admitted to ED with one of the following and is considered high risk or emergent, requires intervention within 10 minutes, and it includes: (active chest pain, suspicious for acute coronary syndrome but does not require an immediate lifesaving intervention, stable), (pathological ECG and chest pain), (chosen pain history during the last 24 h combined with vegetative symptoms), (chest pain + dyspnea), (symptoms of unstable angina), (chest pain ratings as 6-9), (blood pressure ≥160⁄100 & ≤ 180⁄110), (Spo2 < 93% & >90%).

Level 3, the patient status is urgent but stable and can safely wait in the waiting room for 60 minutes, not in danger zone vitals (HR>100, RR> 20, SPO2<92%) and need more than three resources to be managed.

The resources are: (labs as blood troponin), (electrocardiogram, radiograph), (computed tomography, magnetic resonance imaging, ultrasound, angiography), (intravenous fluids) hydration), (intravenous, intramuscular, or nebulized medications), (specialty consultation), (simple procedure = 1 (laceration repair, urinary catheter)), (complex procedure = 2 (procedural sedation)).

Level 4, the patient's status is not urgent, and they can wait for 180 minutes and need one resource to be managed.

Level 5, no ED resources needed.

Tool III: major adverse cardiac events (MACE) incidence among studied patients tool is defined as MACE in 30 days, which is in accordance with the guidelines adopted by **the American Heart Association (Hicks et al., 2015)** and used by **(Yang et al., 2020).** MACE referred to the occurrence of any of the following: cardiac arrest, percutaneous coronary intervention, pulmonary embolus, arrhythmia, coronary artery bypass graft, cardiogenic shock, acute heart failure, and all-cause mortality during the indexed hospitalization or within 30 days of subject recruitment, in addition to the number of readmissions and recurrences of chest pain as determined by electronic health record review emergency and written records, which included discharge letters, revascularization reviews, and some other applicable documentation.

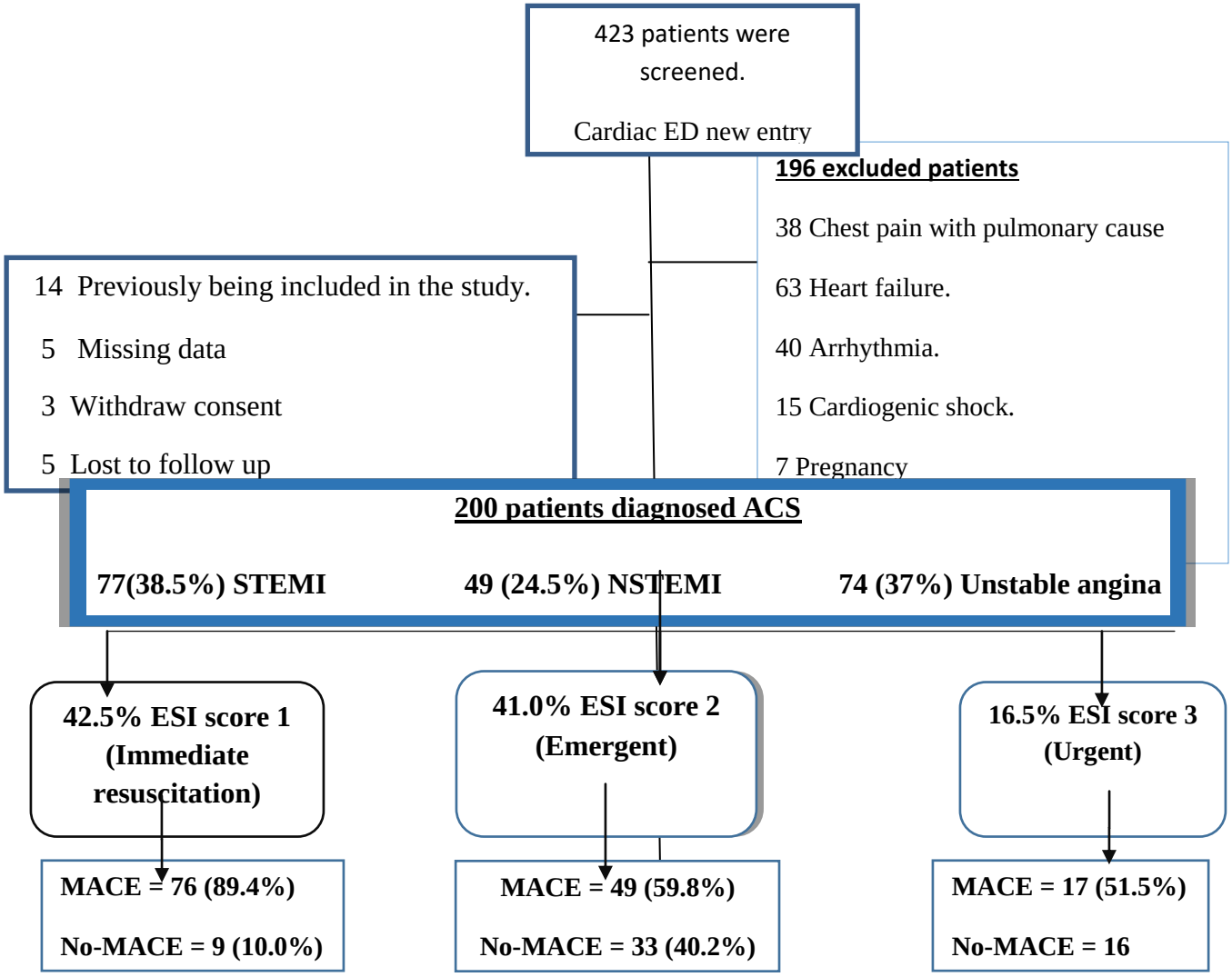

Figure (1): Flow chart of the study

The study was conducted on three phases:

Preparatory phase:

- An official letter from the faculty of nursing was sent to the accountable authorities of the hospital, and approval was obtained to conduct this study after an explanation of the nature and aim of the study.
- The tools used in this study were developed by the researcher based on reviewing the relevant literature **(Hicks et al., 2015), (Gilboy, et al, 2020), (Chmielewski & Moretz, 2022) & (Yang et al., 2020)**.

Content Validity:

The developed tools (I and III) were tested for content validity by a jury of seven experts in the fields of critical care nursing and critical care medicine from Assuit University who reviewed the instrument for clarity, relevance, comprehensiveness, understanding, and applicability.

The Reliability:

- Reliability testing for the tools has been done after reviewing relevant literature using Cronbach's alpha as follows:
- Tool I, Part 2, "vital signs": 0.857
- Tool III: " patient's outcomes": 0.804, which were acceptable

Pilot Study:

A pilot study was done to test the feasibility and applicability of the tools, and the necessary modifications were made. The pilot study was done on 10% of the patients who were included in the study if no major modification was necessary.

Ethical considerations:

- An approval was obtained from the local ethical committee after an explanation of the aim of the

study**,** there is no risk to the study subject during the application of the research; the study followed the common ethical principles in clinical research; informed consent was obtained from the person participating in the study after explaining the nature and purpose of the study; the patient was assured that the data of this research will not be reused without second permission; confidentiality and anonymity were assured; and the patient has the right to refuse to participate in or draw from the study without any reason at any time.

Data collection:

-The study was conducted from February 2023 to July 2023 with 423 patients who presented with suspected ACS in the cardiac ED at Assiut University Heart Hospital.

Impelmentation phase:

- At the patients' arrival in the examination room in the cardiac ED, they were assessed for socio-demographic data and vital signs by using tools I, parts 1 and 2.
- All patients were triaged by ESI triage score immediately at arrival to cardiac ED using Tool II, which includes levels 1 (immediate life-saving intervention is required); level 2 (patient is considered high-risk or emergent); level 3 (urgent but stable and can safely wait in the waiting room); level 4 (non-urgent) and level 5 (no ED resources needed).
- At the time of the chest pain assessment, an ECG was made for all patients to identify ECG changes. ECG may be normal, ST segment elevation, ST segment depression, or inverted T.
- - The researcher had determined the resources needed for every patient in the triage room.
- A blood sample was taken for all patients to measure high-sensitivity troponin T and send it to the hospital laboratory. Only the first troponin T value was used to confirm the patients' diagnosis.
- - These data included all vital signs and resources needed for calculating the ESI triage score. It included vital signs, ECG changes, and blood tests (cardiac enzymes).

Evaluation phase:

- All patients with ACS were evaluated within 30 days for the occurrence of MACE as determined by electronic health record reviews and written records, which included discharge letters, revascularization reviews, and some other applicable documentation.
- Telephone calls had been made to identify those patients who had MACE in 30 days and attended any private medical sector for management.

Statistical analysis:

The data were tested for normality using the Anderson-Darling test and for homogeneity variances prior to further statistical analysis. Categorical variables were described by number and percent (N, %), while continuous variables were described by mean and standard deviation **(Mean, SD).** To compare categorical variables, the **chi-square test** and Fisher exact test are used, while continuous variables are compared using the **t-test** and the **ANOVA test**. **A two-tailed p** < 0.05 was considered statistically significant. We are using person correlation to examine the association between triage scores and MACE incidence. All analyses were performed with the **IBM SPSS 20.0** software.

Results:

Table (1): Distribution of patients' personal characteristics in cardiac emergency department for studied group (n=200)

Socio-demographic data	No. (200)	%
Age: (years)		
< 50	43	21.5%
50 - < 55	55	27.5%
55 - < 60	68	34.0%
60 - 65	34	17.0%
Mean ± SD	53.61 ± 10.82	
Range	24.0-65.0	
Sex:		
Male	136	68.0%
Female	64	32.0%
Marital status:		
Single	10	5.0%
Married	109	54.5%
Divorced	15	7.5%
Widow	66	33.0%
Level of education:		
Illiterate	68	34.0%
Read and write	73	36.5%
Secondary school	22	11.0%
Bachelor degree	26	13.0%
Post-graduate	11	5.5%

Data expressed as mean (SD), frequency (percentage)

Table (2): Distribution of patients' vital signs in cardiac emergency department (n=200).

Vital signs	Statistics (n= 200)
Pulse:	
Mean ± SD	83.72 ± 17.67
Range	50.0-180.0
Systolic BP:	
Mean ± SD	125.65 ± 27.92
Range	60.0-220.0
Diastolic BP:	
Mean ± SD	77.75 ± 14.19
Range	40.0-130.0
Respiration:	
Mean ± SD	19.61 ± 3.35
Range	16.0-32.0
Temperature:	
Mean ± SD	37.03 ± 0.42
Range	36.5-39.0
Blood glucose:	
Mean ± SD	170.57 ± 86.54
Median (Range)	139.0 (69.0-502.0)

Data expressed as mean (SD), frequency (percentage)

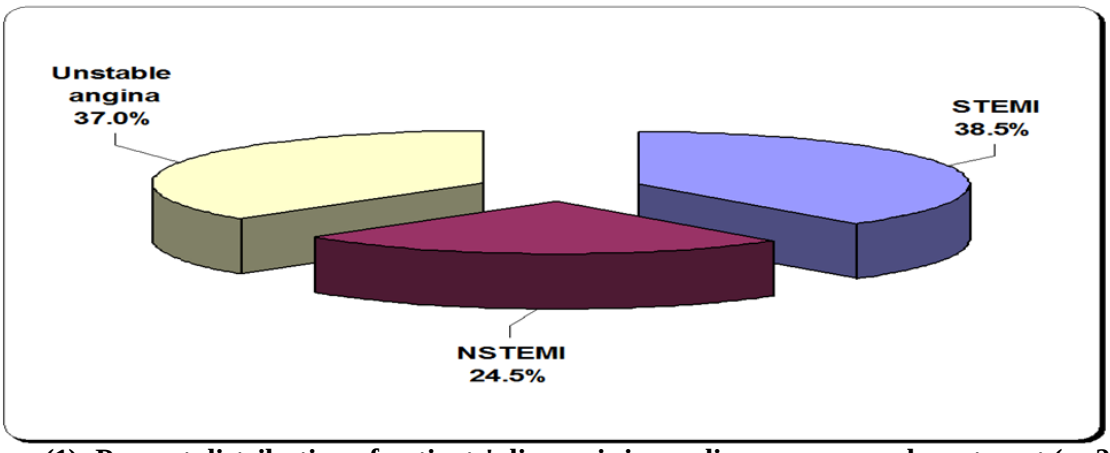

Figure (1): Percent distribution of patients' diagnosis in cardiac emergency department (n=200)

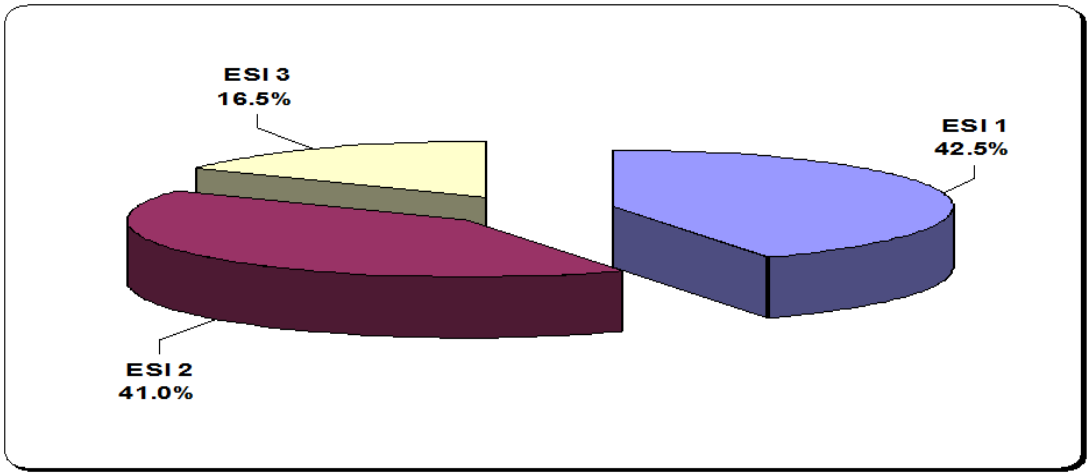

Figure (2): Percent distribution of risk category of patients according to ESI triage score in cardiac emergency department (n=200)

Table (3): Relationship between ESI score and sociodemographic characteristics in cardiac emergency department (n=200)

	ESI score						P-value
	Immediate		Emergent		Urgent		
	No.	%	No.	%	No.	%	
Age: (years)							
< 50	16	37.2%	16	37.2%	11	25.6%	0.067
50 - < 55	28	50.9%	20	36.4%	7	12.7%	
55 - < 60	33	48.5%	25	36.8%	10	14.7%	
60 - 65	8	23.5%	21	61.8%	5	14.7%	
Sex:							
Male	63	46.3%	54	39.7%	19	14.0%	0.194
Female	22	34.4%	28	43.8%	14	21.9%	
Marital status:							
Single	4	40.0%	2	20.0%	4	40.0%	0.198
Married	52	47.7%	42	38.5%	15	13.8%	
Divorced	5	33.3%	6	40.0%	4	26.7%	
Widow	24	36.4%	32	48.5%	10	15.2%	
Level of education:							
Illiterate	24	35.3%	32	47.1%	12	17.6%	0.698
Read and write	30	41.1%	28	38.4%	15	20.5%	
Secondary school	12	54.5%	8	36.4%	2	9.1%	
Bachelor degree	13	50.0%	10	38.5%	3	11.5%	
Post-graduate	6	54.5%	4	36.4%	1	9.1%	

**A Statistically significant p ≤ 0.05* ***A Highly Statistically significant p ≤ 0.001*

Table (4): Relationship between ESI triage score and patient's diagnosis in cardiac emergency department (n=200)

	ESI score						P-value
	Immediate		Emergent		Urgent		
	No.	%	No.	%	No.	%	
Diagnosis:							
STEMI	77	100.0%	0	0.0%	0	0.0%	0.000*
NSTEMI	4	8.2%	43	87.8%	2	4.1%	
UA	4	5.4%	39	52.7%	31	41.9%	

**A Statistically significant p ≤ 0.05* ***A Highly Statistically significant p ≤ 0.001*

Table (5): Distribution of MACE within 30 days from arrival to cardiac emergency department (n=200)

Outcomes	No. (200)	%
None	58	29.0%
Cardiac arrest	7	3.5%
Percutaneous coronary intervention (PCI)	90	45.0%
Pulmonary embolus	1	0.5%
Arrhythmia	18	9.0%
Coronary artery bypass graft	6	3.0%
Cardiogenic shock	17	8.5%
Acute heart failure	12	6.0%
All-cause mortality during the indexed hospitalization or within 30 days of subject recruitment	16	8.0%
The number of readmissions	15	7.5%
Recurrence of chest pain	32	16.0%

Data expressed as frequency (percentage)

Table (6): Relationship between ESI triage score and MACE incidence in suspected ACS patients at cardiac emergency department (n=200)

	No-MACE		MACE		p-value
	No.	%	No.	%	
ESI score:					
Level 1 (Immediate resuscitation)	9	10.6%	76	89.4%	0.000*
Level 2 (Emergent within 10 minutes)	33	40.2%	49	59.8%	
Level 3 (Urgent within 1 hour)	16	48.5%	17	51.5%	

**A Statistically significant p ≤ 0.05* ***A Highly Statistically significant p ≤ 0.001*

Table (7): Distribution of ESI triage score sensitivity and specificity for studied group in predicting MACE in cardiac emergency department (n=200)

Cut-off	Sensitivity	Specificity	+PV	-PV	AUC
≤ 1	53.52	84.48	89.4	42.6	0.704

+PV: positive predictive value, -PV: negative predictive value, AUC: area under the curve

Table (1): Show the distribution of patients' personal characteristics, which found that more than a third of patients (34.0%) were 55–< 60 with Mean±SD 53.61 ± 10.82. More than two-thirds (68.0%) of patients are males and (32.0%) females. More than half (54.5%) of them were married, and 36.5% of them can read and write, and 34.0% are illiterate.

Table (2): Show the distribution of patients' vital signs. It was found that patients pulse ranges from 50.0–180.0 b/m with Mean ± SD 83.72 ± 17.67, their systolic blood pressure range from 60.0–220.0 mmHg with Mean ± SD 125.65 ± 27.92, and their diastolic blood pressure range from 40.0–130.0 b/m with Mean ± SD 77.75 ± 14.19. Also, it was found that patients respiration ranged from 16.0 to 32.0 b/m with Mean ± SD 19.61 ± 3.35, their temperature ranged from 36.5 to 39.0 ºC with Mean ± SD 37.03 ± 0.42, and their blood sugar ranged from 69.0 to 502.0 mg/dl with Mean ± SD 170.57 ± 86.54.

Figure (1): Show the percent distribution of patients' diagnoses. It was found that more than a third (38.5%) of patients diagnosed with STEMI Also, more than a third (37.0%) of them were diagnosed with unstable angina, but less than a quarter (24.5%) of them were diagnosed with NSTEMI.

Figure (2): Show the percent distribution of the risk category of patients according to the ESI triage score in the cardiac emergency department. It was found that more than third (42.5%) of patients were triaged as ESI score 1 (need immediate resuscitation), more than third (41.0%) of patients were triaged as ESI score 2 (emergent), and 16.5% of patients were triaged as ESI score 3 (urgent).

Table (3): Explain the relationship between the ESI triage score and sociodemographic characteristics in

the cardiac emergency department. It was found that there was no statistically significant difference between the ESI triage score and the patients' age, sex, marital status, and level of education.

Table (4): Explain the relationship between the ESI triage score and patient diagnosis in the cardiac emergency department. It was found that there was a statistically significant difference between the ESI triage score and the patients' diagnosis, with a P-value of 0.000.

Table (5): Illustrate the distribution of MACE incidence in suspected ACS patients within 30 days from arrival at the cardiac ED. It was found that more than a third (45.0%) of patients had undergone percutaneous coronary intervention (PCI), and 16.0% of ACS patients had recurrences of chest pain, but more than a quarter (29.0%) of patients had no major adverse cardiac events.

Table (6): Explain the relationship between the ESI triage score and MACE incidence in suspected ACS patients. It was found that there was a statistically significant difference between different ESI triage scores and the occurrence of MACE with a P-value of 0.000.

Table (7): Show the distribution of ESI triage score accuracy in predicting MACE for the studied group. It was found that ESI score ≤ 1 had sensitivity and specificity, positive and negative predictive value, and area under the curve of 53.52% and 84.48%, 89.4%, 42.6%, and 0.704, respectively.

Discussion

Triage nurses are tasked with the unique job characteristic of being able to pick out a clinically acute condition among a group of undifferentiated patients. So, the demand for triage tools that are both accurate and efficient is increasing. The Emergency Severity Index (ESI) tool is the most commonly used triage tool in EDs around the world. ACS is a common complaint in ED settings, and recognizing patients with ACS in the ED remains a major challenge for clinicians **(Frisch et al., 2020).**

ESI is a five-level ordinal scale used to categorize patients based on resource utilization in the ED and likelihood of admission. It provides clinically relevant stratification of patients into five groups from 1 (emergent) to 5 (non-urgent) on the basis of acuity and resource needs **(Sax et al., 2023)**.

The current study figured out that most suspected ACS patients were triaged as ESI triage score 1 (need immediate resuscitation) and ESI triage score 2 (emergent within 10 minutes), and less than twenty percent of patients were triaged as ESI score 3 (urgent within 1 hour). This typically indicates that patients presented to the cardiac ED with severe symptoms and high acuity. Also, this may be due to the higher prevalence of STEMI and unstable angina compared to NSTEMI. This may be due to STEMI (complete blockage of the coronary artery) and unstable angina (transient blockages that cause immediate symptoms) being more likely to present with severe symptoms, but NSTEMI involves partial blockages that may lead to less severe symptoms, causing some patients to delay seeking care. This was somewhat similar to **Obaya, et al (2015)**, who reported that the prevalence of ACS patients admitted to the Critical Care Department, Cairo University, Egypt, was STEMI forty two percent, UA thirty two percent, and NSTEMI twenty five percent for the same age group. These findings were in agreement with **Frisch, et al (2020)** who report that the distribution of ESI scores of one to five in suspected ACS patients was eighteen percent, forty eight percent, twenty eight percent, three out of ten percent, and zero percent, respectively. But this was not in agreement with the study of **Ganjali, et al (2020)** who presented that 400 patients were triaged in the ED by the nurse at eight and half percent ESI score 1, sixteen percent ESI score 2, and fourteen percent ESI score 3.

The present study showed that the main age of triaged patients was around fifty years, and more than two-thirds of patients were males. This denotes that ACS occurs during the working productive age, leading to an economic load on personal and public levels. The familial impact on the development of ACS was more common among young patients than older patients. Also, it is possible that hormonal differences between males and females may play a role in clarifying that male sex is an important risk factor for ACS patients of different diagnoses and age groups. This finding was supported in Egypt by **Bashandy, et al (2019),** who found the age of ACS patients was around fifty years, and the majority of the studied sample was male. These results are not in line with those of **Schrader, et al (2022),** who found that the mean (SD) age of chest pain patients was near fifty years, and more than half were female and presented to the ED without a previous cardiac imaging test.

The findings of this study reveal that there is no statistically significant difference between the ESI triage score and the patients' age, sex, marital status, or level of education. It suggests that these factors may not have a significant impact on the triage score assigned to patients. It could imply that the ESI triage score is robust across different demographic groups. These results agreed with **Stemler, (2021)** who showed no statistical differences between patient characteristics, including age, sex, and the number of resources utilized in ESI triage at the ED. These results were not agreed with **Patel, et al (2024)** who reported differences in ESI triage assignment by patient sex and race/ethnicity after accounting for age,

insurance status, comorbidities, chief complaint, and ED conditions.

The ESI triage score is a tool used to prioritize patients based on the severity of their conditions and the urgency of their need for medical attention. The statistically significant difference between ESI triage scores and patients' diagnoses of ACS with a P-value (0.000) indicates that the severity of ACS may influence the triage scores assigned to patients. This finding could be important for prioritizing care in the ED, ensuring that patients with STEMI receive prompt attention, and preventing further MACE. This was in congruence with **Sanders & DeVon (2016)** who observed that symptom presentation of AMI were significant predictor of ESI triage accuracy. This matches **Seyedhosseini-Davarani, et al (2018)** who reported that the patients with chest pain who were referred to the ED benefitted from the installed triage system through receiving some nursing care, including ECG performance, starting cardiac monitoring, and IV insertion.

Regarding the incidence of MACE within thirty-days, nearly half of the studied patients underwent PCI, followed by nine percent, eight percent, and eight percent who had arrhythmia, cardiogenic shock, and deaths, respectively, but more than a quarter of the studied patients had no MACE. These findings were similar to those of **Srivastava (2021),** who found that the incidence of MACE was more than half of cases. This was not in agreement with **Meier, et al (2023)**, who found that nearly one quarter of patients had at least one MACE within thirty-days, including angina requiring urgent coronary revascularization.

A significant relationship was found between the different levels of triage and the occurrence of MACE with ($p<0.000$). There may be some correlation between ESI scores and the likelihood of experiencing MACE. This provides valuable insights into the effectiveness of triage in identifying patients at risk for cardiac events. This result matches that of **Ganjali, et al (2020)** who report that there is a statistically significant relationship between the different levels of triage performed by the nurse and the outcome of the patient ($p<0.001$), and the five-level system had a highly significant effect on the outcome of the patients. However, **Gholami, et al (2023)** found no statistically significant difference between the triage outcomes, including in-hospital mortality within 24 hours, death in the ED, and discharge from ED.

The present results highlight the accuracy of the ESI triage score in predicting cardiac events among suspected ACS patients in the cardiac ED. Firstly, the ESI triage score at the cutoff of 1 point has sensitivity (53.52%) and correctly identifies about half of the patients who will experience a cardiac event. This relatively low sensitivity highlights a significant limitation: nearly half of the patients at risk for cardiac events are not being flagged by the ESI triage score, indicating a substantial rate of missed cases (false negative), and leading to potential delays in critical care. On the other hand, specificity measures the ability of the ESI to correctly identify patients who will not experience a cardiac event. With a specificity of 84.48%, the ESI is quite effective in correctly identifying patients who are at low risk of a cardiac event. This high specificity indicates a low rate of false positives, meaning that most patients identified as low-risk truly are at low risk. These findings were in agreement with the study by **Sax, et al (2023)** who reported that the sensitivity of ESI was 65.9% and the specificity was 83.4%, for patients with high-acuity needs in the evaluation of the ESI triage score at US EDs for the rate of missed triage.

The positive predictive value (PPV) indicates the proportion of patients identified as high-risk by the ESI triage score who actually experience a cardiac event. A PPV of 89.4% suggests that the ESI is highly reliable in predicting true cardiac events when it does flag a patient as high risk. This high PPV is crucial for ensuring that resources and immediate care are appropriately directed to those who need them. This reflects the likelihood that a positive triage result is accurate. Furthermore, a negative predictive value (42.6%) means that less than half of those classified as low risk are truly free from risk. This relatively low NPV suggests that many patients not identified as high risk might still experience a cardiac event (high false negative rate), which can have serious implications for patient outcomes. On the opposite site **Frisch, et al (2020)** observed that the ESI triage score had a low positive predictive value, and 80% of those classified as having a high acuity level (ESI scores 1 and 2) were event-free for cardiac events in patients with suspected ACS.

Regarding area under the curve (AUC 0.704), it suggests that the ESI triage score has affair level of accuracy in distinguishing between patients who will and will not experience cardiac events. However, it also indicates there is room for improvement. This was not in agreement with **Mistry, et al (2018)** who found that low accuracy for high-acuity cases (ESI levels 1 to 2) (54.0%; 95% CI 49.9% to 58.2%) compared with medium-acuity cases (ESI level 3) (76.4%; 95% CI 72.6% to 80.3%) based on the acuity of standardized cases.

Finally, the ESI triage score has moderate accuracy in predicting cardiac events among suspected ACS patients, with relatively high specificity and PPV but moderate sensitivity and NPV. This implies that while it is good at correctly identifying those at low risk and those flagged as high risk as likely to experience a

cardiac event, it misses nearly half of the actual high-risk cases. This highlights the need for caution for patients flagged as low-risk who might still need careful monitoring to avoid missing significant cardiac events. The fair AUC further suggests that the ESI triage score, while useful, could benefit from enhancements or the integration of additional predictive tools to improve overall accuracy in the cardiac ED setting. The present study results confirm other previous randomized clinical trials by **Shariati, et al (2021)** who reported that the ESI plus cardiac troponin I rapid test may provide a more accurate method for triaging patients with low-risk chest pain compared to the ESI alone in the ED. The ESI is associated with a substantial over-triage rate among patients with low-risk chest pain, and the cardiac troponin I rapid test can substantially reduce this kind of triage error.

Clinical Implications

The moderate sensitivity and high specificity highlight a critical trade-off in the ESI triage score's application. While it is quite effective in identifying patients, who are at low risk (high specificity), it may fail to identify a significant number of high-risk patients (moderate sensitivity). The high PPV is reassuring for decisions based on positive findings, but the low NPV raises concerns about the potential for missed diagnoses.

Limitations of the Study

This was a single institutional study, and the major limitation of this study was the sample size.

Conclusion

This study concludes that the ESI triage score has a moderate accuracy in predicting cardiac events among suspected ACS patients at the cardiac ED.

Recommendations

The need for enhanced training and possibly integrating additional diagnostic tools or biomarkers to improve the ESI triage score's sensitivity and overall predictive accuracy. Reapply this research on a large sample size acquired from different geographical areas in Egypt for better understand the accuracy of ESI in the management of suspected ACS patients.

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