Critical Review Form
Clinical Prediction or Decision Rule

Value of post-resuscitation electrocardiogram in the diagnosis of acute myocardial infarction in out-of-hospital cardiac arrest patients.
Resuscitation. 2011 Sep;82(9):1148-53.

Objectives: "to identify ECG criteria that improve selection for ECA [early coronary angiography] of the patients undergoing AMI," (p. 1149) among patients with return of spontaneous circulation (ROSC) from out-of-hospital cardiac arrest (OHCA).

Methods: This was a single-center, retrospective, observational study conducted on consecutive OHCA patients, age 18 or older, admitted between January 2002 and June 2008. Patients were excluded if they had an obvious noncardiac cause of their arrest, if they did not have sustained ROSC (at least 20 minutes), or if no post-ROSC ECG was available. Per protocol, patients without an obvious noncardiac cause of arrest who had sustained ROSC were taken for ECA, with angioplasty performed as indicated.

The first interpretable post-ROSC ECG was evaluated retrospectively by two experienced observers, blinded to coronary angiography results, with disagreement arbitrated by a third observer. ECGs were evaluated for the presence of:

- ST-segment elevation: ≥ 2 mV of elevation in 2 or more contiguous leads; in women, ≥ 1.5 mV of elevation in V2 or V3 or ≥ 1.0 mV in the rest of the leads.
- ST-segment depression: ≥ 0.1 mV in 2 or more contiguous leads.
- Left bundle branch block (LBBB): QRS ≥ 120 ms with QS or rS pattern in V1 and broad R-waves in I, V5, and V6.
- Right bundle branch block (RBBB): QRS ≥ 120 ms with rSR' in V1 and V2 and S wave in I, V5, or V6.
- Non-specific wide QRS complex: QRS ≥ 120 ms without LBBB or RBBB morphology.

ECA was also retrospectively analyzed by two independent observers, with disagreement arbitrated by a third observer. Acute myocardial infarction (MI) was "defined by the presence of lesions suggestive of ruptured plaques...with evidence of fresh thrombus in a main coronary artery, with TIMI 1 or 0 flow...and troponin concentration was required to increase during the hospital stay to ≥ 4 ng/mL." (p. 1149). Coronary angioplasty was considered to be successful if is resulted in < 50% residual stenosis with TIMI 3 flow.

Between January 2002 and June 2008 there were 3503 OHCA patients in Paris, of whom 235 were admitted to the study Hospital. Of these, 36 were excluded for a noncardiac cause of the arrest, 26 for absence of ROSC, 3 for ROSC < 20 minutes, and 5 for absence of a post-ROSC ECG. Therefore, 165 patients were included in the

study. The median age was 56 and 79% were male. A shockable initial rhythm was present in 84 subjects (82 with VF, 2 with VT). Overall survival was 31% (n = 51), and a favorable neurologic outcome was seen in 43 patients (26%), 29 with a CPC score of 1 and 14 with a CPC score of 2. On coronary angiography, 97 patients (59%) had at least one significant coronary stenosis. Acute MI was diagnosed angiographically in 60 patients (36%), all of whom had elevated troponin levels above 4 ng/mL during hospitalization. Angioplasty was attempted in 87% of patients with acute MI (n = 52) and was successful in 94% of these attempts (n = 49).

	Guide	Comments
I.	*Is this a newly derived instrument* **(Level IV)?**	
A.	Was validation restricted to the retrospective use of statistical techniques on the original database? (If so, this is a Level IV rule & is not ready for clinical application).	No. Validation was not performed. This was solely a derivation study (Level IV).
II.	**Has the instrument been validated? (Level II or III). If so, consider the following:**	
1a	Were all important predictors included in the derivation process?	No. The derivation was performed only on ECG findings. Elements of the history and physical exam, initial cardiac rhythm, and laboratory findings were not included in the derivation process.
1b	Were all important predictors present in significant proportion of the study population?	Yes. A significant proportion of patients had ST-elevation, ST depression, LBBB, RBBB, wide QRS complex.
1c	Does the rule make clinical sense?	Yes. The criteria included ST-segment elevation, ST-segment depression, and LBBB, all of which are used in the assessment of cardiac infarction or ischemia (Bassand 2007). RBBB and nonspecific wide-QRS were included as conduction defects are often present in acute MI, and may make accurate interpretation of ischemic ECG changes difficult.
2	Did validation include prospective studies on several different populations from that used to derive it (II) or was it restricted to a single population (III)?	No validation has yet been attempted.
3	*How well did the validation study meet the following criteria?*	
3a	Did the patients represent a wide spectrum of severity of disease?	Yes. These were all patients suffering out of hospital cardiac arrest with ROSC. Of 165 subjects: 27% had a normal coronary angiogram, 14% had nonsignificant

		coronary stenosis, and 59% had at least one significant stenosis, and 60 (36%) were found to have acute angiographic MI. Angioplasty was attempted in 87% of those with AMI, and was successful in 94% of these.
3b	Was there a blinded assessment of the gold standard?	Uncertain. Coronary angiography was retrospectively analyzed by two independent observers, with disagreement arbitrated by a third observer. The authors do not specifically mention if these observers were blinded to the ECG findings or outcomes.
3c	Was there an explicit and accurate interpretation of the predictor variables & the actual rule without knowledge of the outcome?	Yes. All reference ECGs were interpreted retrospectively by two experienced observers who were blinded to the coronary angiography results. Disagreement was arbitrated by a third observer.
3d	Did the results of the assessment of the variables or of the rule influence the decision to perform the gold standard?	No. All 165 patients in the study underwent coronary angiography based on local protocol.
4	How powerful is the rule (in terms of sensitivity & specificity; likelihood ratios; proportions with alternative outcomes; or relative risks or absolute outcome rates)?	For the diagnosis of angiographically defined acute MI: **ST-elevation alone:** sensitivity 88% (95% CI 77%-95%) specificity 84% (95% CI 75%-90%) PPV 76% (95% CI 64%-85%) NPV 93% (95% CI 85%-97%) LR+ 5.5 (95% CI 3.5-8.5) LR- 0.14 (95% CI 0.07-0.28) **ST elevation or depression:** sensitivity 95% (95% CI 85%-99%) specificity 63% (95% CI 53%-72%) PPV 59% (95% CI 49%-69%) NPV 96% (95% CI 87%-99%) LR+ 2.6 (95% CI 2.0-3.3) LR- 0.08 (95% CI 0.03-0.24) **ST elevation or depression or LBBB or nonspecific QRS widening:** sensitivity 100% (95% CI 93%-100%) specificity 47% (95% CI 37%-57%) PPV 52% (95% CI 42%-61%) NPV 100% (95% CI 91%-100%) LR+ 1.9 (95% CI 1.6-2.2) LR- 0 (95% CI 0-0.19)

		ST elevation or depression or LBBB or nonspecific QRS widening or RBBB: sensitivity 100% (95% CI 93%-100%) specificity 39% (95% CI 30%-49%) PPV 48% (95% CI 39%-57%) NPV 100% (95% CI 89%-100%) LR+ 1.6 (95% CI 1.4-1.9) LR- 0 (95% CI 0-0.23)
III.	**Has an impact analysis demonstrated change in clinical behavior or patient outcomes as a result of using the instrument? (Level I). If so, consider the following:**	
1	How well did the study guard against bias in terms of differences at the start (concealed randomization, adjustment in analysis) or as the study proceeded (blinding, co-intervention, loss to follow-up)?	The study was conducted on consecutive patients presenting with sustained ROSC following OHCA, excluding those with an obvious non-cardiac cause for the arrest. Both electrocardiograms and coronary angiograms were reviewed retrospectively. The electrocardiograms were reviewed by observers blinded to the angiography results; the authors do not mention if the observers reviewing the angiograms were blinded to the ECGs, and it seems likely that these were the same observers that reviewed the ECGs. This could potentially lead to interpretation bias. Five patients were excluded because no ECG tracing could be found; this would not likely introduce significant bias. There was no differential verification bias, as all patients with ROSC underwent coronary angiography (the gold standard).
2	What was the impact on clinician behavior and patient-important outcomes?	No impact analysis has yet been performed. Based on the accuracy of the combined criterion (ST elevation or depression, or LBBB, or QRS widening) the authors conclude that coronary angiography could have been avoided in 49 patients, representing 30% of the 165 patients in the study, while all 60 cases of angiographically defined acute MI would have been diagnosed and treated.

Limitations:

1) This derivation study has not been **prospectively validated**, and has had no **impact analysis** performed.

2) Derivation of the rule involved ECG findings only, and did not take into account clinical characteristics or rhythm analysis.

3) Five patients were excluded due to the lack of a post-resuscitation ECG.

4) ECG criteria were determined by retrospective interpretation by two reported observers:
   a. Clinical practice would require prospective interpretation of ECG findings by a single observer.
   b. The authors do not state if those interpreting the ECGs were emergency physicians or cardiologists.
   c. **Kappa values** for these interpretations were not provided.

5) The authors' conclusion that use of this rule would reduce unnecessary cardiac catheterizations is predicated upon the Parisian model of post-resuscitation care. Implementation in the US would instead result in an *increase* in the rate of unnecessary cardiac catheterizations.

Bottom Line:

This derivation study identified a clinical prediction rule based on ECG findings to assess for the presence of angiographically defined acute MI in patients with ROSC following OHCA. The presence of ST-elevation or depression, a presumed new LBBB, or nonspecific QRS widening predicted AMI with a of sensitivity 100%, a specificity of 47%, a positive predictive value of 52%, and a negative predictive value of 100%. However, of 46 patients without ST-elevation who were positive by ECG criteria, only 7 (15%) had angiographically defined AMI; the other 39 underwent an unnecessary cardiac catheterization. While the authors conclude that use of this rule would have resulted in 30% of the cohort avoiding unnecessary cardiac catheterization, use of such a rule in the US would instead lead to a significant *increase* in cardiac catheterization rates following OHCA. It is unclear if performing cardiac catheterization on patients with ECG findings (other than STEMI) would lead to improved patient outcomes.