Appropriate Cardiac Cath Lab activation: Optimizing electrocardiogram interpretation and clinical decision making for acute ST-elevation myocardial infarction

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Editor’s Synopsis

In 2004, the American College of Cardiology and the American Heart Association jointly declared that both ST-elevation myocardial infarction (STEMI) and chest pain with new left bundle branch block (LBBB) warranted emergency activation of a cardiac catheterization team (class 1A recommendation). Recently, an expert panel criticized these guidelines because they omitted MIs that do not present as a STEMI or new LBBB. Data show that these other MI patterns not only benefit significantly from Cath Lab intervention, but indeed also present with their own recognizable pattern on electrocardiography, making them easy to include in the guidelines. The expert panel suggested that these other recurrent MI patterns should collectively be categorized as “STEMI-equivalents” and that follow the four most significant "STEMI-equivalents” should be included in the current guidelines: posterior MI, acute left main coronary occlusion MI, the Winter ST/T-wave complex MI, and postcardiac resuscitation MI. The expert panel simultaneously recommended a de-emphasis of emergency Cath Lab activation for new onset LBBB. The authors of this review discuss strategies for recognizing a classic STEMI, LBBB, and these four newly proposed "STEMI-equivalents" and strategies for optimizing Cath Lab activation.

Introduction

Emergency medicine personnel are encouraged to base themselves on a single electrocardiography (ECG) to make the time-sensitive diagnosis of ST-elevation myocardial infarction (STEMI) for activating the cardiac catheterization (Cath Lab) team for possible primary percutaneous coronary intervention (PPCI). Experience has shown that this single ECG-prompted Cath Lab activation system suffers from 3 system wide barriers to optimal efficiency:

Baseline ECG Knowledge: Clinicians continue to overlook high-risk ECG findings consistent with acute ischemia. Accuracy Under Time Pressure: Minute matter: efficient Cath Lab activation requires a high degree of diagnostic accuracy (avoiding both false positive and false negative ECG interpretations) under time pressure. Typically, either speed or diagnostic accuracy is compromised in these situations, which is a phenomenon known as the “efficiency challenge”.

Systems-Wide Utilization Standards: Cath Lab activation can best be improved if systems-wide tracking and feedback mechanisms are in place; however, clearly defined criteria that distinguish appropriate vs inappropriate Cath Lab activation are lacking. The authors of this article hope to decrease these three barriers to optimal cath lab activation by summarizing the best methods for quickly recognizing all "Cath Lab-worthy" clinical scenarios and ECG results (STEMIs as well as STEMI-equivalents). More specifically, the authors discuss the best methods for quickly recognizing the following six cardiac scenarios:

1. Classic STEMI
2. Left bundle branch block (LBBB; a STEMI-mimic)
3. Posterior MI (a STEMI-equivalent)
4. Left main occlusion (a STEMI-equivalent)
5. de Winter ST/T-wave complex (a STEMI-equivalent)
6. Resuscitated cardiac arrest (a STEMI-equivalent)
KEY POINTS – Introduction

- Refer to Table 1, which is a succinct summary of this entire article. Continue to refer to this table throughout the remainder of the summary.

Definitions and Background Concepts

"STEMI-equivalent" is a new term that refers to MIs in cardiac territories represented by a negative pole on ECG. Coronary artery occlusion in these territories produces ST-depression rather than ST elevation (STE).

A first step toward improving the care of patients with STEMI-equivalent MIs is to improve ECG recognition of these STEMI-equivalents. Toward this end, expert panels recommend that clinicians no longer name ECG leads by cardiac territories (e.g., "anterior" or "inferior" leads) because all ECG leads reflect more than one cardiac region. For example, STE in the so-called "anterior" leads may indicate an anterior MI, but ST-depression in these exact same "anterior" leads may indicate a posterolateral MI.

KEY POINTS – Definitions and Background Concepts

- Clinicians should refrain from naming ECG leads by a single cardiac territory because each lead represents several cardiac territories.
- In order to efficiently initiate emergency reperfusion, clinicians need a solid diagnostic knowledge of STEMIs, STEMI mimics, and STEMI-equivalents.
- The term STEMI refers to any classic STE ECG pattern that signifies an acute myocardial infarction.
- The term "STEMI-mimic" refers to an ECG pattern that looks like a STEMI but is caused by a (usually chronic) condition that would not benefit from Cath Lab intervention (or fibrinolytics).
- The term "STEMI-equivalent" refers to any consistent ECG pattern statistically associated with an acute coronary occlusion that lacks the "classic" STEMI pattern on ECG.
- The following four STEMI-equivalents should be considered for emergency reperfusion (e.g. emergency Cath Lab activation):
  1. Posterior MI
  2. Acute left main occlusion
  3. de Winter ST/T-wave complex
  4. Resuscitated cardiac arrest

- Clinicians should ask the following three key questions each time they analyze ECG results for the presence of an “emergency-reperfusion-worthy” STEMI or STEMI-equivalent:
  1. **Criteria for Diagnosis:** Are the ST-segments consistent with acute STEMI or a STEMI-equivalent?
  2. **Criteria against Differential:** Has the possibility of chronic ST-segment elevation from conditions other than acute MI been excluded?
  3. **Patient Criteria:** Is the patient a reasonable candidate for reperfusion therapy (PPCI or fibrinolysis)?

- ECG interpretation strategies for identifying an acute STEMI or STEMI-equivalent are the same for patients being considered for PPCI or fibrinolysis.
- Follow this link to the **Appendix** (Online Data Supplement) for a list of classic STEMI categories, equivalents, and mimics.
MAXIMIZING DIAGNOSTIC SPECIFICITY FOR ACUTE CORONARY OCCLUSION

Cardiac Cath Lab Appendix ECG Ib

Optimizing Cath Lab activation is a high-priority, systemwide goal because both over- and under-activation of Cath Labs negatively affect patient safety, resource utilization, career longevity of Cath Lab staff, and community safety (e.g., when entire Cath Lab teams are asked to needlessly rush to the hospital). Under this heading (“maximizing diagnostic specificity”), the authors focus on strategies for distinguishing classic STEMI from a classic STEMI equivalent – left bundle branch block (LBBB).

KEY POINTS – Maximizing Diagnostic Specificity for Acute Coronary Occlusion

- A rate of less than 5% inappropriate Cath Lab activations is considered a reasonable system goal.
- Follow this link to Table 3 titled “Classification of appropriate versus inappropriate Cath Lab activation” and study it.
  - Refer to the yellow area in Table 3. Note that some Cath Lab activations classified as "appropriate" in Table 3 actually do NOT result in PPCI. These are nonetheless categorized as appropriate Cath Lab activations.
  - Currently, emergency department (ED physicians and paramedics have 5%-9% and 20%-23% rates, respectively, of classic STEMI-related, false-positive Cath Lab activations (no culprit artery and negative biomarkers).
  - Refer to the red area in Table 3 for a list of inappropriate Cath Lab activation scenarios. Only the frequency of these scenarios needs to be decreased in order to improve Cath Lab efficiency. (Comment: note the newly added bullet. This program adds an automatic space that I cannot undo. As usual, all of the above bullets should NOT have an empty line between them)

1. Classic STEMI
Reliably diagnosing a STEMI on ECG can be challenging because several factors can distort the classic ECG pattern. Large individual variations in coronary anatomy and collateral circulation, pre-existing disease, misplaced leads, and technical limitations of ECG machines in detecting electrical impulses from certain regions of the heart can all obscure a STEMI on ECG. Experts have developed six rules that help clinicians improve their diagnostic accuracy of STEMI recognition in the presence of these challenges (refer to Key Points).

KEY POINTS – Maximizing Diagnostic Specificity for Acute Coronary Occlusion – Classic STEMI

- In the proper clinical context, the presence of STEMI criteria should trigger Cath Lab activation (class 1A recommendation for angiography with PPCI consideration).
- The original 2004 guidelines define a "classic STEMI" ECG pattern as an ECG that shows at least a 1-mm STE in two adjacent leads. (Refer to Table 1 for these classic American College of Cardiology [ACC]/American Heart Association [AHA] STEMI ECG criteria.) More specifically, they state the following (the links lead to sample ECGs):
  - **STE in two adjacent leads within leads V1-V4** = anterior MI
  - **STE in two adjacent leads within leads II, III, or aVF** = inferior MI
  - **STE in two adjacent leads within leads I, aVL, V5, or V6** = lateral MI
- Since 2004, expert panels have further refined these original guidelines. Clinicians can now add the following six ECG-interpretation strategies to optimize their diagnostic accuracy for a classic STEMI:
Rule 1 (know thy STEs!): The National Cardiac Data Dictionary, the AHA/ACC, and the Heart Rhythm Society currently set the STEMI threshold in leads V2-V3 at 2 mm for men and 1.5 mm for women (instead of the original =1 mm STE in the 2004 guidelines) because benign ST-elevation (STE-mimic) of up to 2 mm in men and 1.5 mm in women may occur in these same leads (V2-V3).

Rule 2 (know thy ST elevation-mimics!): IMPORTANT: solid knowledge of the 10 most common STE-mimics is absolutely mandatory to quickly and reliably distinguish MI-related from non–MI-related STEs. Refer to Table 4 for a list of the 10 most common STE-mimics and learn these! It helps to memorize which ones are narrow versus wide complex in order to quickly exclude half the list of STE-mimics based on QRS width alone (caution – some STE-mimics can present with either a wide or narrow QRS complex). Also refer to ECGs III a, b, c, d, and e from the Appendix. These are five examples of the most common STE-mimics. Know these!

Rule 3 (search for thy reciprocal changes!): Clinicians should evaluate every ECG with suspected STEMI for reciprocal changes. A presence of reciprocal changes (ST depression = 0.5 mm in leads 180° opposite to those meeting STE criteria) is nearly diagnostic of MI (95% specificity if reciprocal changes are present in two leads). Refer to ECGs I a-b from the Appendix. These are two examples of anterior infarcts, one with and one without reciprocal changes. Refer to this chart for the most common reciprocal ECG changes. This chart summarizes the most common reciprocal change patterns; however, the chart does not capture all scenarios with reciprocal changes (e.g., anterior MIs that extend somewhat laterally can have reciprocal changes in III and aVF; refer to ECG I a, for an example of this patterns of reciprocal changes.)

Additional Information about Rule 3
- The presence or absence of reciprocal changes may be helpful in resolving challenging "semi-STEMI" cases near the 1-mm STE threshold.
- If reciprocal changes are present, then the appropriateness of Cath Lab activation is almost certain.
- If reciprocal changes are absent, then the differential diagnosis of a true STEMI without reciprocal changes vs a STE-mimic should be carefully but expeditiously reconsidered.
- By definition, reciprocal ST-depression should never be present in any ECG interpreted as normal or as having a narrow-complex STE-mimic (exception: with pericarditis, lead aVR may have reciprocal changes).

Rule 4 (search for thy Q-waves!): Q waves (= 1-mm duration, excluding lead III) that develop in the leads with ST elevations support a STEMI diagnosis.

Additional Information about Rule 4
- In 56% of patients with symptoms lasting fewer than six hours, a Q wave is already present on baseline ECG.
- Patients who present with Q waves on their baseline ECG have worse outcomes (composite outcome of death, heart failure, or shock at 90 days).
- The absence of Q waves does not exclude acute STEMI.

Rule 5 (don't blindly trust thy computer): Computer-analyzed ECG has a 90% specificity for correctly identifying a STEMI. However, studies show that use of these computer interpretations by emergency medical services teams has led to a higher--rather than a lower--rate of inappropriate Cath Lab activation.

Rule 6 (help thy paramedics!): Transmission of a prehospital ECG to the ED for a "second look" increases the rate of appropriate early Cath Lab activations initiated from the field (the wireless transmission and Physician Interpretation systemm, referred to as "WIPI", provides such an "appropriateness filter" between the prehospital "STEMI alert" and the in-hospital "code STEMI").
2. LBBB
Patients with a LBBB almost always have persistent STE = 1 mm in leads V1-V4 and/or leads II/III/aVF, which means that LBBB is a nearly perfect STE-mimic. Unfortunately, this makes it difficult to distinguish between a STE-mimic and a true STEMI in acutely presenting patients whose QRS complexes on ECG meet LBBB criteria. Because patients with LBBB may indeed have a simultaneous STEMI, the standard for decades has been to treat any new (or presumed new) LBBB as a STEMI-equivalent requiring emergency consideration for reperfusion (class 1A recommendation by the ACC/AHA for Cath Lab activation). Newer data challenge the clinical usefulness of this traditional approach, but alternate guidelines are still lacking.

KEY POINTS – Maximizing Diagnostic Specificity for Acute Coronary Occlusion – LBBB
- The 2004 ACC/AHA guidelines define a presumed new LBBB as a STEMI-equivalent for which Cath Lab activation is a class 1A recommendation.
- Gradually accumulating data now challenge this recommendation.
  - Study results show that patients with either a new or old LBBB have a surprisingly similar, low rate of acute MI. More specifically, more than 90% of patients with either new or old LBBB who present with chest pain to the ED neither have an acute coronary occlusion nor require PPCI.
  - Other study results show that classifying new (or presumed new) LBBB as a STEMI-equivalent that justifies Cath Lab activation consistently results in high rates of inappropriate Cath Lab activation.
  - The latest guidelines state that waiting for biomarker results "may sometimes be helpful" in evaluating stable (key!) patients with new onset LBBB, thus implying that stable patients with a new or old LBBB pattern on ECG justify urgent--rather than emergent--Cath Lab activation.
  - IMPORTANT: The following categories of patients with LBBB and chest pain should continue to receive emergent--not urgent--angiography:
    1. Clinically unstable (key!) patients with new onset LBBB
    2. Patients with new onset LBBB and acutely abnormal anterior wall motion on echocardiography. When in doubt, a quick bedside echocardiography study may resolve the issue.
    3. Patients with ECG signs of simultaneous ischemia (see next point)
  - Clinicians should use the following concordance/discordance ECG criteria (modified Sgarbossa criteria) for detecting subtle signs of coexisting ischemia in patients with chronic LBBB. The presence of the below concordance criteria qualifies LBBB as a STEMI-equivalent for which emergent Cath Lab activation is justified. Follow the below links to the ECG study with LBBB and Sgarbossa criteria and compare it carefully to the ECG with LBBB but without Sgarbossa criteria. Interested readers may also want to follow the third link to an online video explaining traditional Sgarbossa criteria
    - Normal: Chronic LBBB normally has discordance (the direction of the major component of the QRS complex is opposite to that of the ST segment/T wave in any lead = the QRS and T waves point in opposite directions).
    - Suspect MI: QRS/ST concordance (QRS and T waves point in the same direction) with ST elevation = 1 mm (key!) in one (key!) or more leads (modified Sgarbossa criteria) is the most robust predictor of acute ischemia in patients with LBBB. Note that only one lead needs to meet the Sgarbossa criteria. The following online video discussion of Sgarbossa criteria is helpful in understanding the basic Sgarbossa concepts in a visual way:
      - ECG Diagnosis of Acute STEMI-Equivalent in the Presence of Left Bundle Branch Block from Academic Emergency Medicine on Vimeo.
Caution: Concordance is useful when present, but it is not useful when absent. Concordance is 98% specific but is only 20% sensitive for detecting ischemia in patients with LBBB. In other words, 80% of patients with ischemia and LBBB will not have concordance; however, a patient with LBBB and concordance has a 98% probability of ischemia (the authors caution that these data stem from the older fibrinolytic era when cardiac markers, not angiography, were the gold standard).

MAXIMIZING DIAGNOSTIC SENSITIVITY FOR ACUTE CORONARY OCCULSION

Under this heading (“maximizing diagnostic sensitivity”), the authors focus on strategies for recognizing 4 classic, but frequently missed STEMI equivalents – posterior MI, left main artery occlusion, de-Winter complex, and resuscitated cardiac arrest (Editors note: well, ok…the cardiac arrest itself is not missed – just the fact that a patient resuscitated from cardiac arrest may warrant emergency Cath Lab activation). These 4 categories represent scenarios of Cath Lab UNDERutilization (not overutilization as occurs with classic STEMIs versus STEMI mimics, which was discussed in the previous section).

1. Posterior MI

Clinical trials commonly exclude posterior MI, which has resulted in a lack of data for this type of MI. The 2004 guidelines reflect this paucity of evidence by assigning a class 2A-C recommendation to administering fibrinolytics to this subset of patients.

The results of the recent TRITON-TIMI-38 study support an upgrade to a class 1A recommendation for emergency Cath Lab activation for posterior MI. (Paradoxically, some part of the 2004 guidelines already indirectly imply that PPCI is a class 1A recommendation for posterior MI.)

The TRITON-TIMI-38 study was one of the few studies that included non-STEMI patients along with STEMI patients; therefore, it provided a chance to study a "posterior MI" subgroup. The researchers found that roughly 9% of their study population had isolated ST-depression in leads V1-V3 on their baseline ECG. Based on biomarkers and angiography, this subgroup of patients was eventually diagnosed with one of the following three etiologies: "posterior MI" (26%), non-STEMI (54%), and unstable angina (20%). The vast majority (99.6%) of patients in this subgroup with isolated ST-depression in leads V1-V3 were treated with nonemergent PCI (> six hours after initial ECG). Interestingly, the fraction of patients within this subgroup with a posterior MI did significantly worse than the other 2 fractions in this subgroup (the non-STEMI and unstable angina patients). These data challenge the current "one-size-fits-all" urgent--rather than emergent--Cath Lab activation for all patients with ST-depression.

KEY POINTS – Maximizing Diagnostic Sensitivity for Acute Coronary Occlusion – Posterior MI

- By definition, the ECG pattern for posterior MI is isolated ST-depression = 0.5 mm in leads V1-V3 or = 0.5 mm STE in leads V7-V9 (additional posterior chest wall leads). Refer to the ECG study with posterior MI. In addition, the following is known about posterior MIs:
  - Associated T-waves are either upright or inverted.
  - Appearance of tall R-waves in V1-V2 may be delayed.
- Data from the TRITON-TIMI-38 study suggest that a true posterior MI should be treated as a STEMI-equivalent with emergent Cath Lab activation:
  - "Slowly treated" ST-depression patients who ultimately received a diagnosis of posterior MI (26% of all ST-depression patients in the study!) had a significantly higher 30-day mortality rate than those who had ST-depression and were classified by angiography/biomarkers as a non-STEMI.
ST-depression patients in the study who ultimately received a diagnosis of posterior MI were found to have an acutely occluded coronary artery (most commonly the left circumflex), implying that emergent PPCI might have preserved cardiac muscle.

EDITOR'S NOTE: The authors did not mention strategies for distinguishing a posterior MI from a non-STEMI on an ECG with ST-depression. Solid criteria may not have been established.

2. Left main coronary occlusion
Acute left main coronary occlusion (LMCO) generally causes a massive cardiac infarct and is rapidly lethal, but a small proportion of patients have enough perfusion from right-sided collaterals to arrive at the hospital alive. One Cath Lab registry analysis collected the following data about patients with LMCO who arrived alive at the hospital:

- About 0.35% of all cardiac patients who survived to PPCI had LMCO.
- About one-third of these LMCO patients did not present in cardiogenic shock.
- About 42% of these LMCO patients lived to hospital discharge.

KEY POINTS – Maximizing Diagnostic Sensitivity for Acute Coronary Occlusion – Left main coronary occlusion

- A 2007 combined analysis of three studies found that the following easily missed ECG pattern had an > 75% sensitivity and specificity for LMCO:
  1. presence of = 0.5-mm STE in lead aVR (key feature!), especially when
  2. the degree of STE in aVR is greater than in lead V1 and
  3. there is lead II/III/aVF ST-depression (compare this criterion to the below 2009 and 2010 definitions).
- Follow this link to an ECG that meets LMCO criteria.
- Despite the fact that LMCO is a life-threatening condition and STEMI-equivalent ECG criteria exist for diagnosing acute LMCO, these criteria have yet to be incorporated into the ACC/AHA guidelines for activating Cath Labs.
- A 2009 AHA scientific statement recommends: "When the resting ECG reveals ST-depression > 1 mm in eight or more surface leads (key feature #1), coupled with STE in aVR and/or VI (key feature #2), but is otherwise unremarkable, then the ECG machine should be programed to suggest ischemia due to multivessel or left main coronary artery obstruction."
- A 2010 international consensus document recently provided similar STEMI-equivalent criteria as the AHA scientific statement: "Acute LMCO (or severe angiographic disease) is evidenced by a myocardial ischemia vector causing ST-depression in six or more leads (maximal depression in V4-V6) and associated STE limited to leads aVR and V1."

EDITOR'S NOTE: Carefully compare the 2007, 2009, and 2010 ECG criteria for LMCO. They overlap some, but a standardized description of the ECG criteria for LMCO has obviously not yet been developed (it remains unclear which criteria play a major vs a supporting role). Also note that a particularly severe, massive, and usually rapidly fatal coronary event--LMCO--may often present with nondramatic ECG findings. At other times, LMCO can look very dramatic, but confusing, which may initiate a pursuit of the wrong diagnosis. The starting point for recognizing LMCO is to look for STE in lead aVR and to then notice ST-depression in nearly all other ECG leads. It should be a habit to consciously screen any “bizarre looking” ECG for this pattern. Otherwise, LMCO – a very rare condition with a tough ECG – will be missed.

3. de Winter ST/T-wave complex
In 2008, de Winter and colleagues described a novel STEMI-equivalent ECG pattern that signifies acute occlusion of the proximal left anterior descending artery (LAD). The de Winter ST/T-wave pattern was first recognized in 30 patients (all with normal baseline serum potassium levels) who represented 2% of all angiographically confirmed anterior MIs.

**KEY POINTS – Maximizing Diagnostic Sensitivity for Acute Coronary Occlusion – de Winter ST/T-wave complex**

- The De Winter complex describes a massive anterior MI that initially presents with St depression rather than the classic STE.
- ECG criteria for the de Winter ST/T-wave pattern include 1-3 mm of ST-depression that is upsloping at the J-point in leads V1-V6 and is associated with persistently tall, upright, and symmetric precordial T-waves. Refer to the ECG study that meets de Winter criteria (Table 1 and Online Appendix II.c).
- The de Winter ST/T-wave complex is distinct from the transient hyperacute T-waves that may occur within minutes of an acute coronary occlusion and then generally quickly morph into a classic STEMI pattern.
- The de Winter ST/T-wave complex should not be confused with Wellens syndrome in which ECG demonstrates either biphasic or inverted T waves in leads V2-V3. Wellens syndrome typically involves a chronic high-grade LAD stenosis that can usually be evaluated by nonemergent angiography. Refer to the ECG study that meets Wellens criteria.

4. Resuscitated cardiac arrest

Neither the ACC/AHA nor the European guidelines comment on the role of immediate diagnostic coronary angiography for survivors of out-of-hospital cardiac arrest (OHCA), but observational registry data have demonstrated good outcomes in survivors of OHCA who received emergency Cath Lab analysis/intervention. Based on these data, patients who have an OHCA are increasingly viewed as simply being a dramatic presentation of acute coronary occlusion. Therefore, certain scenarios of OHCA with return of spontaneous circulation (ROSC) are gaining acceptance as a trigger for emergent Cath Lab activation.

**KEY POINTS – Maximizing Diagnostic Sensitivity for Acute Coronary Occlusion – Resuscitated cardiac arrest**

- In OHCA with ROSC, sudden death with ROSC, not a specific ECG pattern, is the clinical STEMI-equivalent.
- The PROCAT45 registry study (the largest study to date on the topic) demonstrated that successful PPCI was an independent predictor of survival (odds ratio: 2.1) for OHCA regardless of ECG pattern after resuscitation. Overall survival to hospital discharge was 40% in the PROCAT45 registry compared with the national survival rate of 10% for OHCA with ROSC.
- In the PROCAT45 registry, there was an impressive 94% rate of favorable neurologic outcomes in a cohort in which 68% patients had a shockable first rhythm and 85% of patients received in-hospital therapeutic hypothermia.
- The 2008 International Liaison Committee on Resuscitation recommended aggressive postresuscitation care involving both PPCI and invasive hemodynamic support for a greater proportion of survivors of OHCA.
- Considering all of these data, the following three OHCA scenarios warrant consideration for emergent Cath Lab activation. Refer to Table 2. These three scenarios are:
  1. Acute STEMI diagnosed by prehospital ECG in a cardiac arrest witnessed by emergency medical services, followed by prompt defibrillation and ROSC.
  2. Bystander-witnessed OHCA, early activation of 9-1-1, and early chest compressions with presence of a shockable rhythm and ROSC achieved, followed by ECG diagnostic of acute STEMI or STEMI-equivalent.
  3. Witnessed arrest with immediate chest compressions, shockable rhythm and ROSC achieved, but postresuscitation ECG is not diagnostic of acute STEMI or STEMI-equivalent.
APPROPRIATE PATIENT SELECTION

The decision to activate a Cath Lab is a two-pronged decision. First of all, it involves ECG interpretation and diagnosis of a condition that warrant emergency cath Lab activation. Secondly, prior to Cath Lab activation a brief yet careful assessment of the patient (age, comorbidities, functional status, do-not-resuscitate status, family perspective, and patient preferences) should be completed to ascertain that an individual patient is a "candidate" for PPCI.

During the early era of Cath Lab activation and PPCI-based myocardial reperfusion, selection of appropriate "candidates" was influenced by significant concerns regarding meaningful neurologic recovery especially of patients resuscitated from a cardiac arrest.

Newer data show that therapeutic hypothermia significantly improves the rate of good neurological recovery (number needed to treat is six). These newer findings are altering patient selection strategies for PPCI, especially in patients resuscitated from sudden cardiac arrest.

KEY POINTS – Appropriate Patient Selection
- The current AHA expert statements emphasize deferral of cerebral recovery prognostication for at least 72 hours after sudden death with ROSC in patients treated with therapeutic hypothermia.
- Baseline neurologic status immediately after ROSC should not preclude early Cath Lab activation.
- Until a definite protocol has been agreed upon, current consensus suggests initiating hypothermia as early as possible (before arrival to the Cath Lab) using some approximation of the 4/24/8/@33 protocol.
  - The 4/24/8/@33 protocol consists of a four-hour induction period with a 1° per hour temperature decrease to a target temperature of 33°, then a 24-hour maintenance period at 33° with minimal temperature variation, and finally an eight-hour rewarming period with a 0.5° per hour temperature increase back to normothermia.

CONCLUSION
Clinicians need a better, more comprehensive list of precise ECG as well as patient criteria to make the time-pressured decision of emergent Cath Lab activation, because not all "acute MIs" have classic STE on ECG results (e.g., STEMI-equivalents, certain OHCA scenarios), not all STE patterns are "true STEMIs" (e.g., STE-mimics), and some patients with "true STEMI" are not reasonable candidates for an aggressive treatment strategy involving PPCI.