American Journal of Hospital Medicine
Promoting research and education in the field of hospital medicine. ISSN 2474-7017 (online)

January-March 2015: Volume7 Issue 1

Evaluation of Acute Coronary Syndrome Risk by Hospitalists to Expedite Discharge of Low Risk Patients

January 5, 2015 January-March 2015: Volume7 Issue 1

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ABSTRACT

Background: Chest pain is a leading cause of Emergency Department (ED) visits. Risk stratification of risk for Acute Coronary Syndrome (ACS) is applied with variability. Revaluation of ACS risk by hospitalists may provide the opportunity to identify patients eligible for expedited discharge.

Objective: To evaluate the efficacy and cost-effectiveness of an ACS Risk Score assessment.

Design: Retrospective cohort study

Methods: Patients presenting to UNC Hospitals, referred to the hospitalist service for ACS rule out from January 1, 2011 to September 1, 2011, were included. Records were reviewed for demographic data, primary major adverse events at 90 days including myocardial infarction, unstable angina, and death. Secondary outcomes included repeat ED visits for chest pain, stress test performance, and cost. We developed a Hospitalist Chest Pain (HCP) Risk Score dichotomizing patients as low or high risk based on patient demographics and lab data.

Results: 259 patients were included. 31.8% were classified as Low Risk by the HCP Risk Score. A cardiac event occurred in 5.8% (n=8) of the patients in the High Risk Group versus 0.0% of patients in the Low Risk Group. Use of the HCP Risk Score could result in savings of $1798 per patient and $250,751 annually for the studied cohort.

Conclusions and Limitations: The HCP Risk Score can serve as a tool to identify patients at low risk for ACS and thereby be eligible for expedited discharge. Our study was limited by its retrospective, single center design, confounders at presentation, and difficulty in capturing follow-up events for patients.

INTRODUCTION

Chest pain is the second leading reason for visits to the Emergency Department (ED), accounting for well over 5

million ED visits annually [1]. Correct identification of patients with chest pain who are not at risk for Acute Coronary Syndrome (ACS) and can be expeditiously discharged home, remains challenging with up to 38% of such patients being hospitalized for further evaluation [2,3]. The American College of Cardiology and American Heart Association (ACC/AHA) provide comprehensive guidelines addressing the diagnosis and management of patients with ACS [4]. The ACC/AHA task force emphasizes the importance of an initial evaluation that quickly answers two questions: (1) "What is the likelihood that the signs and symptoms represent ACS secondary to obstructive coronary artery disease (CAD)?"; and (2) "What is the likelihood of an adverse clinical outcomes (death, myocardial infarction, stroke, heart failure, recurrent myocardial ischemia, or serious arrhythmia)?" The integration of information from the medical history, physical examination, electrocardiogram, and cardiac biomarkers helps ED providers answer these questions, leading to an estimation of risk for presence of CAD and short-term risk of ACS.

Because this risk estimate is complex and multivariate, a number of algorithms and risk assessment tools have been developed to help standardize the process [3,5-11]. The use of such algorithms varies from ED to ED and provider to provider. For example, Mahler et al. demonstrated that 10% of admissions to an urban chest pain observation unit were avoidable and that ED physicians varied by 10 fold in rates of avoidable admissions [12]. Avoidable admissions expose patients to the risks associated with potential complications from hospitalization and the possibility of additional testing, which may be invasive or involve radiation. Additionally, avoidable admissions are costly, contributing adversely to overall national healthcare spending and opportunity costs for patients.

In many hospital settings, hospitalists are called upon by ED providers to admit patients with an admission diagnosis of chest pain. As part of this admission process, hospitalists conduct a new patient evaluation (independent of the ED provider's evaluation). The vantage point of the hospitalist differs from that of providers who evaluate a patient on presentation because of factors such as: elapsed time; evolution of patient symptoms; decreased situational acuity; and availability of lab results. Indeed, the hospitalists' evaluation may provide a unique opportunity to reexamine a patient's ACC/AHA risk stratification and potentially identify a cohort of patients who are low enough risk for immediate discharge home with no further testing. No guidelines or algorithms for assigning the ACC/AHA risk stratification scheme have been studied in the context of the independent, secondary, admission evaluations performed by hospitalists.

We hypothesized that the use of a standardized algorithm (of established risk factors for CAD and ACS) by a hospitalist group can appropriately identify a cohort of patients who are low risk for ACS and eligible for expedited discharge home, resulting in a reduction in unnecessary hospitalizations, diagnostic testing, and costs.

METHODS

Study Design

We performed a retrospective cohort study examining the potential effectiveness and cost savings of a standardized risk stratification scoring system for hospitalists compared with usual care. The study was approved by the University of North Carolina (UNC) Institutional Review Board.

Study Setting and Patient Population

UNC Hospitals is an academic, tertiary, referral center in a suburban location with a fully integrated Electronic Health Record (EHR). The hospital has 804 licensed inpatient beds, and 75,000 adult patients are seen in the ED per year. The ED is responsible for 52% of the hospital's admission with an admission rate of 30%. Patients who do not have ACS on presentation are referred for admission to either the resident teaching service or the UNC Hospitalist Service (Internal Medicine trained physicians). Patients were considered eligible for the study if they were between 18 and 70 years of age and referred for admission to the UNC Hospitalist Service from January 1, 2011 through September 1, 2011 with an admitting diagnosis of chest pain. Exclusion criteria included: positive urine toxicology screen for cocaine; a condition limiting the patient's ability to give an accurate history (moderate to severe cognitive impairment, malingering, or active psychosis), involvement of hospice on presentation; a clear alternative etiology for chest pain (traumatic, clinical, or radiologic); transferred from another facility; left the facility against medical advice prior to obtaining a full diagnostic work-up; or primary residence located outside of North Carolina.

Study Intervention

This study examined the use of a clinical decision aid, which we have called the Hospitalist Chest Pain (HCP) Risk Score. The HCP Risk Score combines five variables that are known risk factors for CAD and ACS including: (1) Personal history of CAD; (2) Family history of CAD; (3) Atypical or typical anginal chest pain; (4) Electrocardiogram results; and (5) Troponin I value.

The HCP Risk Score dichotomizes patients into 2 groups: Low risk for ACS and eligible for immediate discharge (Low Risk); and High risk for ACS and recommended for 24 hour observation admission (High Risk). Each answer of "yes" (variables 1-3) or "abnormal" (variables 4 and 5) is assigned one point. A score greater than zero results in a patient being categorized "High Risk". Conversely, a score of zero results in a patient being categorized as "Low Risk".

Definition of Variables

A personal history of Coronary Artery Disease (CAD) was considered positive if a patient had a documented history of: Acute Coronary Syndrome, Peripheral Vascular Disease (PVD), or CAD with CAD defined as presence of a stent or coronary artery stenosis greater than 70%. A positive family history of CAD was defined as first degree relative (male aged less than 56 or female less than 66) with ACS, PVD, or CAD. Chest pain was defined as atypical or anginal based on ACC/AHA guidelines and the composite score ("yes/1 point" or "no/0 points") using the following three questions: (1) Is the chest discomfort substernal?; (2) Are symptoms precipitated by exertion?; and (3) Is the discomfort promptly relieved by rest or nitroglycerin? A summed score of 0 or 1 equals "non-anginal" chest pain ; a score of 2 equals "atypical" chest pain; and a score of 3 equals "anginal" chest pain. This simple scoring system is based on the validated method by Diamond and Forrester for estimating the pretest probability of coronary artery disease (CAD) using age, sex, and characterization of chest pain [13]. Electrocardiograms (ECGs) were defined as abnormal based on an adaptation of established criteria (2012 Third Universal Definition of Myocardial Infarction), if any of the following were present: (a) ST segment depression or elevation of at least 0.05 mV in two contiguous leads; (b) t-wave inversions of at least 0.1 mV in two contiguous leads; (c) q waves of at least 0.1 mV in two contiguous leads; (d) old or new left bundle branch block; or (e) any new arrhythmia [14]. The cut-off for an abnormal Troponin I value was less than 0.034 ng/ml, which is the 99th percentile upper reference limit. UNC Hospitals uses Troponin I (Ortho Clinical Diagnostics) with a reference range of 0.0-0.034 ng/mL.

Database

We created the Hospitalist Chest Pain Discharge Database, which was populated by manual data extraction of the integrated EHR and included: patient demographic data, presenting symptoms, laboratory and clinical data, diagnostic tests and procedures, discharge diagnosis codes, and outcomes data. Physicians on the research team performed all data extraction. Data from the ED physician and nursing documentation, the hospitalists' history and physicals, and cardiology consult notes were used by the physician research team to determine personal history, family history, and chest pain character. A three physician adjudication process was used to ensure the fidelity of the five variables in the HCP Risk Score. Agreement by two physicians was needed for all instances without a clear "yes or "no" answer and for all abnormal ECG's.

Study Outcomes:

The primary outcome was 90 day cardiac event rate (ST Elevation Myocardial Infarction, Non-ST Elevation Myocardial Infarction, unstable angina, revascularization, sudden unexplained death, or death from a cardiac cause). Secondary outcomes were: 30 day Emergency Department (ED) visit rates for chest pain, rates of stress test performance, and cost.

Statistical Analysis

To ensure capture of cardiac events that may be related to the incident admission for chest pain, we examined outcomes for a 90 day period and calculated an appropriate sample size based on estimations of ACS incidence. Bhuiya et al. demonstrated that for all patients presenting to the ED with chest pain in the US, 13% had a discharge diagnosis of ACS [1]. Because the estimate of 13% includes patients presenting to the ED with ACS,

which was not the case in our cohort, we estimated that the incidence of ACS in our study would be considerably lower. Thus using a conservative approach, we assumed ACS risk over a 90 day period to be: Low Risk Group (0.1% risk of ACS event) and High Risk Group (2.0% risk of an ACS event). Using these assumptions regarding ACS incidence, we determined apriori that a sample size of at least 100 patients in in the High Risk Group would be required to capture at least two ACS events. Given that the expected incidence in the Low Risk Group approaches zero, a study powered study to demonstrate ACS incidence in this group was not technically or financially feasible.

For cost analysis, we defined cost as the amount charged to a payor (individual or third party). We estimated the average cost of a 24 hour inpatient hospitalization to be $1616 based on 2010 estimates for North Carolina Hospitals [15]. The average cost for an inpatient consult by a hospitalist was $194 based on 2010 Centers of Medicaid/Medicare Services (CMS) estimates for an "Initial Inpatient Hospital Care Code" 99223 [15]. We estimated the cost of a stress test to be $376, which is the average charge for the two most commonly performed stress tests at our institution –stress echocardiogram ($289) and nuclear stress test ($461). These estimated charges for stress tests were based on calculations from CMS reported previously by Priest et al [16]. Cost analysis assumed a hypothetical, prospective scenario in which patients in the Low Risk Group incur a hospitalist inpatient consult charge, but avoid the charges for a 24 hour inpatient hospitalization and stress testing. ED charges should remain the same in both groups. Bed capacity savings for our institution (UNC Hospitals) were calculated with the assumption that all low risk patients could be discharged immediately following the initial hospitalist assessment, resulting in one additional 24 hour bed space availability per patient. For national cost savings and bed capacity calculations, we based this estimate on the calculated number of patients admitted to hospitals for evaluation of chest pain by multiplying the average overall rate of ED admissions (13%) by the total number of annual ED visits for chest pain (5.5 million), resulting in 715,500 admissions from the ED for chest pain.

For analysis, predetermined endpoints of 90 days for primary outcomes and 30 days for ED visit rates were used with descriptive statistics provided. Because we expected to find no primary outcomes in the Low Risk Group, statistical significance testing was not performed.

RESULTS

Of the 292 sequential patients identified between January 1, 2011 and September 1, 2011, who were age 18 to 70 years with an admitting diagnosis of chest pain and referred for admission to the hospitalist service, 259 (88.7%) met inclusion criteria for the study (Figure 1). Baseline characteristics are shown in Table 1. Patients in the High Risk Group were more likely to be female, black, and have public insurance compared to the Low Risk Group. Rates for all three comorbidities associated with CAD (diabetes, hypertension, and hyperlipidemia) were more elevated in the High Risk Group. The High Risk Group was also more likely to smoke, but less likely to drink alcohol. The HCP Risk Score categorized nearly one third (31.8%) of the patients into the Low Risk Group (Table 2).

Table 1: Patient Baseline Demographics, Comorbid Conditions, and Clinical Findings

	Patients, Number (%)		
	Entire Cohort (n = 259)	Low Risk (n = 93)	High Risk (n = 166)
Age (years)	50.8	51.6	50.7
Sex (male)	54 (44.4)	41.57%	
Race			
White	66 (53.2)	50.60%	
Black	43 (34.7)	43.98%	
Other	11 (8.9)	5.42%	
Insurance			
Private	31.27%	44 (35.5%)	33.13%
Public	37.84%	46 (37.1)	48.19%
Self-pay	15.06%	30 (24.2)	18.67%
Past Medical History			
Diabetes	28.57%	20.43%	33.73%
Hypertension	61.29%	49.46%	66.87%
Hyperlipidemia	40.55%	23.66%	48.80%
ACS	23.17%	0.00%	39.16%
Smoking (% yes ever)	46.72%	51.61%	58.43%
Alcohol use (% yes current)	21.20%	26.88%	18.07%
Family History of ACS	26.64%	0.00%	50.00%
Presenting Vitals			
Heart rate	82.5	81.1	83.7
Systolic Blood Pressure (mm Hg)	142.8	144.6	141.6
Objective Data			
Cardiac Enzymes (% abnormal)	2.70%	0.00%	4.82%
Average Creatinine (mg/dL)	0.97	0.88	1.04
Chest X-ray (% abnormal)	7.34%	5.38%	10.24%
EKG (% abnormal)	12.90%	0.00%	18.67%

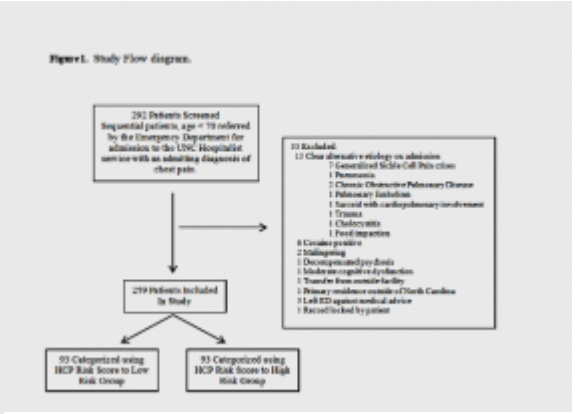

Table 2: Hospitalist Chest Pain Risk Score Variables

	Patients, Number (%)		
	Entire Cohort (n = 259)	Low Risk (n = 93)	High Risk (n = 166)
I. ACS/CAD	23.17%	0.00%	39.16%
II. Family History of ACS	26.64%	0.00%	50.00%
III. Diamond Forrester Score			
Non-Anginal (% Score =0,1)	55.98%	100.00%	46.99%
Atypical Angina (% Score=2)	18.92%	0.00%	35.54%
Typical Angina (% Score =3)	8.88%	0.00%	17.47%
IV. Cardiac Enzymes (% abnormal)	2.70%	0.00%	4.82%
V. EKG (% abnormal)	12.90%	0.00%	18.67%

The primary outcome, 90 day cardiac event(s), occurred in 5.8% (n=8) of the patients in the High Risk Group versus 0.0% (n=0) of patients in the Low Risk Group (Table 3). The ACS rate in the High Risk Group was 2.4% (n=4). The rate of stress testing in each group was similar at 36.7% and 37.4% in the Low and High Risk Groups respectively. The High Risk Group had a cardiac catheterization rate of 18%, versus 5% in the Low Risk Group; and no cardiac catheterizations were positive in the Low Risk Group. The High Risk Group had more return ED visits within 30 days (14.46% versus 6.45%). In this cohort, the HCP Risk Score test characteristics were: sensitivity 100%; specificity of 35%; positive predictive value 4.8%; and negative predictive value of 100% (Table 4).

Table 3: Primary and Secondary Outcomes

	Low Risk (n = 93)	High Risk (n = 166)
Cardiac Event(s)	0.00%	5.76%
Acute Coronary Syndrome	0.00%	2.41%
Deaths	0.00%	0.00%
ED Visit within 30 Days	6.45%	14.46%
Stress Test		
Performed (%)	36.67%	37.41%
Abnormal (%)	2.50%	8.63%
Cardiac Catheterization		
Performed (%)	5.00%	17.99%
Abnormal (%)	0.00%	5.76%

Table 4: Test Characteristics of the Hospitalist Chest Pain (HCP) Risk Sco

		Cardiac Endpoint +	Cardiac Endpoint -	
HCP Risk Score	+	8	158	166
	-	0	93	93
		8	251	

Sensitivity:	100.00%
Specificity:	37.05%
Positive Predictive Value:	4.82%
Negative Predictive Value:	100.00%

In our hypothetical cost model, deploying the HCP Risk Score for this cohort would have resulted in: per patient savings of $1798 and an extrapolated savings of $250,751 for all potential Low Risk patients over a one year period (Table 4). By applying the proportion of Low Risk patients in our cohort (31.8%), to the national estimate of patients admitted annually for chest pain (715,500), we calculated a potential national savings of $408,983,378 annually. Application of the HCP Risk Score would also increase bed capacity at UNC Hospitals by 11 bed days per month; and 18,960 bed days per month nationally.

DISCUSSION

In this study, utilization of the HCP Risk Score by a hospitalist group would have identified nearly one third of patients as Low Risk for ACS and as potential candidates for immediate discharge home. By avoiding unnecessary hospitalization and testing for patients, the HCP Risk Score could result in substantial savings on both the local ($250,751) and national (over $400 million) levels. Also avoided, but not calculated, are the patient opportunity costs associated with hospitalizations; costs from potential hospital complications; and costs from additional testing (ECGs, labs, or cardiac catheterizations).

None of the patients in the Low Risk Group experienced a cardiac event at 90 days, while the cardiac event rate was 5.8% in the High Risk Group. As a screening test, the HCP Risk Score performed well with a sensitivity of 100%. While the specificity was low (35%), it is consistent with that reported for other risk stratification tools [8,10,11,17-19].

LIMITATIONS

Our study has several potential limitations. First, as a retrospective study, confounders may have been introduced that we were unable to control for or measure. Second, determination of chest pain characteristics is subjective, but by using physician adjudication we standardized the process as much as possible. Third, this study was not powered to detect ACS events in the Low Risk Group, given a very low predicted event rate. While an event rate that approaches zero would appear to be acceptable, additional research is needed to establish provider and societal risk thresholds. Fourth, while every patient had follow-up until the end of their incident hospitalization, it is possible that patients presented to a facility outside of our healthcare system with a subsequent primary outcome, which would not be captured in our EMR. Finally, the event rate in our High Risk Group is approximately half the incidence (10.7%) reported by Kohn et al [2]. The actual event rate in fact confirms our expectation of a comparatively lower incidence of ACS within our cohort because patients with ACS on presentation were not referred for admission to our hospitalist group [2].

CONCLUSION

Given the predominance of cardiac disease, hospitalists will continue to play an integral role in the evaluation and assessment of patients presenting with chest pain. The combination of a busy ED, urgency of ED providers to triage and determine ACS risk, and provider variability all play a role in making the ACS risk stratification process an imperfect art. Thus, the manner in which we triage and risk stratify such patients is an area of study, which requires continued research. In the current paradigm of hospital care, rarely does a hospitalist reverse a decision to admit a patient referred by the ED. However, our study suggests hospitalists may indeed have a unique opportunity to identify substantial numbers of patients who are low risk for ACS and thus appropriate for expedited discharge home. A basic scoring system, like our proposed HCP Risk Score, can help provide hospitalists with objective criteria on which to base disposition decisions. In the current healthcare economic environment, the potential impact of the hospitalists' role in ACS risk re-evaluation and timely patient disposition merits additional study.

ACKNOWEDGEMENTS

Contributors: We thank Mark Harris and Jonathan Kirsch for their assistance in the planning and conduct of the study.
Funder: This study was not funded.
Prior Presentation: Society of General Internal Medicine, May 2012

Conflict of Interest:
There are no relevant conflicts of interest for any of the authors.

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