Clinical Summary

Los Angeles ECG study reports high sensitivity and specificity for LIFEPAK® 15 monitor/defibrillator's STEMI detection algorithm

Bosson N, Sanko S, Stickney R, et al. Causes of prehospital misinterpretations of ST elevation myocardial infarction. *Prehospital Emergency Care*. November, 2016. (Online) Journal homepage: http://www.tandfonline.com/doi/full/10.1080/10903127.2016.1247200

Purpose:

Physio-Control, Los Angeles Fire Department (LAFD) and Los Angeles County EMS Agency (LACEMSA) collaborated on a clinical study primarily to identify opportunities for improvement in cath lab activation for STEMI. The purpose of this study was to evaluate cases in which a computerized interpretive algorithm disagreed with the clinical diagnosis of STEMI in patients with suspected acute cardiac ischemia, and to determine the potential reasons for this discordance in order to identify the leading opportunities for improving prehospital STEMI identification.

Methods:

- About 45,000 consecutive cases with 12-lead ECGs recorded by LIFEPAK 15 monitors in LAFD were retrospectively analyzed. The data were from a 12-month period from July 2011 - June 2012.
- LACEMSA's STEMI receiving center (SRC) database contained data collected from all SRCs in the county and was used to classify 99% of the ECGs as STEMI or not. The remaining 1% were classified by majority of 3 independent cardiologists who were given just the raw ECG, age and gender.
- Experts examined each STEMI false positive and false negative to determine the causes.

Results:

- Only 711 out of 45,000 ECGs were classified as STEMI false positives (1.6%). Of these 711 ECGs, 126 (18%) could be considered appropriate for cath lab activation due to borderline or greater ST deviation consistent with coronary occlusion. Of the remaining false positives, the reasons were as follows:
  - 20% ECG artifact
  - 16% early repolarization
  - 13% probable pericarditis/myocarditis
  - 12% indeterminate
  - 8% left ventricular hypertrophy
  - 5% right bundle branch block
  - 18 other causes (< 4% each)
- 47 out of 45,000 ECG's were classified as false negatives (0.10%). Of these false negatives, the reasons were as follows:
  - Borderline ST elevation (40%)
  - ST/T ratio low due to tall T waves (15%)
  - 11 other causes (≤ 3 occurrences each)

Definitions/Clarifications

- LIFEPAK 15 sensitivity and specificity were high for all races and both genders, but large differences in STEMI prevalence between races and genders caused large differences in positive predictive value (PPV). What is PPV? Why does this matter?
  - PPV = the % of LIFEPAK 15 device STEMI statements that were truly STEMIs
  - In other words, when the LIFEPAK 15 device said STEMI, in what % of cases was it correct?

LIFEPAK 15 device STEMI accuracy

	LIFEPAK 15
Sensitivity	92.8%
Specificity	98.7%
Positive predictive value	51.0%
Negative predictive value	99.9%

  - Only 539 of the 45,000 ECGs were actual STEMIs (1.5% prevalence).
  - 76% of patients did not have chest pain or discomfort.
  - The low STEMI prevalence was the primary cause of low PPV.

Conclusions:

- LIFEPAK 15 sensitivity and specificity for STEMI were high.
- There were no actionable opportunities to improve the LIFEPAK 15's sensitivity for STEMI because there were relatively few missed STEMIs and 40% of them were due to borderline ST elevation.
- The LIFEPAK 15's sensitivity and specificity were higher than reported in two previous studies, but the PPV was lower due to low STEMI prevalence.[1,2,3]

- The leading opportunities for reducing STEMI false positives were:
  - ECG transmission for physician overread (potential 65% reduction)
  - Reducing ECG artifact (potential 10% reduction)
  - Incorporating the study data in the continuous improvement process for the computerized interpretive algorithm (potential 10-15% reduction).

Physio-Control Discussion Points:

- STEMI detection by any computerized interpretive algorithm is not accurate enough for activating the cath lab without ECG overread. The AHA Guidelines 2015 recommend against it, as well.[4] Algorithms are intended to be used as a STEMI screening tool by providing a second opinion
- This study showed that false cath lab activations can be minimized in three ways:
  - Using trained paramedics to make the STEMI call in the field
  - Transmitting 12-lead ECGs for physician overread
  - Minimizing ECG artifact
- Physio-Control can help clinicians implement these three methods with the following:
  - Live and online training is designed to improve accuracy for identifying STEMIs, ruling out STEMI imposters and minimizing ECG artifact.
  - The LIFENET® System gives clinicians a quick and efficient tool to transmit 12-leads from EMS to hospitals for immediate overread and alert clinicians of an incoming STEMI patient.
  - ECG artifact in the EMS environment is a common challenge for all ECG devices from all manufacturers. Physio-Control has tools that provide guidance on proper skin prep, how to recognize each type of artifact and which steps will minimize that artifact.
  - ECG Artifact poster (GDR 3328841)
  - Minimizing ECG Artifact pocket guide (GDR 3306627)
- For EMS systems that do not train their paramedics to identify STEMI, the optimum STEMI solution may be to use the LIFEPAK 15 monitor's relatively high sensitivity for STEMI to identify which ECGs to transmit, via the LIFENET System, for physician overread. This STEMI solution may achieve both an acceptably low STEMI false negative rate and an acceptably low cath lab false activation rate, while minimizing time from first ECG to definitive treatment for STEMI.

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2. Macfarlane P, Hampton D, Clark E, et al. Evaluation of age and sex dependent criteria for ST elevation myocardial infarction. *Computers in Cardiology.* 2007;34:293-6.
3. Clark E, Sejersten M, Clemmensen P, et al. Automated electrocardiogram interpretation programs versus cardiologists' triage decision making based on teletransmitted data in patients with suspected acute coronary syndrome. *Am J Cardiol.* 2010;106:1696-702.
4. O'Connor R, Al Ali A, Brady Wetal. Part 9: Acute Coronary Syndromes. 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation.* 2015;132[suppl 2]:S483–500.

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