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Emergency Department Triage Factors Predictive of Acute Coronary Syndrome

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1. Introduction

Emergency department (ED) nurses triage over136 million patients each year.[1] The goal of triage is to assess and identify clinical conditions in order to prioritize those with significant risk of morbidity and mortality. Most EDs in the United States use the Emergency Severity Index score (ESI),[2]which has limitations including subjectivity,[3] racial bias,[4-6] poor relation to patient-centered outcomes, and failure to differentiate acute patients(poor specificity).[7] As such, the ESI tool fails to identify patient-specific factors that are present at the time of triage that accurately predict clinical conditions requiring life-saving interventions.

Due to its time sensitive nature, complex symptomatology, and variable outcomes, acute coronary syndrome was selected as an exemplary time-sensitive critical condition. Chest pain is frequently recognized as a sign of potential ACS and is the 2nd leading reason to seek medical care in the ED, accounting for nearly 7 million visits yearly.[8] Of 800,000 new annual ACS cases, nurses fail to identify approximately 50% of them during triage.[9-13] In fact, our preliminary work demonstrates that only 38% of ED chest pain patients who manifest true ACS during hospitalization received the highest ESI score at initial nurse triage. This suggests an urgent need to improve triage tools, specifically one that correctly identifies ACS early, which could reduce mortality by 10%- 20%.[14,15] To address these gaps, the purpose of this study aimed to identify key patient factors available at initial ED presentation using binary logistic regression to predict ACS in an attempt to help nurses rapidly interpret clinical information to classify patients and eliminate unnecessary morbidities and mortality.

B. Methods

B.1 Research Design

This was a retrospective, correlational, descriptive study from the EMPIRE parent study that prospectively enrolled consecutive chest pain or equivalent patients that called 9-1-1 from January 2014 to June 2015 having a 12-lead electrocardiogram (ECG) performed by the City of Pittsburgh emergency medical services (EMS).[16] A waiver of informed consent was obtained to enroll all consecutive chest pain patients that were transported by ambulance to three academic affiliated hospitals. Clinical data from an a prior patient feature list from pre-hospital and in-hospital phases of care, and 30-day follow up were collected.

B.2 Participant Inclusion and Exclusion

Consecutive patients who met the following criteria were included: (1) 21 years of age or older; (2) present with a chief compliant of non-traumatic chest pain or other atypical symptoms suspicious of ACS (e.g. shortness of breath); and (3) arrived at the ED by EMS transport with 12-lead electrocardiogram (ECG) already obtained. There were no restrictions to sex or race. The following patients were excluded:

(1) those with traumatic chest pain; (2) those arriving to ED by private vehicle; and (3) those with pacing or uninterpretable 12-lead ECG due to excessive noise.

B.3 Variables

B.3.1 Defining Patient Factors (Predictive Independent Variables)

Patient factors from the in-hospital electronic health records (EHR) at the initial patient encounter that could be known at nurse triage were extracted. Standard patient charting is by exception only. This means the nurse only documents abnormal findings; if it is not charted, it is presumed to be normal. The following variables according to the American College of Cardiology initial assessment requirements were considered in the development of a multivariable regression model: (1) patient demographic characteristics (e.g. age, sex, race); (2) patient initial vital signs (e.g. systolic blood pressure, heart rate, pulse oximetry, respiratory rate); and (3) patient self-reported past medical history and chart past medical history (e.g. history of hypertension, diabetes mellitus, etc.).

B.3.2 Defining Patient Outcome Variable (Dependent Variable): Acute Coronary Syndrome

ACS was defined as per the American Heart Association and American College of Cardiology Universal Definition criteria as: (1) elevated cardiac troponin (greater to or equal to the 99th percentile of normal reference), (2) ECG indicative of ischemic changes, (3) echocardiographic images evident with new loss of viable myocardium or new regional wall motion abnormalities, or (4) coronary angiographic or nuclear imaging demonstrating great than 70% stenosis of a major coronary artery with or without treatment.[17,18] Two independent reviewers examined available medical and diagnostic records to adjudicate the presence of ACS. Disagreement was resolved by a third reviewer.

B.3.4 Statistical Analysis

All statistical analyses were performed on SPSS® version 25 (IBM, Armonk, NY). Prior to any inferential analysis, we performed a detailed descriptive analysis of each variable. We presented continuous variables as means and standard deviation or as median (interquartile range) and tested with a Student t test or the Mann-Whitney U test. We presented categorical variables as percentages and tested with Chi-Square. Graphical techniques were used to identify outliers. Statistical adjustments of score altering and winterization were done as needed. The associations of key patient factors with extraneous covariates were investigated to determine the need for covariate adjustment. Due to the exploratory nature of this analysis, predictors of ACS at $p < 0.50$ in a univariable logistic regression were entered in a multivariable logistic regression model with a cut off of 0.5 for backward selection. Significance level was set at 0.05 for two-sided hypothesis testing. Binary logistic regression was used to analyze data to ensure robust results. Adjusted odd-ratios with 95% confidence intervals and p-values are reported for the final model.

C. Results

After excluding three participants with missing ED data, the final sample was n=747 (age 59±17 years, 43% female, and 41% Black). One hundred and fifteen (15.4%) of participants had the outcome of ACS. Of those who developed ACS, the mean age was greater than the non-ACS group (p=0.03). Within the ACS group, 79% were Caucasian and 62% were males. The final odd ratios (95% confidence interval) of the parsimonious model had the following variables that were significant: 1) age, 1.020 (1.004, 1.035), p=0.012; 2) race (Caucasian) 0.289 (0.172, 0.486), p<0.001; 3) past medical history of hypertension, 0.519 (0.306, 0.880), p= 0.015; 4) past medical history of insulin use, 3.313 (1.801, 6.093), p<0.001; 5) past medical history of coronary artery disease, 0.490 (0.264, 0.910), p=0.024; 6) initial ED heart rate, 0.030 (0.004, 0.245), p=0.001; and 7) initial ED respiratory rate, 1.114 (1.057, 1.175), p<0.001. The following positive interactions between: past medical history of insulin use and initial ED heart rate (p=0.006), initial ED respiratory rate (p=0.034) and history of coronary heart disease (p=0.018), respectively were noted. Other positive interactions between past medical history of CABG/ PCI and initial systolic blood pressure (p=0.012) and initial heart rate (p=0.011) were also noted. Lastly, past medical

history of coronary artery disease interacted with initial ED heart rate (0.011) and past medical history of hypertension (p=0.019).

D. Discussion

Emergency department nurse triage of ACS is a one-time only critical evaluation that cannot be replicated within the hospital stay. The current ESI tool used at triage is neither ACS-specific or linked to patient-specific outcomes of ACS. This study is on the forefront of linking patient factors at triage with ACS-specific outcomes. The complex disease process of ACS is demonstrated by the number of independent variable interactions in this analysis and may need to be considered in tandem to accurately identify patients at high-risk for ACS.

This study aligns with known research that as patients age, the greater the odds of developing ACS. With a past medical history of using insulin, combined with heart rate, respiratory rate and history of coronary artery disease, this may increase a patient's odds of having ACS. It is known that having a history of open-heart surgery/ coronary heart disease or having a coronary angiogram in the past may imply heart disease and when combined with initial vital signs in the ED, you may have a greater odds of having ACS. It should also be noted that the interaction between having a history of coronary artery disease and hypertension may increase the odds of having ACS. Non-Caucasian race decreases the odds of having ACS. In this cohort of patients, the black race were younger and 48% female. This could contribute to the protective effect for race.

This study is limited to one healthcare system and needs to be expanded to include multiple hospitals in future studies. Future studies should have a larger sample to examine all patient factors that are available at initial nurse triage. This study begins to shed light on patient factors that may need to be considered at triage to properly identify patients suspicious of ACS. Triage nurses in the ED need to be aware of the complexity of ACS clinical presentation, which will allow for early recognition to potentially improve patient outcomes.

Title:
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Abstract Summary:
Emergency department nurse triage is tasked with differentiating clinical conditions at high-risk for morbidity and mortality. Nurses struggle to identify acute coronary syndrome at triage to help initiate life-saving treatments. This study sought to find patient factors to help nurses better understand complex acute coronary syndrome presentation at triage.

Content Outline:
I. Introduction

A. Emergency department nurses triage over 136 million patients a year in the United States.

B. The popular triage tool, the Emergency Severity Index has significant limitations including subjectivity, racial bias, poor relation to patient-centered outcomes and poor specificity.

C. Chest pain is the 2nd leading reason to seek emergent care in the emergency department, accounting for nearly seven million patients yearly. Nurses are failing approximately 50% of the time to identify acute coronary syndrome at emergency department (ED) triage. Early identification of acute coronary syndrome (ACS) has potential to reduce mortality by 10%- 20%.

II. Methods

A. Retrospective analysis of the EMPIRE parent study investigated the association of patient factors that could be known at the time of nurse triage to a patient-centered outcome of acute coronary syndrome.

1. Electronic health record data is readily available to extract.

2. Independent Variables: Patient Factors available at nurse triage.

a) Patient demographic characteristics such as age, sex, and race were extracted.

b) Patient initial vital signs were extracted.

c) Patient self-reported past medical history and chart past medical history were

B. Dependent Variable: Acute Coronary Syndrome is a universally defined outcome by the American Heart Association and the American College of Cardiology.

1. Acute coronary syndrome was adjudicated by two independent reviewers. Disagreement was resolved by a third reviewer.

C. Statistical Analysis

1. Binary logistic regression was used to analyze data with significance level of 0.05 for two-sided hypothesis testing.

a) Due to this analysis being on the forefront of ED triage, the patient predictors with a $p<0.50$ in a univariate logistic regression were entered into a multivariable logistic

D. Results

1. The parsimonious model had the following variables that were significant: 1) age; 2) race; 3) past medical history of hypertension; 4) past medical history of insulin use; 5) past medical history of coronary artery disease; 6) initial ED heart rate; and 7) initial ED respiratory rate.

a) The following interactions were noted: 1) past medical history of insulin use and initial ED heart rate; 2) past medical history of insulin use and history of coronary artery disease; 3) past medical history of insulin use and initial ED respiratory rate; 4) past medical history of CABG/PCI and initial systolic blood pressure; 5) past medical history of CABG/PCI and initial ED heart rate; 6) past medical history of coronary artery disease and initial ED heart rate; and 7) past medical history of coronary artery disease and past medical history of hypertension.

III. Conclusion

A. This study is on the forefront of linking patient factors at triage with ACS-specific outcomes.

B. The complex disease process of ACS is demonstrated by the number of independent variable interactions in this analysis and may need to be considered in tandem to accurately identify patients at high-risk for ACS. Triage nurses in the ED need to be aware of the complexity of ACS clinical presentation, which will allow for early recognition to potentially improve patient outcomes.

C. Future studies need to consider a larger sample size to examine all patient factors that may need to be considered at triage to properly identify patients suspicious of ACS.

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