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Prospective, real-world evidence showing the gap between ST elevation myocardial infarction (STEMI) and occlusion MI (OMI)☆

H. Pendell Meyers [b], Stephen W. Smith [a,*]

[a] Hennepin County Medical Center, University of Minnesota School of Medicine, HCMC ER, R-2, 701 S. Park Ave., Minneapolis, MN 55415, United States of America
[b] Stony Brook University, Stony Brook, United States of America

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The original premise of the STEMI vs. NSTEMI paradigm was that ST elevation on the ECG is a surrogate for acute coronary occlusion, and therefore ST Elevation can be used to identify patients who would benefit from emergent reperfusion therapy [1]. The landmark Fibrinolytic Therapy Trialists Collaborative group (FTT) Meta-analysis of 9 thrombolytic trials showed that patients with presumed myocardial infarction with some amount of poorly defined "ST Elevation," in contrast to ST depression or no ST shift, had lower mortality when treated with thrombolytics than with placebo (there are no trials of coronary intervention vs. placebo or no reperfusion therapy). At that time, there were no established "STEMI criteria"; the criteria used today originate from a cohort of patients with AMI from the 1980s, diagnosed only by Creatine Kinase-MB fraction, without angiographic data [2].

However, the evidence and experience of the past 25 years with cardiac catheterization and advances in ECG interpretation have demonstrated poor accuracy of the STEMI paradigm to identify Occlusion MI (OMI). Twenty-five percent of patients diagnosed with NSTEMI have complete occlusion of the culprit vessel found on delayed angiogram, and a similar percentage of our cardiac catheterization lab activations turn out to be false positives [3]. These false negatives [STEMI(−) OMI] are denied the opportunity to benefit from reperfusion therapy, while the false positives [STEMI(+) non-ACS] may receive harm from unnecessary cardiac catheterization. Despite the evidence of its failure, the STEMI vs. NSTEMI paradigm has not been significantly changed or even challenged until recently [4].

Hillinger et al. contribute valuable data to this discussion by performing a prospective observational study of 2486 Emergency Department patients presenting with signs and symptoms of possible ACS. This was a high-risk population compared to North American cohorts, with a prevalence of type 1 acute MI (AMI, both types), STEMI, and Non-STEMI of 18% ($n = 438$), 3% ($n = 81$, 78 of which had OMI), and 15% ($n = 357$), respectively, and with 58 of 236 (25%) adjudicated Non-STEMI having OMI. If we use instead Occlusion MI (OMI) vs. Non-Occlusion MI (NOMI) as the outcome, the prevalence of AMI, OMI, and NOMI would be 18% ($n = 438$), 5.5% ($n = 136$), and 12.5% ($n = 302$). However, the true prevalence of OMI is likely even higher because occlusion was defined by angiography, and the 21% of AMI patients who did not undergo angiography were optimistically assumed to have NOMI.

In summary, there were 2436 suspected ACS, with 438 AMI, of which 136 were OMI and 302 were NOMI. Of the 136 OMI, 78 were STEMI (+) OMI (true positive STEMI), and 58 were STEMI (−) OMI (STEMI adjudication did not identify OMI), and of the 302 NOMI, 5 met STEMI criteria but the ST elevation was not due to ischemia (false positive), with 297 STEMI (-) OMI. There were an additional 19 patients without any MI who met STEMI criteria.

The authors report the accuracy of computer algorithm identification of STEMI criteria on presentation ECG versus blinded cardiology visual interpretation, judged against the reference standard: non-blinded cardiology adjudication for the final diagnosis of STEMI using retrospective review of all data (all electrocardiograms, clinical data, biomarker results, angiographic findings, etc.). Overall, specificity and negative predictive value were uniformly high (%) due to the overall low prevalence of STEMI and OMI, despite low positive predictive value in the 50–60% range. Demonstration of a low prevalence of OMI (5.5%) among a high-risk group with acute chest pain is, by itself, an important finding. Most importantly, sensitivity of the computer algorithm for cardiologist-adjudicated STEMI was remarkably low (35%), and the diagnosis of STEMI by the cardiologist identified only 49% of patients with Occlusion MI upon catheterization. See Table 1.

Abbreviations: STEMI, ST elevation myocardial infarction; Non-STEMI, non ST elevation myocardial infarction; OMI, occlusion myocardial infarction; NOMI, non-occlusion myocardial infarction; ACS, acute coronary syndrome.

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* Corresponding author.
E-mail address: smith253@umn.edu (S.W. Smith).

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Table 1
Diagnostic Utility for "Any MI", STEMI, or OMI, of Computer Algorithm vs. Cardiologist. Blinded Visual Review. ***The 21% of AMI patients who did not receive undergo an angiogram, and thus could not be adjudicated for OMI vs. NOMI, were simply assumed to be NOMI for the purposes of this optimistic calculation. In reality the prevalence of OMI is expected to be even higher, and the performance of listed criteria even lower.

Outcome	Any acute MI	STEMI	OMI
Computer algorithm using STEMI Criteria	Sens 6.4% Spec 99% PPV 63% NPV 83%	Sens 35% Spec 99% PPV 54% NPV 98%	Sens 21% Spec 99% PPV 54% NPV 96%
Computer using STEMI criteria on serial ECGs	9.4%	Sens 51%	Sens 30%
Blinded cardiologist visual ECG interpretation of STEMI	Sens 17% Spec 98% PPV 63% NPV 85%	Sens 82% Spec 98% PPV 58% NPV 99%	Sens 49% Spec 98% PPV 58% NPV 97%

MI = Myocardial Infarction.
STEMI = ST Elevation Myocardial Infarction.
OMI = Occlusion Myocardial Infarction.
Sens = sensitivity.
Spec = specificity.
PPV = Positive Predictive Value.
NPV = Negative Predictive Value.

Hillinger et al. also report 58 (25%) total Occlusion MIs among the 236 retrospectively adjudicated Non-STEMI patients who underwent early (within 24 h) angiography. These data conform with many prior studies showing poor accuracy of the current STEMI vs. Non-STEMI paradigm for deciding which patients need emergent reperfusion therapy. Data from Khan [3], From [5], Schmitt [6], and Pride [7] et al. represent 10 studies with a combined total of over 45,000 NSTEMI patients, each reporting that approximately 25% of "Non-STEMI" patients are found to have complete occlusion at delayed angiogram. Non-STEMI patients with occlusion that was only diagnosed later had roughly double the short and long-term mortality of those without occlusion, and the survivors had higher rates of complications and morbidity.

This is a valuable, prospective, real-world dataset demonstrating the inadequacy of both computer and physician identification of acute complete coronary occlusion under the current STEMI vs. Non-STEMI paradigm. This study conforms with an extensive body of literature which has led us to propose a paradigm shift from the STEMI vs. Non-STEMI paradigm to one we call Occlusion MI vs. non-Occlusion MI (OMI vs. NOMI) paradigm [4]. It would have been even more enlightening if Hillinger et al. had reported the respective outcomes for patients with Non-STEMI with and without OMI, and of all OMI with and without rapid reperfusion. Nevertheless, we believe this data will improve awareness of missed Occlusion MIs, encourage further research aimed at reducing both false positives and false negatives, and ultimately improve patient outcomes from this common and deadly disease process.

Until there is more such research, what can be done to rapidly recognize these OMI patients in order to provide timely emergent reperfusion therapy? There are a number of ECG findings of STEMI (−) OMI that have been discovered in recent years [8]. Furthermore, patients whose ECG truly is non-diagnostic can be diagnosed with emergent echocardiography [9]. Future studies may establish a role for rapid early high sensitivity troponin testing. Finally, when OMI is highly suspected in patients with refractory symptoms, emergent angiography may be necessary even in the absence of ECG or biomarker confirmation, as suggested by the European guidelines for NSTEMI [10].

Declaration of Competing Interest

None.

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