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Frequency and factors associated with inappropriate for intervention cardiac catheterization laboratory activation☆,☆☆

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ABSTRACT

Background: Current guidelines emphasize timely coronary intervention with a door to balloon time of ≤90 min for favorable survival impact after STEMI. Efforts to achieve these targets may result in unnecessary emergent angiography for inappropriate activations.
Objective: Evaluate the frequency, trend and factors which are significantly associated with inappropriate for intervention cardiac catheterization laboratory (CCL) activation.
Methods: We analyzed 1764 consecutive emergent CCL activation for possible ST segment elevation myocardial infarction (STEMI) between 7/2005 and 8/2013. Inappropriate for intervention activation was defined as negative STEMI (incorrect diagnosis: insignificant coronary lesion, not requiring any intervention) and inappropriate patients (true STEMI but poor CCL candidacy).
Results: Inappropriate for intervention CCL activation occurred in 317 patients (17.9%): 292 incorrect diagnosis (negative STEMI diagnosis), 25 inappropriate patients, with no difference in the frequency based on time of the day (18.6% regular hours vs. 17.6% off-hours, $p = 0.6$). On multivariable analysis, female gender (OR 1.9 [1.2–3.0]), African American race (OR 1.9[1.3–2.7]), and prior coronary artery bypass graft surgery (OR 3.6 [2.3–5.5]) were significantly associated with incorrect diagnosis (negative STEMI diagnosis) (all $p < 0.005$) and hyperlipidemia (OR 0.2 [0.1–0.3]), tobacco use (OR 0.2 [0.1–0.3]), and stroke/TIA (OR 0.2 [0.1–0.4]) had a significant inverse association (all $p < 0.001$). ST Elevation with no reciprocal depression and pericarditis/myocarditis were the most common ECG finding and etiology respectively.
Conclusion: Inappropriate for intervention CCL activation is not uncommon and should be closely monitored to maximize resource utilization. Females, African American patients with few or no risk factors and patients presenting ST elevation but no reciprocal depression constitute a population that may require attention.

1. Introduction

In the USA, approximately 650,000 acute coronary syndromes occur each year, of which around 250,000 are ST Segment elevation myocardial infarction (STEMI) [1,2]. Current guidelines recommend timely coronary intervention with a door to balloon (D2B) time of <90 min for favorable impact on survival after STEMI [2].

D2B time is tracked by a number of clinical registries, since it is tied to reimbursement from Centers for Medicare & Medicaid Services (CMS) and the Joint Commission. A multidisciplinary system approach including the emergency medical services, emergency room physicians and the interventional cardiology team has been taken by institutions to achieve this target [3–9].

The above strategies may have helped to decrease the D2B time but there is a concern that this potentially may have led to unnecessary emergent angiography.

Accordingly we sought to determine the frequency, trend and predictors of emergent CCL activation for suspected STEMI, which didn't require any emergent interventions.

2. Methods

We performed a retrospective observational cohort study of consecutive adult patients with suspected STEMI in whom there was an emergent activation of CCL and who underwent an emergent coronary angiography at The Cleveland Clinic Main Campus, Cleveland, Ohio

Abbreviations: STEMI, ST segment elevation myocardial infarction; D2B, door to balloon; ECG, electrocardiography; NSTEMI, non ST segment elevation myocardial infarction; UA, unstable angina; CCL, cardiac catheterization laboratory; PCI, percutaneous coronary intervention; CABG, coronary artery bypass graft surgery.

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between July 2005 and August 2013. The Institutional Review Board at Cleveland Clinic approved this study, with waiver of informed consent as all data were collected and recorded as part of routine clinical care.

2.1. Study variables

Demographics, clinical variables, time of presentation, lab values, ECG, and angiographic data, as defined by ACCF/AHA guidelines [10] were obtained by analysis of standard activation log, electronic medical records, diagnostic catheterization database, and the PCI database which were entered at the time of admission. Patients who presented between 7 AM and 5 PM on weekdays were considered on-hours admission and those who presented between 5 PM and 7 AM on weekdays, all weekend, and holidays were considered off-hours admission. Type of treatment provided to the patient (Intervention, surgery and/or medical) was ascertained by the cardiologist performing the procedure and/or cardiothoracic surgeon.

2.1.1. CCL activation: appropriateness for intervention

The CCL activations were classified on the basis for the need of intervention as: 1) Appropriate for intervention (Significant coronary lesion >70% requiring emergent intervention: percutaneous coronary intervention/coronary artery bypass graft surgery (CABG); complex coronary lesions not amenable to intervention were also included)—True STEMI diagnosis and 2) Inappropriate for intervention which was further divided into a) Incorrect Diagnosis (insignificant coronary lesion not requiring any intervention)—Negative STEMI diagnosis (i.e. no culprit lesion) and b) Inappropriate Patients (Patients had significant coronary lesions but were disqualifiers for CCL e.g. Extreme age, active bleeding, known terminal illness, DNR status, patient's/family preference and severe co-morbid condition, etc.).

2.2. End point

The study end point was inappropriate for intervention activation after an emergent CCL activation.

2.3. Statistical analysis

Baseline characteristics were described per the status of CCL activation. Continuous variables are expressed as mean ± SD and compared using ANOVA. Categorical data are expressed as percentage and compared using Chi-square test. Subsequently multivariable analysis using backward elimination logistic regression was performed incorporating all the variables. Odds Ratios with 95% confidence intervals (CIs) were calculated. The patients were classified on the basis of the CCL activation and the time of presentation and its trend was charted. Inappropriate patients were excluded from statistical analysis and prediction model, because they had a true event and their clinical characteristics would be very similar to the patients with appropriate activation (true STEMI diagnosis); hence placing the inappropriate patients in the incorrect group (negative STEMI diagnosis) would affect the difference between the two groups. All statistical tests were 2-tailed and CI was reported at 95% level (p-value <0.05 was considered significant). Statistical analysis was performed using SPSS version 20 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY).

3. Results

A total of 1764 emergent CCL activations for suspected STEMI occurred between 7/2005 and 8/2013. The baseline and clinical data in the study population as a whole and divided into various CCL activation subgroups are shown in Table 1. This was an older population majority of which was comprised of white men.

3.1. Inappropriate for intervention CCL activation and population characteristics

Inappropriate for intervention CCL activation occurred in 17.9% (317 patients) of the cohort, of which 292 patients had incorrect diagnosis (negative STEMI diagnosis) whereas 25 patients were inappropriate patients for revascularization (Table 2). Table 1 shows the baseline characteristics of cohort stratified by CCL activation subgroups. A significant proportion of patients with incorrect diagnosis (negative STEMI diagnosis) were younger (58.2 ± 14.3 years vs 60.8 ± 13.1 years, $p = 0.002$), female (41.1% vs 31.6%, $p = 0.002$), and African American (44.6% vs 29.2%, $p < 0.001$) when compared to patients who were appropriate for intervention (true STEMI diagnosis). There was a lower prevalence of history of coronary artery disease (CAD) (29.8% vs 36.1%, $p = 0.04$), history of prior myocardial infarction (MI) (16.1% vs 26.6%, $p < 0.001$), prior stroke/transient ischemic attack (TIA) (2.7% vs 14.7%, $p < 0.001$), family history of CAD (1.0% vs 16.6%, $p < 0.001$), hypertension (49.3.4% vs 78.5%, $p < 0.001$), hyperlipidemia (25% vs 70.4%, $p < 0.001$), tobacco use (22.6% vs 67.9%, $p < 0.001$), elevated cardiac enzymes on presentation (43.5% vs 94.4%, $p < 0.001$) and diabetes (25.3% vs 31.2%, $p = 0.045$) in patients with incorrect diagnosis (negative STEMI diagnosis). The patients with incorrect diagnosis (negative STEMI diagnosis) had a higher proportion of history of prior coronary artery bypass graft surgery (CABG) (31.2% vs 13.5%, $p < 0.001$). The inappropriate patients group was older (73.4 ± 12.9 years) with multiple co-morbidities (Diabetes 36.0%, stroke/TIA 24.0%, hypertension 60.0%, peripheral arterial disease (PAD) 16.0%, congestive heart failure 32.0%, chronic obstructive pulmonary disease (COPD) 4.0%, atrial fibrillation 16.0%, on dialysis 20.0%) (Table 1).

3.2. Trends in inappropriate for intervention CCL activation

Emergent CCL activation happened during work hours (7 AM to 5 PM) in 35.3% patients. There was no difference in the frequency of inappropriate for intervention CCL activation depending on the time of the day (18.6% during regular hours vs 17.6% during off-hours, $p = 0.6$). Over the years, the frequency trend was statistically not significant ($p = 0.053$) (Fig. 1).

3.3. ECG findings and diagnosis in inappropriate for intervention CCL activation

On evaluating the presenting ECG, ST elevation with no reciprocal depression (27.1%), ST elevation with PR depression (13.0%), and non-specific ST-T wave changes (10.3%) were found to be the common ECG findings in the incorrect diagnosis group (negative STEMI diagnosis) (Fig. 2). The most common etiologies in this group were pericarditis/myocarditis (15.4%), rhythm disturbance (15.4%) and structural heart disease (includes left ventricular hypertrophy, severe aortic stenosis, severe mitral regurgitation, hypertrophic obstructive cardiomyopathy, left ventricular aneurysm, myocardial bridging) (9.9%) (Fig. 3).

3.4. Factors significantly associated with incorrect diagnosis (negative STEMI diagnosis)

On multivariable analysis using backward logistic regression, female gender, African American race, history of prior CABG, absence of history of stroke/TIA, absence of history of hyperlipidemia, absence of history of tobacco use, absence of family history of CAD and absence of elevated cardiac enzymes were significantly associated with incorrect diagnosis (negative STEMI diagnosis) (Table 3).

Age, sex, race, body surface area, body mass index, systolic blood pressure, diastolic blood pressure, heart rate, history of CAD, history of prior MI, history of prior CABG, history of atrial fibrillation, history of stroke/TIA, history of CHF, family history of CAD, hypertension, diabetes mellitus, chronic kidney disease, hyperlipidemia, dialysis, smoking, and elevated cardiac enzymes were used in the model.