Title

Prehospital Acute ST-Elevation Myocardial Infarction Identification in San Diego: A Retrospective Analysis of the Effect of a New Software Algorithm

Journal

Journal of Emergency Medicine, 55(1)

ISSN

0736-4679

Authors

Coffey, Christanne
Serra, John
Goebel, Mat
et al.

Publication Date

2018-07-01

DOI

10.1016/j.jemermed.2018.04.007

Peer reviewed

The Journal of Emergency Medicine, Vol. 55, No. 1, pp. 71–77, 2018

0736-4679/$ - see front matter

https://doi.org/10.1016/j.jemermed.2018.04.007

Selected Topics: Prehospital Care

PREHOSPITAL ACUTE ST-ELEVATION MYOCARDIAL INFARCTION IDENTIFICATION IN SAN DIEGO: A RETROSPECTIVE ANALYSIS OF THE EFFECT OF A NEW SOFTWARE ALGORITHM

Christanne Coffey, MD,* John Serra, MD,*† Mat Goebel, NRP,* Sarah Espinoza, MD,* Edward Castillo, PHD, MPH,* and James Dunford, MD*†

*University of California San Diego Health System, San Diego, California and †San Diego Fire - Rescue Department, San Diego, California
Corresponding Address: Mat Goebel, NRP, University of California San Diego Health System, 200 W. Arbor Dr., San Diego, CA 92103

□ Abstract—Background: A significant increase in false positive ST-elevation myocardial infarction (STEMI) electrocardiogram interpretations was noted after replacement of all of the City of San Diego's 110 monitor-defibrillator units with a new brand. These concerns were brought to the manufacturer and a revised interpretive algorithm was implemented. Objectives: This study evaluated the effects of a revised interpretation algorithm to identify STEMI when used by San Diego paramedics. Methods: Data were reviewed 6 months before and 6 months after the introduction of a revised interpretation algorithm. True-positive and false-positive interpretations were identified. Factors contributing to an incorrect interpretation were assessed and patient demographics were collected. Results: A total of 372 (234 preimplementation, 138 postimplementation) cases met inclusion criteria. There was a significant reduction in false positive STEMI (150 preimplementation, 40 postimplementation; $p < 0.001$) after implementation. The most common factors resulting in false positive before implementation were right bundle branch block, left bundle branch block, and atrial fibrillation. The new algorithm corrected for these misinterpretations with most postimplementation false positives attributed to benign early repolarization and poor data quality. Subsequent follow-up at 10 months showed maintenance of the observed reduction in false positives. Conclusions: This study shows that introducing a revised 12-lead interpretive algorithm resulted in a significant reduction in the number of false positive STEMI electrocardiogram interpretations in a large urban emergency medical services system. Rigorous testing and standardization of new interpretative software is recommended before introduction into a clinical setting to prevent issues resulting from inappropriate cardiac catheterization laboratory activations.

□ Keywords—computer interpretation; ECG; false positive; paramedic; prehospital; STEMI

INTRODUCTION

The prehospital diagnosis of ST-elevation myocardial infarction (STEMI) leading to activation of the cardiac catheterization laboratory (CCL) is associated with reduced "door-to-balloon" time and reduced mortality (1–8). With emergency medical services (EMS) transporting >50% of all patients with STEMI, prehospital personnel are at the forefront of rapidly and accurately triaging chest pain patients to appropriate care. Several different systems exist for making the rapid diagnosis of a STEMI. Attempted solutions have included to rely solely on the paramedic's interpretation, to transmit electrocardiograms (ECGs) to a "base station" hospital for physician interpretation, to rely strictly on computer algorithms to provide interpretation,

Reprints are not available from the authors.

RECEIVED: 21 September 2017; FINAL SUBMISSION RECEIVED: 21 February 2018;
ACCEPTED: 10 April 2018

or some combination of these approaches (9,10). The reported test characteristics of each method vary widely. Variation may be related to differences in the training of personnel, differences in computer software, and differences in prehospital system design (11–34). Multiple factors have been identified as affecting the accuracy of prehospital STEMI diagnosis (31,32). For some, controlling has proven difficult, such as for patient gender and underlying heart rhythm. Other factors can be influenced, such as the technical quality of the ECG and software used to analyze it. Of particular interest is the variability between software algorithms of different manufacturers, or between different versions from the same manufacturer, regarding their programming to derive a diagnosis of a STEMI. False positive STEMI interpretations can lead to unnecessary CCL activations, thereby putting patients at risk of adverse events, while simultaneously summoning CCL teams in error, which increases costs and reduces clinical efficiency.

The City of San Diego EMS relies on computer interpretation for the diagnosis of STEMI. Once a STEMI is identified, paramedics transmit the ECG to the STEMI receiving center and provide prearrival notification via radio. When the STEMI receiving center receives this notification, the radio room nurse delivers the ECG to a physician for interpretation and determination of CCL activation. The physician's specialty varies between facilities. Some use emergency physicians while others use cardiologists for interpretation.

In December 2010, the City of San Diego EMS system replaced all 110 monitor-defibrillator units (brand A) with new devices (brand B) during a scheduled equipment upgrade with a goal of achieving an enhanced ability to transmit accurate and interpretable prehospital 12-lead ECGs. Shortly after implementation, quality improvement personnel noted a significant increase in false positive STEMI ECG notifications. Specifically, the false positive rate increased from 14% to 38% when compared to 2 equivalent 3-month intervals over the 2 previous years. The positive predictive value of an apparent STEMI decreased from 70% to 37%. These concerns were brought to the attention of the manufacturer and a revised interpretive software algorithm was introduced into service on July 1, 2012.

We describe the City of San Diego's experience with a revised ECG interpretive software algorithm to identify STEMI when used by paramedics. The modified algorithm was developed by a device manufacturer, in response to our concerns regarding an increase in false-positive STEMI diagnoses, coincident with the introduction of a new monitor-defibrillator.

The modified algorithm focused on specific rhythms identified as causing false positive prehospital STEMIs in the City of San Diego. The objective of this study was to determine if a revised algorithm improved the sensitivity and specificity of the prehospital identification of STEMI. In addition, we reviewed the stability of the revised ECG algorithm 10 months after its initial implementation.

MATERIALS AND METHODS

Data from the City of San Diego EMS electronic health record (TapChart; Imagetrend Inc., Lakeville, MN) were reviewed from 6 months before and 6 months after algorithm implementation on July 1, 2012. Records were again reviewed 10 months later for a 3-month period (May 1–August 1, 2013) for follow-up. Records from STEMI cases were identified using the following search criteria: "STEMI probable," incident narrative contains "STEMI" or "acute MI," and does not contain "no STEMI, negative STEMI, neg STEMI or systemic." Each record was reviewed manually so as to include only those ECGs that identify an apparent STEMI because of functioning of the device's interpretative software. Cases meeting the inclusion criteria were deidentified and entered into an Excel registry database (Microsoft Corp., Redmond, WA). STEMI receiving centers in the county participate in a regional database, providing information such as final diagnosis and percutaneous coronary intervention (PCI) results. Research records were matched to this database to confirmed final diagnosis with the receiving hospital. An acute STEMI was defined as the presence of a coronary occlusion requiring emergent PCI. False positives were defined as cases not warranting PCI per the STEMI receiving center physician or no significant coronary artery occlusion found on PCI. For cases determined to be false positives, factors contributing to an incorrect algorithm interpretation were identified. Each receiving hospital was requested to report any false negative ECGs via the regional database for interpretation in a similar manner to the false positive tracings. Patient demographics were assessed, including age, gender, and chief complaint. A chi-square test was used to assess gender and an independent t test was used to assess age between the pre- and postimplementation periods. A chi-square test was used to assess the change in true and false positive rates between periods. $p < 0.05$ was considered statistically significant. The institutional review board of the University of California San Diego Health System reviewed and approved the study protocol and considered this study to be exempt from informed consent.

RESULTS

A total of 510 cases were reviewed, and 461 of these cases met inclusion criteria (234 preimplementation, 138

Table 1. Patient Demographics

Category	FP before	FP after	TP before	TP after	Follow-Up
Male	91	28	61	75	19
Female	59	12	23	23	5
Total	150	40	84	98	24
Average age (years)	68.5	62.9	62.3	63.6	67.4
Age range (years)	19–104	28–91	33–99	39–91	22–95

FP = False positive; TP = true positive.

postimplementation, and 89 follow-up). Forty-four cases were excluded (30 preimplementaion, 14 postimplementation), because no follow-up data were available in the regional STEMI database. An additional 5 cases were excluded because the prehospital provider incorrectly interpreted the ECG, rather than the ECG misinterpretation being related to the programmed function of the ECG machine. No cases were excluded or lost to follow-up during the 10-month re-evaluation. There were no significant differences between groups with regard to age ($p = 0.086$) or gender ($p = 0.052$; Table 1).

When compared with the period 6 months before the introduction of the revised algorithm, there was both a significant reduction in the rate of false positive STEMI cases (150 preimplementation vs. 40 postimplementation; $p < 0.001$) and an increase in the identification of true STEMI (84 preimplementation vs. 98 postimplementation; $p < 0.001$) after the revised software was introduced. These cases are summarized in Figure 1. Each receiving hospital was requested to report false negative ECGs for analysis in a similar manner, though none were reported during the study period.

Table 2 lists the factors associated with false positive STEMI in all 3 periods. Before implementation, the most common factor resulting in incorrect prehospital 12-lead interpretation was right bundle branch block (RBBB, 38%), left bundle branch block (15%), and atrial fibrillation (13%). After implementation, RBBB made up only 8% of false positives. The new algorithm appeared to correct for these misinterpretations with most subsequent false positives attributed to benign early repolarization (BER, 25%) or poor technical quality of the tracing (20%).

In a follow-up review 10 months postimplementation, a total of 24 ECGs were identified during a 3-month period. One year after the implementation, BER continued to be the leading source of false positives, accounting for 54% of cases.

DISCUSSION

Previous studies have shown ECG interpretive software to have generally robust specificity but sometimes lower sensitivity (35–37). Notably, positive predictive value can be near 50% (38–40). Comparison of test characteristics is difficult because of significant heterogeneity between studies. Researchers use different criterion standards for STEMI (e.g., physician consensus vs. PCI outcomes)

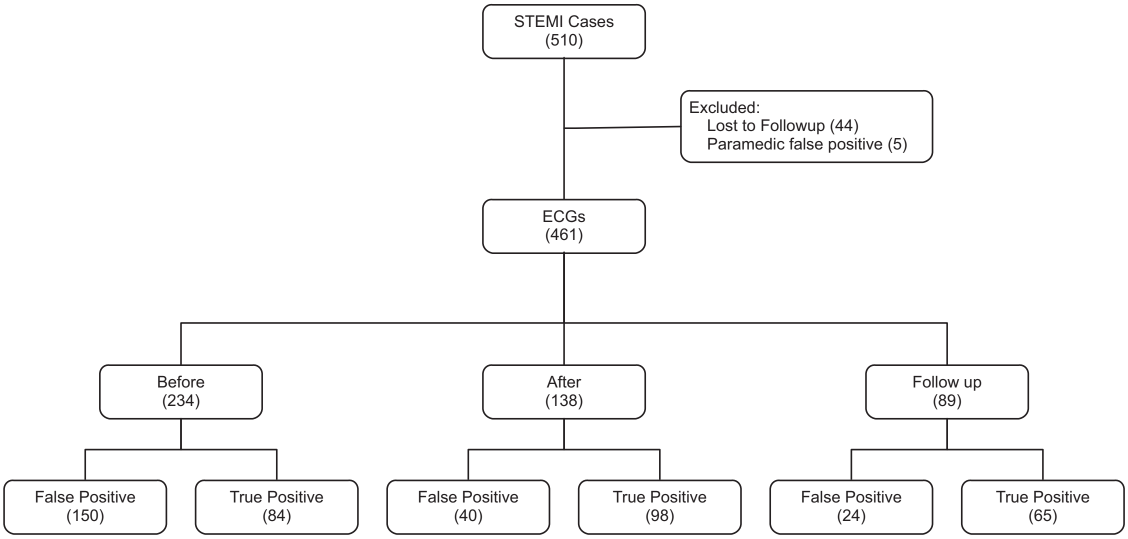

Figure 1. Summary of cases. STEMI = ST-elevation myocardial infarction; ECG = electrocardiogram.

Table 2. Factors Affecting False Positives

Factor	Before (%)	After (%)	Follow-Up (%)
RBBB	57 (38.00)	3 (7.50)	3 (12.50)
LBBB	22 (14.67)	1 (2.50)	3 (12.50)
Atrial fibrillation	19 (12.67)	3 (7.50)	0 (0.00)
BER	17 (11.33)	10 (25.00)	13 (54.17)
IVCD	12 (8.00)	0 (0.00)	0 (0.00)
Poor quality	11 (7.33)	8 (20.00)	0 (0.00)
LAFB	9 (6.00)	0 (0.00)	1 (4.17)
Atrial flutter	6 (4.00)	1 (2.50)	1 (4.17)
STEMI criteria met	6 (4.00)	6 (15.00)	1 (4.17)
ST	2 (1.33)	1 (2.50)	1 (4.17)
Diffuse STE	2 (1.33)	1 (2.50)	1 (4.17)
Q waves	2 (1.33)	1 (2.50)	0 (0.00)
Hyperdynamic T waves	2 (1.33)	0 (0.00)	0 (0.00)
LVH	2 (1.33)	0 (0.00)	0 (0.00)
Peaked T waves	2 (1.33)	0 (0.00)	0 (0.00)
Ventricular tachycardia	1 (0.67)	0 (0.00)	0 (0.00)
STE single lead	1 (0.67)	2 (5.00)	0 (0.00)
Diffuse STD	1 (0.67)	2 (5.00)	0 (0.00)
Diffuse PR depression	0 (0.00)	1 (2.50)	1 (4.17)
Incomplete RBBB	0 (0.00)	1 (2.50)	0 (0.00)
Sinus rhythm	0 (0.00)	2 (5.00)	0 (0.00)
PVC	0 (0.00)	0 (0.00)	1 (4.17)
Pacer malfunction	0 (0.00)	0 (0.00)	1 (4.17)
Total ECGs reviewed	150	40	24
Total no. of risk factors found	174	43	27

BER = benign early repolarization; IVCD = intraventricular conduction defect; LAFB = left anterior fascicular block; LBBB = left bundle branch block; LVH = left ventricular hypertrophy; RBBB = right bundle branch block; STD = ST segment depression; STE = ST segment elevation; STEMI = ST segment elevation myocardial infarction; PVC = premature ventricular complex; ECG = electrocardiogram.

and study different versions of different manufacturers' software. Despite these challenges, our data are generally consistent with previous literature.

After correction for RBBB misinterpretation, BER accounted for the greatest portion of persistent false positives. Previous studies have shown that differentiating STEMI from BER is difficult for cardiologists and emergency physicians alike (41). Therefore, it is not surprising that a software interpretation algorithm may also make this error.

Previous studies have noted BER, pericarditis, previous MI, stress cardiomyopathy, myocarditis, left bundle branch block, left ventricular aneurysm, and left ventricular hypertrophy as common causes for false positive STEMI interpretation by physicians (41–44). RBBB is not traditionally a common cause of false positive interpretation, yet it was the most common cause in this study. Subsequently, RBBB accounted for the most significant reduction in false positives after implementation of the new software.

Limitations

Limitations of this study include the lack of known prevalence of false negatives. The current data collection system depends on STEMI centers to report cases that were not identified prehospital to a regional database. Prehospital and hospital records are not otherwise connected. The City of San Diego EMS system performs >1300 ECGs every month. Even if every prehospital ECGs were reviewed, outcome data were not necessarily available to classify it as a true or false negative. False negatives are likely underreported and are arguably the most concerning ECG misinterpretation. It is possible that the new algorithm decreased the false positive interpretations at the expense of an increased rate of false negatives. We attempted to obtain follow-up on all cases, specifically requesting further information from each designated STEMI center, but there remained 44 ECGs for which no data were available in the regional STEMI database nor provided after requests to the STEMI centers. These cases were excluded from the study.

While part of the case definition for a false positive test was a negative catheterization, it is possible that some of these interventions were diagnostically appropriate rather than therapeutically necessary. In cases such as cocaine vasospasm, the ECG may be indistinguishable from an acute coronary syndrome and can only be differentiated on PCI. In addition, with some difficult to interpret ECGs, an interventional cardiologist may agree that PCI is necessary to rule out acute coronary syndrome. Even in some instances where the diagnosis of STEMI is clear on the ECG, physicians may decline to refer the patient for PCI because of comorbidities, patient wishes, etc. These clinical subtleties cannot be teased out through our methods.

These data include results from the City of San Diego EMS system, which constitutes approximately 70% of EMS providers in the greater San Diego area. Data from the remaining 30% of EMS providers were not available. Finally, ECGs were reviewed by a single reviewer (CC) and not corroborated by an additional blinded reviewer.

CONCLUSIONS

This study showed that the introduction of a revised 12-lead interpretive software algorithm resulted in a significant reduction in the number of false positive STEMI activations in a large urban EMS system.

Six months after the new algorithm implementation, BER was the leading cause of false STEMIs. This finding remained stable at 10 months of follow-up with the same algorithm and with no intervening factors or changes to local protocols. This study also shows the importance of careful quality improvement to detect variance resulting from a change in equipment. EMS and other health care agencies should remain vigilant during new equipment introductions for potential effects on time-critical conditions, such as STEMI. Decreasing false positive STEMI interpretation can lead to a decrease in unnecessary cardiac catheterization laboratory activations, thereby reducing cost and improving efficiency.

REFERENCES

1. So DYF, Ha ACT, Turek MA, et al. Comparison of mortality patterns in patients with ST-elevation myocardial infarction arriving by emergency medical services versus self-transport (from the prospective Ottawa Hospital STEMI Registry). Am J Cardiol 2006;97:458–61.
2. Rezaee ME, Conley SM, Anderson TA, Brown JR, Yanofsky NN, Niles NW. Primary percutaneous coronary intervention for patients presenting with ST-elevation myocardial infarction: process improvements in rural prehospital care delivered by emergency medical services. Prog Cardiovasc Dis 2010;53:210–8.
3. McNamara RL, Herrin J, Bradley EH, et al. Hospital improvement in time to reperfusion in patients with acute myocardial infarction, 1999 to 2002. J Am Coll Cardiol 2006;47:45–51.
4. Brodie BR, Hansen C, Stuckey TD, et al. Door-to-balloon time with primary percutaneous coronary intervention for acute myocardial infarction impacts late cardiac mortality in high-risk patients and patients presenting early after the onset of symptoms. J Am Coll Cardiol 2006;47:289–95.
5. Brainard AH, Raynovich W, Tandberg D, Bedrick EJ. The prehospital 12-lead electrocardiogram's effect on time to initiation of reperfusion therapy: a systematic review and meta-analysis of existing literature. Am J Emerg Med 2005;23:351–6.
6. Bradley EH, Curry LA, Webster TR, et al. Achieving rapid door-to-balloon times: how top hospitals improve complex clinical systems. Circulation 2006;113:1079–85.
7. Bradley EH, Herrin J, Wang Y, et al. Strategies for reducing the door-to-balloon time in acute myocardial infarction. N Engl J Med 2006;355:2308–20.
8. Adams GL, Campbell PT, Adams JM, et al. Effectiveness of prehospital wireless transmission of electrocardiograms to a cardiologist via hand-held device for patients with acute myocardial infarction (from the Timely Intervention in Myocardial Emergency, NorthEast Experience [TIME-NE]). Am J Cardiol 2006;98:1160–4.
9. Garvey JL, MacLeod BA, Sopko G, Hand MM. Pre-hospital 12-lead electrocardiography programs: a call for implementation by emergency medical services systems providing advanced life support—National Heart Attack Alert Program (NHAAP) Coordinating Committee; National Heart, Lung, and Blood Institute (NHLBI); National Institutes of Health. J Am Coll Cardiol 2006;47:485–91.
10. Diercks DB, Kontos MC, Chen AY, et al. Utilization and impact of pre-hospital electrocardiograms for patients with acute ST-segment elevation myocardial infarction. J Am Coll Cardiol 2009;53:161–6.
11. Bosson N, Kaji AH, Niemann JT, et al. The utility of prehospital ECG transmission in a large EMS system. Prehosp Emerg Care 2015;19:496–503.
12. Brown JP, Mahmud E, Dunford JV, Ben-Yehuda O. Effect of prehospital 12-lead electrocardiogram on activation of the cardiac catheterization laboratory and door-to-balloon time in ST-segment elevation acute myocardial infarction. Am J Cardiol 2008;101:158–61.
13. Camp-Rogers T, Dante S, Kontos MC, Roberts CS, Kreisa L, Kurz MC. The impact of prehospital activation of the cardiac catheterization team on time to treatment for patients presenting with ST-segment-elevation myocardial infarction. Am J Emerg Med 2011;29:1117–24.
14. Cone DC, Lee CH, Van Gelder C. EMS activation of the cardiac catheterization laboratory is associated with process improvements in the care of myocardial infarction patients. Prehospital Emerg Care 2013;17:293–8.
15. Davis DP, Graydon C, Stein R, et al. The positive predictive value of paramedic versus emergency physician interpretation of the prehospital 12-lead electrocardiogram. Prehospital Emerg Care 2007;11:399–402.
16. Drew BJ, Dempsey ED, Joo TH, et al. Pre-hospital synthesized 12-lead ECG ischemia monitoring with trans-telephonic transmission in acute coronary syndromes: pilot study results of the ST SMART trial. J Electrocardiol 2004;37(suppl):214–21.
17. Feldman JA, Brinsfield K, Bernard S, White D, Maciejko T. Real-time paramedic compared with blinded physician identification of ST-segment elevation myocardial infarction: results of an observational study. Am J Emerg Med 2005;23:443–8.
18. Ioannidis JP, Salem D, Chew PW, Lau J. Accuracy and clinical effect of out-of-hospital electrocardiography in the diagnosis of acute cardiac ischemia: a meta-analysis. Ann Emerg Med 2001;37:461–70.
19. Karagounis L, Ipsen SK, Jessop MR, et al. Impact of field transmitted electrocardiography on time to in-hospital thrombolytic therapy in acute myocardial infarction. Am J Cardiol 1990;66:786–91.
20. Keeling P. Safety and feasibility of prehospital thrombolysis carried out by paramedics. BMJ 2003;327:27–8.
21. Kerem Y, Eastvold JS, Faragoi D, Strasburger D, Motzny SE, Kulstad EB. The role of prehospital electrocardiograms in the recognition of ST-segment elevation myocardial infarctions and reperfusion times. J Emerg Med 2014;46:202–7.
22. Kudenchuk PJ, Maynard C, Cobb LA, et al. Utility of the prehospital electrocardiogram in diagnosing acute coronary syndromes: the Myocardial Infarction Triage and Intervention (MITI) Project. J Am Coll Cardiol 1998;32:17–27.
23. Millar-Craig MW, Joy AV, Adamowicz M, Furber R, Thomas B. Reduction in treatment delay by paramedic ECG diagnosis of myocardial infarction with direct CCU admission. Heart 1997;78:456–61.
24. Morrison LJ, Brooks S, Sawadsky B, McDonald A, Verbeek PR. Prehospital 12-lead electrocardiography impact on acute myocardial infarction treatment times and mortality: a systematic review. Acad Emerg Med 2006;13:84–9.
25. Nestler DM, White RD, Rihal CS, et al. Impact of prehospital electrocardiogram protocol and immediate catheterization team

activation for patients with ST-elevation-myocardial infarction. Circ Cardiovasc Qual Outcomes 2011;4:640–6.

26. Ong ME, Wong AS, Seet CM, et al. Nationwide improvement of door-to-balloon times in patients with acute ST-segment elevation myocardial infarction requiring primary percutaneous coronary intervention with out-of-hospital 12-lead ECG recording and transmission. Ann Emerg Med 2013;61:339–47.
27. Ortolani P. Clinical impact of direct referral to primary percutaneous coronary intervention following pre-hospital diagnosis of ST-elevation myocardial infarction. Eur Heart J 2006;27: 1550–7.
28. Sekulic M, Hassunizadeh B, McGraw S, David S. Feasibility of early emergency room notification to improve door-to-balloon times for patients with acute ST segment elevation myocardial infarction. Catheter Cardiovasc Interv 2005;66:316–9.
29. Squire BT, Tamayo-Sarver JH, Rashi P, Koenig W, Niemann JT. Effect of prehospital cardiac catheterization lab activation on door-to-balloon time, mortality, and false-positive activation. Prehospital Emerg Care 2014;18:1–8.
30. Strauss DG, Sprague PQ, Underhill K, et al. Paramedic transtelephonic communication to cardiologist of clinical and electrocardiographic assessment for rapid reperfusion of ST-elevation myocardial infarction. J Electrocardiol 2007;40:265–70.
31. Swan PY, Nighswonger B, Boswell GL, Stratton SJ. Factors associated with false-positive emergency medical services triage for percutaneous coronary intervention. West J Emerg Med 2009;10: 208–12.
32. Bosson N, Sanko S, Stickney RE, et al. Causes of prehospital misinterpretations of ST elevation myocardial infarction. Prehospital Emerg Care 2017;21:283–90.
33. Swor R, Hegerberg S, McHugh-McNally A, Goldstein M, McEachin CC. Prehospital 12-lead ECG: efficacy or effectiveness? Prehospital Emerg Care 2006;10:374–7.
34. Terkelsen CJ, Lassen JF, Nørgaard BL, et al. Reduction of treatment delay in patients with ST-elevation myocardial infarction: impact of pre-hospital diagnosis and direct referral to primary percutanous coronary intervention. Eur Heart J 2005;26:770–7.
35. Bhalla MC, Mencl F, Gist MA, Wilber S, Zalewski J. Prehospital electrocardiographic computer identification of ST-segment elevation myocardial infarction. Prehospital Emerg Care 2013;17:211–6.
36. Kado HS, Wilson RE, Strom JA, Box LC. Retrospective validation of pre-hospital electrocardiogram with Zoll E-Series monitoring system for field identification of ST elevation myocardial infarction patients [abstract]. Circ Cardiovasc Qual Outcomes 2012;5:A237.
37. Wilson RE, Kado HS, Percy RF, et al. An algorithm for identification of ST-elevation myocardial infarction patients by emergency medicine services. Am J Emerg Med 2013;31:1098–102.
38. de Champlain F, Boothroyd LJ, Vadeboncoeur A, et al. Computerized interpretation of the prehospital electrocardiogram: predictive value for ST segment elevation myocardial infarction and impact on on-scene time. Can J Emerg Med 2014;16:94–105.
39. Sanko S, Eckstein M, Bosson N, et al. Accuracy of out-of-hospital automated ST segment elevation myocardial infarction detection by LIFEPAK 12 and 15 devices: the Los Angeles experience. Ann Emerg Med 2015;66(suppl):S6–7.
40. Youngquist ST, Shah AP, Niemann JT, Kaji AH, French WJ. A comparison of door-to-balloon times and false-positive activations between emergency department and out-of-hospital activation of the coronary catheterization team. Acad Emerg Med 2008;15:784–7.
41. Turnipseed SD, Bair AE, Kirk JD, Diercks DB, Tabar P, Amsterdam EA. Electrocardiogram differentiation of benign early repolarization versus acute myocardial infarction by emergency physicians and cardiologists. Acad Emerg Med 2006;13:961–6.
42. Brady WJ, Perron AD, Chan T. Electrocardiographic ST-segment elevation: correct identification of acute myocardial infarction (AMI) and non-AMI syndromes by emergency physicians. Acad Emerg Med 2001;8:349–60.
43. Larson DM, Menssen KM, Sharkey SW, et al. “False-positive” cardiac catheterization laboratory activation among patients with suspected ST-segment elevation myocardial infarction. JAMA 2007; 298:2754–60.
44. Otto LA, Aufderheide TP. Evaluation of ST segment elevation criteria for the prehospital electrocardiographic diagnosis of acute myocardial infarction. Ann Emerg Med 1994;23:17–24.

ARTICLE SUMMARY

1. Why is this topic important?

Emergency medical services plays a critical role in identifying ST-elevation myocardial infarction (STEMI) to triage to an appropriate facility and activate hospital resources before patient arrival to reduce door-to-balloon time. Monitors capable of acquiring 12-lead electrocardiograms (ECGs) are ubiquitous in the prehospital setting.

2. What does this study attempt to show?

This study shows the importance of quality improvement monitoring during the introduction of new cardiac monitoring equipment. Rigorous testing and standardization of interpretative software is recommended before that software is introduced into any clinical setting, to optimize clinical efficiency of monitoring devices.

3. What are the key findings?

After changing cardiac monitor manufacturers, the City of San Diego emergency medical services system experienced a large increase in the rate of ECGs that were false positives for the occurrence of a STEMI. After contacting and cooperating with the manufacturer, a revised interpretative algorithm was introduced. Programming this new algorithm into the software resulted in a decreases false positive rate for STEMIs. This decrease was sustained at the time of a 10-month follow-up.

4. How is patient care impacted?

False positive STEMI activations leading to cardiac catheterization exposes patients to unnecessary risk, reduces efficiency, and increases costs.