A Comparison of the Performance of SVEAT Score Versus HEART Score in Predicting In-Hospital MACE in Patients Admitted for Chest Pain

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Abstract

Background. Chest pain is a common reason for emergency room visits. The HEART score is used as a risk stratification tool to aid in clinical decision making. The HEART score is a useful tool due to its good sensitivity, however it has low specificity. The SVEAT score was developed as an improved risk stratification tool which outperformed the HEART score in previous studies. Both the performance of HEART and SVEAT scores lack data in our locality.

Objective. To compare the performance of Symptoms, Vascular disease, Electrocardiography, Age, Troponin-I (SVEAT) score and History, Electrocardiography, Age, Risk factors, Troponin-I (HEART) score as predictors of in-hospital Major Adverse Cardiovascular Events (MACE) among adult patients admitted in Chong Hua Hospital Cebu for chest pain.

Methods. This single-center, retrospective, observational analytic study included adult patients, ages 18 years old and above, who were admitted for chest pain from January 1, 2022 to December 31, 2022. All patients who passed the inclusion and exclusion criteria were included in the data analysis. Both SVEAT and HEART scores were calculated for each of the included subjects. The performance of both scoring criteria was compared using logistic regression and area under the receiving-operator characteristic curve.

Results. A total of 113 cases were analyzed after exclusion criteria were applied. A total of 50 (44.2%) individuals suffered MACE. The difference in AUC of both SVEAT (0.946, 95%CI) and HEART (0.936, 95%CI) was not statistically significant (95% CI – 0.013 – 0.033, p = 0.400). With a cut-off of <4, both SVEAT and HEART scores had 100% sensitivity (95%CI), but SVEAT had higher specificity of 76% (95%CI) compared to 41% (95%CI) of HEART score.

Conclusion. SVEAT and HEART scores had similar performance in predicting in-hospital MACE. Using a cut-off value of <4, SVEAT showed better specificity compared to HEART.

Keywords. Chest pain, SVEAT, HEART, myocardial infarction, MACE, acute coronary syndrome

Introduction

Chest pain is one of the most common reasons for Emergency Department visits.[1] Careful evaluation of patients with this complaint will lead to a sound management. The evaluation of chest pain is challenging due to the myriad of possible causes ranging from mild gastric causes to devastating and fatal causes such as Acute Coronary Syndrome.[2]

Acute Coronary Syndrome (ACS) is a group of diseases (ST-elevation myocardial infarction, non-ST segment elevation myocardial infarction, unstable angina) in which there is decreased blood flow towards the heart leading to various symptoms such as chest pain, dyspnea, palpitations. The leading symptom that leads to evaluation for acute coronary syndrome is chest pain. ACS is responsible for one-third of deaths of adults aged greater than 35 years old.[3]

Many patients present with chest pain are low risk and can be managed as an outpatient basis. The HEART score was developed to assess if the patients presenting with chest pain are low risk, intermediate or high risk for short-term cardiovascular outcomes. HEART score is technically an abbreviation of five parameters that are evaluated in a patient presenting with chest pain. It is composed of the History, ECG abnormalities, Age of the patient, Risk factors, Troponin I levels. The HEART score of a patient guides the emergency department (ED)

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physician in deciding whether the patient can be safely sent home from the ED or not.[4]

The SVEAT score is a recently developed risk stratification scoring composed of the following parameters: Symptoms, history of Vascular disease, Electrocardiography, Age, and Troponin I.[1] It was shown that compared to HEART score and TIMI (Thrombolysis in Myocardial Infarction) score, SVEAT score of 4 had less 30-days major adverse cardiovascular events (MACE) compared to low risk HEART score and TIMI score patients.[5] Additionally, SVEAT score was also able to identify a larger group of patients at low risk of MACE compared to HEART and TIMI.[5]

As of this writing, there is still no data on the performance of both SVEAT score and HEART score in the local setting.

Significance of the Study

The performance of SVEAT score was noted to be superior in predicting the outcomes of chest pain patients compared to HEART score. However, there is no data as of this writing in our locality. The study aimed to provide benchmark data on SVEAT score and compare its performance to HEART score in predicting in-hospital MACE.

Research Question

"In adult patients admitted for the chief complaint of chest pain, how does the performance of SVEAT score compare to that of HEART score in predicting patients that will suffer in-hospital MACE?"

General Objective

To compare the performance of SVEAT score and HEART score as predictors of in-hospital MACE among adult patients admitted for chest pain

Specific Objectives

1. To summarize baseline demographic and clinical characteristics of patients admitted for chest pain from January 1, 2022 to December 31, 2022
2. To determine the outcome in terms of MACE among patients admitted for chest pain
3. To measure the performance of SVEAT score in predicting in-hospital MACE among patients admitted for chest pain and compare it with the performance of HEART score.

Operational Definition of Terms

1. T Myocardial Infarction: Death of myocardial tissue primarily due to inadequate oxygen delivery commonly caused by decrease in blood flow through a diseased coronary artery.
2. ST-elevation Myocardial infarction: Myocardial infarction with electrocardiogram changes showing elevation of the ST segments.
3. Non-ST-elevation Myocardial infarction: Myocardial infarction with no ST-segment elevation on ECG but with elevated troponin I.
4. Unstable Angina: Chest pain produced by inadequate delivery of oxygen to myocardial tissues without resulting death of myocardial tissue or elevation of cardiac enzymes
5. ACS: Acute coronary syndrome, a group of diseases resulting from coronary pathology causing acute chest pain.
6. ECG: Electrocardiogram, a recording of the electrical activity of the heart.
7. Troponin I: A cardiac biomarker used to detect myocardial infarction
8. MACE: **M**ajor **A**dverse **C**ardiovascular **Events**. In this study, MACE is used as the outcome and is composed of 5 different entities which are the following: acute myocardial infarction, all-cause mortality, newly diagnosed coronary artery disease treated pharmacologically, advised/did revascularization, unstable angina.
9. HEART (**H**istory, **E**lectrocardiography, **A**ge, **R**isk Factors, **T**roponin-I) score: a risk stratification tool which uses parameters such as characteristics of chest pain, ECG, age, risk factors, and Troponin I levels to determine risk of MACE on patients presenting with chest pain.
10. SVEAT (**S**ymptoms, **V**ascular Disease, **E**lectrocardiography, **A**ge, Troponin-I) score: a new risk stratification tool which uses symptoms, history of vascular disease, ECG, age, and Troponin I levels to determine risk of MACE on patients with chest pain.
11. TIMI (**T**hrombolysis **I**n **M**yocardial **I**nfarction) score: is another scoring criteria used for predicting outcomes of patients admitted for chest pain.
12. Youden index: it is a statistical measure used to evaluate the performance of a diagnostic test.

Study Design

This was a single-center, retrospective, observational, analytical study.

Study Setting

The study was done at Chong Hua Hospital, Cebu City, a private tertiary hospital with a total bed capacity of 660. This institution is a percutaneous coronary intervention capable institution.

Study Population

The study reviewed all patients admitted with the chief complaint of chest pain from January 1, 2022 to December 31, 2022. A total of 255 charts were included and reviewed. Among the 255 patients, only 113 of them were included in the final data analysis.

Inclusion Criterion

1. Adult patients aged 18 years old and above who were admitted for chest pain from January 1, 2022 to December 31, 2022

Exclusion Criteria

1. Hemodynamic instability (unstable vital signs, patients in shock, unstable arrhythmias)
2. Traumatic non-cardiac chest pain
3. Clear cut ST-segment elevation on 12-L ECG
4. Incomplete work-up/data (Lacking 12-L ECG, no troponin I, Discharge against medical advice, transfer to another institution)
5. Unretrievable chart

Sample Size

A sample size of 246 was calculated prior to initiation of the study. A total of 255 charts were initially screened, however only 113 cases were included in the data analysis.

Data Collection/Maneuvers

After approval by the Institutional Review Board of Chong Hua Hospital, a list of patients admitted with the chief complaint of "chest pain" from January 1, 2022 to December 31, 2022 was requested from the IT department and the medical records section. A list of 255 patients admitted was provided by the Information Technology department and access was approved by the Medical Records section. The electronic data of each patient listed was reviewed using a computer at the Medical Records section. Pertinent data such as age, sex, smoking history, comorbidities, BMI, ECG, Troponin I were recorded, and the history, physical examination findings, and overall clinical presentation, as well as the course of the admission, laboratory findings, angiogram reports, and final diagnoses of each patient were reviewed.

Using the data extracted from the electronic chart review, a HEART and SVEAT score (see Appendix 1 and 2) was calculated for each patient by the principal investigator. The investigator assigned a score of 0 under the Vascular criterion of the SVEAT score when the patient did not fulfill any of the parameters listed since the original study did not specify. The assay used for the determination of Troponin I was a Mini Vidas High Sensitivity Troponin I assay with a recommended 99th percentile cut-off of 19ng/l. The Troponin I values were converted by the investigator to ng/ml for ease of use. The SVEAT Troponin I parameters were adjusted accordingly to fit the assay's recommended cut-off point. The adjustments include the following:

- -2 points for Troponin I of < 0.019ng/ml after >4 hrs of constant chest pain (</= 0.04ng/ml on original study)
- 0 points for normal Troponin I (< 0.019ng/ml) with unclear duration of chest pain (</= 0.04 on original study)
- 1 point for Troponin I of 0.019 to 0.057ng/ml or 1 to 3 times the cut-off (>0.04 to </= to 0.12ng/ml on original study)
- 2 points for Troponin I of 0.058ng/mg to 0.332ng/ml or >3 to 17.4 times the cut-off (>0.12 to 0.7ng/ml on original study)
- 5 points for Troponin I of 0.333ng/ml or greater or >/= 17.5 times the cut-off (0.7ng/ml or higher on original study)

It was recorded whether the patient suffered from in-hospital MACE (composite of acute myocardial infarction, all-cause mortality, newly diagnosed coronary artery disease treated pharmacologically, advised or performed revascularization, unstable angina) as the primary endpoint. Data collected from each patient was written in number coded case record forms with no patient identifiers. The case record forms (see appendix) were then encoded into an electronic database which only the researcher had access to in a password-protected laptop. The case record forms were placed in a secured container under lock and key then disposed appropriately after completion of the study.

Figure 1 illustrates the schematic diagram of the study. Among the charts reviewed, 9 patients were excluded due to hemodynamic instability, 34 cases were excluded due to ST-segment elevation on presentation. Due to incomplete data 96 cases were excluded, this was mostly due to lack of admitting Troponin I. Among the cases with incomplete data, 3 were due to discharge against medical advice or transferred to another institution. There was 1 case of traumatic noncardiac chest pain and 2 cases of unretrievable charts. A total of 142 cases were excluded.

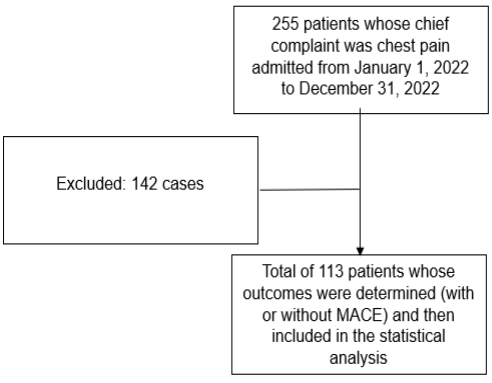

Figure 1. Comparison of the Performance of SVEAT Score Versus HEART Score in Predicting In-Hospital MACE in Patients Admitted for Chest Pain

Statistical Analysis

Descriptive statistics was done to present the demographics of the population. The demographic data of those who suffered MACE were compared to those who did not. Quantitative variables such as age were presented as mean and +/- SD and qualitative variables such as risk factors were presented as percentages. The logistic regression was done to determine predictive power for in-hospital MACE for both SVEAT and HEART scores and were compared using an area under the receiving-operator characteristic curve (AU-ROC). A paired sample comparison of both areas under the curve was done to compare the performance of both scoring systems. The highest Youden index of both HEART and SVEAT were identified and the diagnostic performance of both scoring systems were outlined.

Statistical Analysis

The researcher ensured that this research complied with the ethical principles set forth in the Declaration of Helsinki and National Ethical Guidelines for health and health related research. All data gathered were considered confidential and no patient identifiers were recorded during the data collection. The case record forms were stored and kept with utmost care and disposed of properly thereafter. The electronic spreadsheets were number coded and no patient identifiers were included.

The research was self-funded. It was not supported by any drug company or another individual. This research was done for the compliance with the requirements set by the Chong Hua Hospital Internal Medicine Training program and the Philippine College of Physicians, and for the genuine pursuit of the researcher to contribute to the field of science and medical research.

Results

A total of 255 charts were screened for this study and 142 were excluded as previously discussed. Out of the 113 samples analyzed, 50 or 44.2% suffered MACE. Among the patients who suffered MACE, there was one mortality due to myocardial infarction. A total of 35 patients suffered from myocardial infarction, 10 patients had unstable angina, and the remaining 5 patients were diagnosed with coronary artery disease on angiogram and were advised revascularization.

Table I presents a comparison of the demographic and clinical characteristics of patients who were admitted for chest pain. The analysis distinguished between patients who experienced major adverse cardiovascular events (MACE) during their hospital stay and those who did not. It is important to note that individuals who experienced in-hospital MACE had a notably higher average age of 64 years, compared to 52 years in the group without MACE. The gender distribution was quite similar, with a slight male predominance in both groups. Approximately a quarter of patients in both subsets were smokers, with a slightly higher prevalence among those who developed in-hospital MACE, although this difference was not statistically significant. Recent alcohol consumption and recent smoking were relatively rare in both groups, and there were no significant differences between the subsets. In terms of comorbidities, those who suffered in-hospital MACE generally had a higher frequency of these conditions. Hypertension was significantly more prevalent in this subset, with rates of 87.8% compared to 70.4% in the group without MACE. Similarly, history of coronary artery disease was significantly more common among those with MACE (34.7% compared to 17.2% in the non-MACE group). Notably diabetes mellitus was markedly more prevalent at 61.2% in the MACE group compared to 29.7% in the non-MACE group. However, obesity and dyslipidemia were slightly more common in the non-MACE group, although the difference was not statistically significant.

Moreover, patients who suffered in-hospital MACE displayed a notably higher incidence of previous acute coronary syndrome (ACS) compared to those who did not. Similarly, individuals who experienced in-hospital MACE were slightly more likely to have a history of prior percutaneous coronary intervention (PCI). The average troponin levels were significantly elevated in the group with in-hospital MACE (0.09 ng/mL vs 1.70 ng/mL, $p = 0.001$). It is worth noting that the mean Troponin I of the patients who did not suffer MACE was much higher than the set cut-off value of the assay(0.019ng/ml). This is due to one case of Viral myocarditis with a Troponin I of 5.2168ng/ml affecting the mean.

Consistent with these findings, both the SVEAT and HEART scores were markedly elevated in patients with in-hospital MACE. This alignment is corroborated by the Receiver Operating Characteristics Curve illustrated in figure 2, indicating that both SVEAT and HEART scores performed comparably well in predicting outcomes, with AUC values exceeding 90%. The highest Youden Indices were observed at scores of 3.5 and 5.5, respectively. The performance of both indicators is outlined in table II, demonstrating their similarity. The difference in AUC, which was 0.010, was not statistically significant (95% CI – 0.013 – 0.033, $p = 0.400$).

Furthermore, the performance of both tests was evaluated using cut-offs suggested by literature (SVEAT of 4 and HEART of 3) and is outlined in table III. When using a HEART score of 3 as cut-off, the Sensitivity and Negative Predictive Value improved to 1.0, however both specificity and positive predictive values of the test decreased. The performance of a SVEAT score of 4 had a slight decrease in sensitivity and negative predictive value with also a slight improvement of the positive predictive value and specificity.

	Without In-Hospital MACE (n=63, 55.8%)	With In-Hospital MACE (n=50, 44.2%)	p
Age, years, mean (SD)	51.92 (18.96)	64.57 (13.59)	**0.001**
Sex, male, frequency (%)	33 (51.6)	27 (55.1)	0.709
Smoking, frequency (%)	17 (26.6)	18 (36.7)	0.246
Recent Smoking, frequency (%)	10 (15.6)	13 (26.5)	0.154
Recent Alcohol Intake, frequency (%)	8 (12.5)	12 (24.5)	0.098
Hypertension, frequency (%)	45 (70.3)	43 (87.8)	**0.027**
Diabetes Mellitus, frequency (%)	19 (29.7)	30 (61.2)	**0.001**
CAD, frequency (%)	11 (17.2)	17 (34.7)	**0.046**
Obesity, frequency (%)	18 (28.1)	12 (24.5)	0.665
Dyslipidemia, frequency (%)	22 (40.8)	22 (34.4)	0.483
Family History of CAD, frequency (%)	21 (32.8)	19 (38.8)	0.511
Prior ACS, frequency (%)	3 (4.7)	10 (20.4)	**0.009**
Prior CABG, frequency (%)	0 (0.0)	1 (2.0)	-
Prior PCI, frequency (%)	5 (7.8)	10 (20.4)	0.051
Prior Peripheral Revascularization, frequency (%)	0 (0.0)	0 (0.0)	-
BMI, kg/m^2, mean (SD)	27.52 (4.75)	26.41 (5.38)	0.806
Troponin – I, ng/mL, mean (SD)	0.09 (0.65)	1.70 (6.41)	**0.001**
SVEAT Score, mean (SD)	1.98 (2.86)	7.71 (2.81)	**0.000**
HEART Score, mean (SD)	3.88 (1.86)	7.47 (1.45)	**0.000**
Length of Hospital Stay, days, mean (SD)	4.94 (5.59)	7.98 (7.87)	**0.020**

Table I. Comparison of Demographic and Clinical Characteristics of Patients Admitted for Chest Pain

	SVEAT (3.5 or <4)	HEART (5.5 or <6)
Sensitivity (95% CI)	1.00 (1.00)	0.90 (0.83-0.98)
Specificity (95% CI)	0.76 (0.64-0.88)	0.86 (0.76-0.96)
Positive Predictive Value (95% CI)	0.84 (0.76-0.92)	0.89 (0.81-0.97)
Negative Predictive Value (95% CI)	1.00 (1.00)	0.88 (0.79-0.97)
PLR (95% CI)	4.17 (2.54-6.82)	6.46 (3.24-12.91)
NLR (95% CI)	-	0.11 (0.05-0.24)
AUC (95% CI)	0.946	0.936
Paired Sample Comparison of AUC		
▪ AUC Difference (95% CI)	0.010 (-0.13-0.033)	
▪ p	0.400	

Diagnostic Data from Point Estimates from AUC with highest Youden Index

Table II. Diagnostic Performance of SVEAT Score and HEART Score in Predicting In-Hospital MAC

	SVEAT (4)	HEART (3 or <4)
Sensitivity (95% CI)	0.92 (0.84-0.99)	**1.00 (1.00)**
Specificity (95% CI)	0.84 (0.75-0.93)	0.41 (0.29-0.53)
Positive Predictive Value (95% CI)	0.82 (0.72-0.92)	0.57 (0.47-0.67)
Negative Predictive Value (95% CI)	0.92 (0.86-0.99)	**1.00 (1.00)**
PLR (95% CI)	5.80 (3.26-10.29)	1.70 (1.38-2.09)
NLR (95% CI)	0.10 (0.04-0.24)	0.00 (0.00)

Table III. Diagnostic Performance of SVEAT Score and HEART Score in Predicting In-Hospital MACE using Cut-offs used in Literature (SVEAT of 4 and HEART of 3).

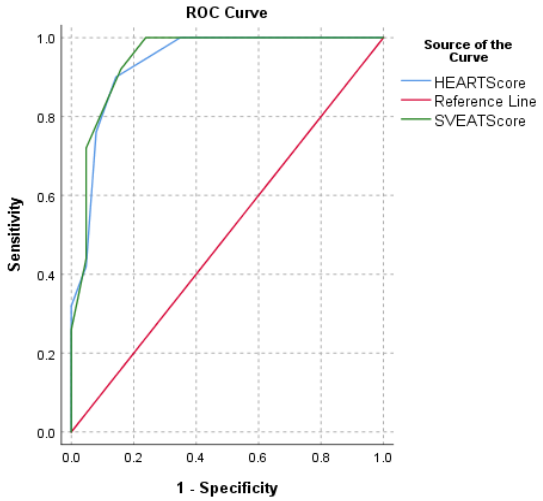

Figure 2. A Comparison of the Performance of SVEAT Score Versus HEART Score in Predicting In-Hospital MACE on Patients Admitted for Chest Pain

Discussion

Coronary artery disease is the main cause of acute myocardial infarction. Patients with a history of acute coronary syndrome are at higher risk of recurrent cardiovascular events and hospitalization.[10] Ageing and the changes that comes with it are the most important determinants of cardiovascular health.[11] Increased blood pressure and diabetes mellitus are associated with increased coronary heart disease incidence and mortality.[12]

The HEART score has been and is currently used as a clinical determinant in risk stratifying patients with chest discomfort.[6] A Low risk patient according to the HEART pathway is a score of less than 3 with negative 0, 3 hour conventional Troponin assay or, 0, 2 hour High sensitivity troponin assay.[6] The use of HEART score in clinical decision making increases emergency department discharge by 21%, decreases 30-day objective testing by 12% and decreases length of hospital stay by 12 hours.[6] A Low-risk heart score (0-3) has high sensitivity, negative predictive value, and negative likelihood ratio for predicting short term MACE.[7] In a meta-analysis published last 2018, the HEART score of 4 has a sensitivity of 95.9% in predicting 30-day MACE making it an ideal clinical decision tool.[13] Staying true to its power as a rule-out test, this study showed that a HEART score with a cut-off value of 3 has both sensitivity and negative predictive value of 100% (95%CI) in predicting in-hospital MACE. The downside of HEART score is its low specificity.[13] This is mirrored by our data which shows specificity of 41% (95%CI) when it comes to identifying In-hospital MACE. This means that more than half of true low risk patients were subjected to further work-up and expenses.

A new risk stratification tool, the SVEAT score, was developed with a clearer definition for chest pain, more specific ECG criteria, as well placing more weight on Troponin I level compared to HEART score.[1] SVEAT was reported to outperform both HEART and TIMI scores in predicting outcomes of chest pain patients visiting the emergency department.[1][2] The inaugural study showed that SVEAT score was also able to identify a larger proportion of low-risk patients compared to HEART and TIMI.[1]

In this study, SVEAT did not outperform HEART score when it came to predicting in-hospital MACE. This could be due to the endpoint used (composite of acute myocardial infarction, all-cause mortality, newly diagnosed coronary artery disease treated pharmacologically, advised/performed revascularization, unstable angina) in the study design. The SVEAT tool struggled to identify unstable angina as high risk thus affecting its sensitivity. A total of 10 patients had unstable angina, 3 of which were identified as low risk with 4 as cut-off.

When a SVEAT score of 3.5 (<4) as cut-off was used, it showed 100% sensitivity (95% CI) and negative predictive value of 100% (95% CI) making this an ideal rule-out test when it comes to predicting in-hospital MACE. Also, the specificity of a SVEAT score of <4 is higher (76%, 95%CI) compared to HEART score of <4 (41%, 95%CI).

The study was only limited to patients admitted for chest discomfort in a single center over a period of 1 year. The collection of data, analysis, storage, and interpretation of HEART and SVEAT scores were done solely by the principal investigator with the help of a statistician for the data analysis. The outcomes reported were based on hospital records only. Major adverse cardiovascular events defined in this study included unstable angina which was not used as part of MACE in previous studies of both HEART and SVEAT.[1] The positive outcome in this study was limited to in-hospital MACE as compared to 30-day MACE used by previous studies on HEART and SVEAT.

Conclusion

SVEAT did not outperform HEART score in terms of predicting in-hospital MACE in adult patients admitted for chest pain. However, using a SVEAT score of <4 as cut-off is as sensitive to a HEART score of <4, but is more specific in correctly predicting in-hospital MACE and is potentially useful in our setting as a clinical decision tool.

Recommendations

The researcher recommends a multi-center study with patients admitted from the emergency department with chest pain recruited as cohorts. This is to accommodate the varying demographics of different institutions to have a larger study population. Instead of in-hospital MACE, it is recommended to measure outcomes after 30 days or 6 weeks. The researcher also recommends modification of the original SVEAT score criteria especially on the Troponin I and Vascular parameters. Instead of using absolute values, the researcher recommends using multiples of the trop-I results similar to what was done in

this study. This is to accommodate different cut-off values from different troponin-I assays of different institutions. With regards to the vascular component, the researcher suggests assigning a score of zero for those who do not have history of coronary or peripheral arterial disease (see Appendix 4).

References

1. Roongsritong C, Taha ME, Pisipati S, Aung S, Latt H, Thomas J, Namballa L, Al-Hasnawi HJ, Taylor MK, Gullapalli N. SVEAT Score, a Potential New and Improved Tool for Acute Chest Pain Risk Stratification. Am J Cardiol. 2020 Jul 15;127:36-40. doi: 10.1016/j.amjcard.2020.04.009. Epub 2020 Apr 20. PMID: 32418720.
2. Johnson K, Ghassemzadeh S. Chest Pain. [Updated 2022 Dec 14]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK470557/
3. Singh A, Museedi AS, Grossman SA. Acute Coronary Syndrome. [Updated 2022 Jul 11]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK459157/
4. Brady W, de Souza K. The HEART score: A guide to its application in the emergency department. Turk J Emerg Med. 2018 Jun 14;18(2):47-51. doi: 10.1016/j.tjem.2018.04.004. PMID: 29922729; PMCID: PMC6005932.
5. Antwi-Amoabeng D, Roongsritong C, Taha M, Beutler BD, Awad M, Hanfy A, Ghuman J, Manasewitsch NT, Singh S, Quang C, Gullapalli N. SVEAT score outperforms HEART score in patients admitted to a chest pain observation unit. World J Cardiol. 2022 Aug 26;14(8):454-461. doi: 10.4330/wjc.v14.i8.454. PMID: 36160811; PMCID: PMC9453257.
6. Gulati M, Levy PD, Mukherjee D, Amsterdam E, Bhatt DL, Birtcher KK, Blankstein R, Boyd J, Bullock-Palmer RP, Conejo T, Diercks DB, Gentile F, Greenwood JP, Hess EP, Hollenberg SM, Jaber WA, Jneid H, Joglar JA, Morrow DA, O'Connor RE, Ross MA, Shaw LJ. 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation. 2021 Nov 30;144(22):e368-e454. doi: 10.1161/CIR.0000000000001029. Epub 2021 Oct 28. Erratum in: Circulation. 2021 Nov 30;144(22):e455. PMID: 34709879.
7. Laureano-Phillips J, Robinson RD, Aryal S, Blair S, Wilson D, Boyd K, Schrader CD, Zenarosa NR, Wang H. HEART Score Risk Stratification of Low-Risk Chest Pain Patients in the Emergency Department: A Systematic Review and Meta-Analysis. Ann Emerg Med. 2019 Aug;74(2):187-203. doi: 10.1016/j.annemergmed.2018.12.010. Epub 2019 Feb 2. PMID: 30718010.
8. Backus BE, Six AJ, Kelder JC, Mast TP, van den Akker F, Mast EG, Monnink SH, van Tooren RM, Doevendans PA. Chest pain in the emergency room: a multicenter validation of the HEART Score. Crit Pathw Cardiol. 2010 Sep;9(3):164-9. doi: 10.1097/HPC.0b013e3181ec36d8. PMID: 20802272.
9. Scheen AJ. De l'athérosclérose à l'athérothrombose: D'une pathologie chronique silencieuse à un accident aigu critique [From atherosclerosis to atherothrombosis : from a silent chronic pathology to an acute critical event]. Rev Med Liege. 2018 May;73(5-6):224-228. French. PMID: 29926559.
10. Bustea C, Tit DM, Bungau AF, Bungau SG, Pantea VA, Babes EE, Pantea-Roșan LR. Predictors of Readmission after the First Acute Coronary Syndrome and the Risk of Recurrent Cardiovascular Events—Seven Years of Patient Follow-Up. *Life*. 2023; 13(4):950. https://doi.org/10.3390/life13040950
11. North, B. J., & Sinclair, D. A. (2012). The intersection between aging and cardiovascular disease. *Circulation Research*, *110*(8), 1097–1108. https://doi.org/10.1161/circresaha.111.246876
12. Jousilahti, P., Vartiainen, E., Tuomilehto, J., & Puska, P. (1999). Sex, age, cardiovascular risk factors, and coronary heart disease. *Circulation*, *99*(9), 1165–1172. https://doi.org/10.1161/01.cir.99.9.1165
13. Fernando, S. M., Tran, A., Cheng, W., Rochwerg, B., Taljaard, M., Thiruganasambandamoorthy, V., Kyeremanteng, K., & Perry, J. J. (2018). Prognostic Accuracy of the HEART score for prediction of major adverse cardiac events in patients presenting with chest pain: a systematic review and meta-analysis. *Academic Emergency Medicine*, *26*(2), 140–151. https://doi.org/10.1111/acem.13649

Appendix 1

HEART Score Table

HEART Score		
Component	**Grading**	**Score**
History	Highly suspicious	2
	Moderately suspicious	1
	Slightly or non-suspicious	0
ECG	Significant ST-depressions	2
	Nonspecific repolarization disturbance	1
	Normal	0
Age	≥ 65 years	2
	45-64 years	1
	≤ 45 years	0
Risk factors	≥ 3 risk factors, or history of atherosclerotic disease	2
	1-2 risk factors	1
	No known risk factors	0
Troponin	≥ 3X normal limit	2
	> 1 - < 3X normal limit	1
	< Normal limit	0

Note: From "Long, B. (2021, May 24). The Great and Powerful HEART Score: Does it have a weakness? emDOCs.net - Emergency Medicine Education. http://www.emdocs.net/great-powerful-heart-score-weakness/"

APPENDIX 2

SVEAT Score Table

Component	Characteristics	Points
Symptoms	Typical unstable angina pectoris	3
	Stable angina, Canadian Cardiovascular Society Class I or II	1
	Non-cardiac chest pain	-2
Vascular disease	Recent myocardial infarction or percutaneous coronary intervention < 90 days	2
	Coronary artery bypass grafting > 5 years	2
	Prior coronary event other than above	1
	Prior revascularization for peripheral disease or carotid disease	2
EKG	Dynamic or new ischemic ST or T wave changes	3
	ST depression of unknown duration without cause	2
	ST changes with left ventricular hypertrophy, intraventricular conduction delay, digitalis, or metabolic issue	1
	Old Q wave indicating prior myocardial infarction or pre-existing ST changes	1
	No ST changes	0
	Normal EKG in the presence of severe ongoing chest pain	-2
Age (years)	> 75	2
	50-75	1
	30-49	0
	< 30	-1
Troponin I (ng/mL)	0.7 or higher	5
	> 0.12 but < 0.7	2
	> 0.04 but < or = 0.12	1
	Normal (< or = 0.004) with unclear duration of chest pain	0
	Normal after > 4 h of constant chest pain	-2

Note: From "SVEAT Score: A Potential New and Improved Tool for Acute Chest Pain Risk Stratification," by Roongsritong, C., Taha, M.E., Pisipati, S., Aung, S., Latt, H., Thomas, J., Namballa, L., Al-Hasnawi, H.J., Taylor, M.K., & Gullapalli, N., 2020, American Journal of Cardiology, 127:36-40 (https:// doi: 10.1016/j.amjcard.2020.04.009. Epub 2020 Apr 20. PMID: 32418720.)

APPENDIX 3
CASE RECORD FORM

CASE NUMBER:
DATE ADMITTED:
DATE DISCHARGED:
DATE OF DATA COLLECTION :
DEMOGRAPHICS

AGE:	
SEX:	
NATIONALITY/ETHNICITY	
OCCUPATION IF APPLICABLE	

PLEASE ENCIRCLE IF **Y** IF YES OR **N** IF NO
HISTORY OF RECENT TRAUMA TO THE CHEST: Y/N
RISK FACTORS:
SMOKING HISTORY: Y/N
DRUG USE: Y/N SPECIFY:

RECENT ALCOHOL USE: Y/N
HYPERTENSION: Y/N
FAMILY HISTORY OF CAD: Y/N
BMI:
DYSLIPIDEMIA: Y/N
DIABETES MELLITUS: Y/N
RECENT OR CURRENT SMOKER(WITHIN 30 DAYS) Y/N
IS THE PATIENT TERMINALLY ILL? Y/N
HISTORY OF ACS: Y/N IF YES, WHEN? _____
HISTORY OF CABG: Y/N IF YES, WHEN? ____
HISTORY OF PCI: Y/N IF YES, WHEN? _____
PRIOR REVASCULARIZATIOBN FOR PAOD/CAROTID DISEASE: ____ IF YES, WHEN?

EMERGENCY DEPARTMENT DATA

SENSORIUM: GCS___
BP: ___ HR: ___RR: ___ T: ____ O2SAT: _____
ECG INTERPRETATION:
INITIAL TROP-I LEVEL:
TROP-I CONVERTED TO NG/ML:
EXCLUSION CRITERIA:
CLEAR CUT ST SEGMENT ELEVATION: Y/N
TRAUMATIC NON-CARDIAC CHEST PAIN: Y/N
UNABLE TO PROVIDE CONSENT Y/N
HEMODYNAMIC INSTABILITY: Y/N

ADMITTING IMPRESSION:

DISCHARGE DIAGNOSIS:

SVEAT SCORE:_____
HEART SCORE:_____
(SEE ATTACHED TABLES FOR GUIDANCE OF SVEAT AND HEART SCORE CRITERIA)
OUTCOME:
PLEASE WRITE YES IF APPLICABLE AND NO IF NOT APPLICABLE
MACE(ALL CAUSE MORTALITY, MYOCARDIAL INFARCTION, CORONARY REVASCULARIZATION, UNSTABLE ANGINA): Y/N
IF YES THEN
PLEASE SPECIFY AMONG LIST OF MACE:_____
HEALTHY (NO MACE) _____
DAYS IN HOSPITAL

APPENDIX 4

Suggested SVEAT score modification

Component	Characteristics	Points
Symptoms	Typical Unstable angina pectoris	3
	Stable angina, Canadian Cardiovascular society class I or II	1
	Non-cardiac chest pain	-2
Vascular disease	Recent myocardial infarction or percutaneous coronary intervention < 90 days	2
	Coronary artery bypass graft > 5 years	2
	Prior coronary event other than above	1
	Prior revascularization for peripheral or carotid disease	2
	No known history of coronary, peripheral or carotid disease	0
EKG	Dynamic or new ischemic ST or T wave changes	3
	ST depression of unknown duration without cause	2
	ST changes with left ventricular hypertrophy, intraventricular conduction delay, digitalis, or metabolic issue	1
	Old Q wave indicating prior myocardial infarction or pre-existing ST changes	1
	No ST changes	0
	Normal EKG in the presence of severe ongoing chest pain	-2
Age (years)	>75	2
	50-75	1
	30-49	0
	<30	-1
Troponin I	17.5 times cut-off value or higher	5
	>3 to 17.4 times cut-off value	2
	1 to 3 times cut-off value	1
	<1 of cut-off value	0
	< 1 of cut-off value after >4 hrs of constant chest pain	-2