



# Carroll County Department of Fire and EMS

## EMS Policies and Procedures

<b>Standard Operating Procedure: 3.24</b>	<b>Effective Date: June 8, 2023</b>
<b>Subject: Pre-Hospital 12-Lead ECG &amp; STEMI Alert</b>	<b>Section: Emergency Medical Services</b>
<b>Authorized: Michael Stoner, Assistant Chief</b>	<b>Revision Date: N/A</b>

### I. PURPOSE

In order to maintain the highest quality of EMS care in Carroll County, this policy is in place for early recognition of STEMI patients and notification to receiving hospitals of patients meeting STEMI criteria in an attempt to reduce the “Door to Balloon time”. This policy is not intended to conflict with Maryland Medical Protocols but to provide additional criteria to enhance the care provided by EMS.

### II. DEFINITIONS

- A. Cardiac Intervention Center - A center approved by the Maryland Healthcare Commission to offer primary or emergency angioplasty for patients experiencing an acute myocardial infarction (AMI) that manifests with ST segment elevation on 12 lead ECG.
- B. STEMI - Is the shorthand medical term for ST-segment elevation myocardial infarction. The scientific literature reports that between 34% and 70% of all AMIs present with STEMI 12-lead electrocardiogram (ECG) evidence. Providers should note that this implies that the other 30% to 66% of AMIs do not present with specific 12/15-lead ECG evidence.
- C. STEMI Alert - A notification by DFEMS EMS providers to the receiving facility that a patient being treated and transported to that facility meets the diagnostic criteria for a ST Elevation Myocardial Infarction, and that preparation for appropriate definitive treatment measures, including assembling the team for emergent coronary reperfusion, should be initiated.
- D. Return of Spontaneous Circulation (ROSC) - Is resumption of sustained and perfusing mechanical cardiac activity associated with adequate blood pressures after cardiac arrest.
- E. Anginal equivalents - Are a group of symptoms heralding angina pectoris that does not include chest pain (for example, dyspnea, diaphoresis, profuse nausea/vomiting, or arm or jaw pain).
- F. Contiguous ECG leads - Are “next” to one another anatomically speaking. They evaluate the same general area of the heart.
- G. The Sgarbossa Criteria are a set of electrocardiographic findings that can be used to identify myocardial ischemia and infarction in the presence of a left bundle branch block (LBBB) or a ventricular paced rhythm. Normal Concordance is when the ST

segment and T wave deflect in an expected direction relative to the baseline for a given ECG lead in LBBB. Discordance is when the ST segment and T wave deflect opposite of what is expected for a given ECG lead and is the relationship that has been found to be predictive of myocardial ischemia in certain cases of LBBB.

### III. PROCEDURES

#### A. 12/15-LEAD ECG GUIDELINES:

1. Acquisition of a 12-lead ECG shall be a priority for potential Acute Coronary Syndrome (ACS) cases and should be accomplished early in the course of assessment, **under usual circumstance prior to moving the patient to the ambulance for transport as this may exacerbate the patient's illness.**
2. ALS providers shall acquire and interpret a 12/15-lead ECG as indicated by the Maryland Medical Protocols, as well as the following patients:
  - a. Chest Pain Over 30 - Any patient over the age of 30 that presents with discomfort, pain, aching, pressure, dullness, burning from the umbilicus to the nose without evidence of trauma.
  - b. Provider Suspicion - Any patient that presents with signs and symptoms that the ALS provider believes may be consistent with or concerning for ACS.
  - c. Anginal Equivalents - Any patient that either:
    - i. Is over the age of 50.
    - ii. Has a history of diabetes, coronary artery disease, or hypertension.
    - iii. AND presents with one or more "anginal equivalent" symptoms, which are consistent with an atypical presentation of an AMI. These include, but are not limited to:
      - a) Chest discomfort (pain, aching, pressure, dullness, burning, heaviness) or cardiac awareness from the mid-abdomen (umbilicus) to the sternal notch
      - b) Pain or numbness in neck, jaw, or either arm or shoulder
      - c) Palpitations
      - d) Dyspnea
      - e) Indigestion, heartburn, vomiting, or nausea.
      - f) Syncope, near-syncope, dizziness, light-headedness, weakness, or fatigue
      - g) Diaphoresis
  - d. Blunt Force Trauma with Signs & Symptoms of AMI - Any patient with blunt force trauma to the chest with signs and symptoms that would be consistent with possible AMI.
  - e. Toxic Ingestion and Metabolic Abnormality - Any patient where toxic ingestion or metabolic abnormality such as hyper-/hypokalemia is suspected.
  - f. Cardiac Arrhythmia - Any patient with signs or symptoms concerning for cardiac arrhythmia such as extreme tachycardia, palpitations, or syncope.
3. If the ALS provider is not able to acquire a 12/15-lead ECG for any of the above patients, the ALS provider shall document the circumstances that prevented acquisition or their rationale for their decision to not acquire it in

the prehospital patient care report.

4. ALS Providers shall ensure the patient's last name, first initial, age, and gender are entered into the LifePak during lead placement, so it is included with transmission.
5. ALS Providers should consider repeating a 12/15-lead ECG every five to ten minutes or if the patient's condition changes, as patient care priorities allow.
6. If a 12/15-lead is indicated for a patient, then a complete ALS "workup," to include oxygen, initiation of an IV, and continuous ECG monitoring shall occur, unless a specific reason exists not to implement an intervention or if other patient care priorities and time are prohibitive. In these cases, providers shall document in the patient narrative the rationale for why any indicated procedures were not implemented.
7. Providers shall utilize "ST Elevation Trending" capabilities when available, as certain LifePak 15 units allow for ST segment trending that will automatically detect ST changes.
8. Please note that 12/15-lead ECGs should be acquired but are not normally reliable for STEMI evaluation in the following cases
  - a. Ventricular Tachycardia
  - b. High degree AV blocks with a wide QRS
9. Special attention shall be paid to proper skin preparation and ECG lead placement. See **Attachment A** for proper 12/15-lead ECG lead placement.
10. For all patients with presentations concerning for AMI, ALS providers should strongly consider performing a 15-lead ECG (which includes the right and posterior views using V4R, V8 and V9), unless other patient care priorities truly do not allow. Posterior infarct accompanies about 15-20% of STEMIs which, if discovered, is predictive of increased risk of left ventricular dysfunction and death. Additionally, three to 11% of STEMIs are isolated to just the posterior, which will not be detected on a standard 12-lead ECG but should still undergo coronary reperfusion. See **Attachment B** for a description of the procedure.
11. ALS Providers shall perform a 15-lead ECG on all patients exhibiting:
  - a. Posterior ECG changes (ST segment depression in V1 and V2).

#### B. STEMI ALERT CRITERIA

1. A patient will be considered a STEMI ALERT patient when the patient manifests any clinical assessment finding consistent with possible AMI, including anginal equivalents/atypical presentations, AND the provider's interpretation of the 12/15-lead ECG determines that any ONE of the following conditions are met
  - a. ST segment ELEVATION where there is a narrow QRS complex (less than 0.12 seconds)
    - i. 1mm in two or more contiguous limb and/or precordial leads.
      - a) When evaluating leads V2 or V3 to diagnose, 1.5mm (female patient) or 2mm (male patient) is required to be considered diagnostic of a STEMI
      - b) See **Attachment C** for definition of contiguous leads.
    - ii. ST SEGMENT DEPRESSION where there is a narrow QRS complex (less than 0.12 seconds)
      - a) 1mm in leads V1 and V2, AND
      - b) R wave S wave ratio of greater or equal to one (1)
      - c) Perform a 15 Lead ECG that includes the right and

posterior views (V4R, V8 and V9). When this is done, clearly mark each changed lead and cross out the machine's interpretation on the ECG printout. This ST depression may give the appearance of a tall R wave in those leads.

- iii. QRS complexes that are wider than 0.12s are unable to diagnose STEMI without the use of advanced decision-making criteria such as the Sgarbossa Criteria **Attachment D**.

#### C. STEMI ALERT NOTIFICATIONS

1. The provider-in-charge shall
  - a. TRANSMIT ECG: Immediately, or as soon as patient care priorities and network connectivity allows, transmit the ECG from which you have identified STEMI to the receiving Cardiac Intervention Center (also ensure that name, age and gender have been entered). If transmission fails due to network connectivity issues, continue patient care and transmit at the earliest time when connectivity has been re-established.
  - b. If unable to transmit due to connectivity issues this shall also be relayed to receiving facility during consultation.
  - c. For any 15 lead ECG's that are being transmitted, "Posterior" needs to be added to the Patient ID on the ECG prior to transmission. If a 15 lead is transmitted an immediate notification shall be made to the receiving facility to avoid any confusion or misinterpretation of ECG.
2. CONSULTATION: All "STEMI ALERT" patients are Priority 1, and thus require a formal EMRC consult with the receiving hospital as soon as possible.
  - a. During the required consultation, information transmitted should include:
    - i. All associated cardiac symptoms - actual, equivalent, and atypical.
    - ii. The time of symptom onset.
    - iii. The timestamp of the EKG from which STEMI was identified.
    - iv. The patient's vital signs, with emphasis on whether the patient is hypotensive.
    - v. Specific 12/15-lead ECG findings.
    - vi. ETA to receiving facility.
  - b. If the patient is post cardiac arrest with ROSC be sure to include
    - i. Whether or not the arrest was witnessed
    - ii. If bystander CPR was performed
    - iii. Initial rhythm (especially V-Fib or V-Tach)
    - iv. Approximate time to ROSC (total down time).
    - v. Number and timing of ACLS interventions (defibrillations and medications)

#### IV. RECISION

This Standard Operating Procedure rescinds all directives regarding Pre-Hospital 12-Lead ECG & STEMI Alert or similar content previously issued for personnel of the Carroll County Department of Fire and EMS.



# Carroll County Department of Fire and EMS

## Pre-Hospital 12-Lead ECG & STEMI Alert

### Attachment A

RA and LA	On the right and left arms on the lower forearm, or anywhere distal to the shoulder (deltoid or distal). DO NOT place these electrodes on the chest wall for 12-lead acquisition.
RL and LL	On the right and left legs over the lower calf, or anywhere below the inguinal fold anteriorly and the gluteal fold posteriorly <sup>1</sup> . DO NOT place these electrodes on the chest wall or abdomen for 12-lead acquisition.
V1	4 <sup>th</sup> ICS at the right sternal border. Find location by counting intercostal spaces from the 2 <sup>nd</sup> ICS, orienting by palpating the angle of Louis, which is on the sternum at the level of the 2 <sup>nd</sup> rib.
V2	4 <sup>th</sup> ICS at the left sternal border
V3	Midway between V2 and V4
V4	5 <sup>th</sup> ICS at the left midclavicular line. This is approximately over the apex.
V5	Level with V4 at the left anterior axillary line
V6	Level with V4 at the left midaxillary line
<ol style="list-style-type: none"> <li>1. Do not place electrode over bone, as it does not conduct electricity well.</li> <li>2. Prepare skin by cleaning and abrading it with alcohol preps.</li> <li>3. For female patients, preserve privacy and place electrodes under breast tissue if possible or on breast tissue if that provides the most accurate horizontal and vertical electrode position<sup>2</sup>.</li> </ol>	

<sup>1</sup> Pipberger HV, Arzbaecher RC, Berson AS, et al. Recommendations for standardization of leads and of specifications for instruments in electrocardiography and vectorcardiography: Report of the Committee on Electrocardiography, American Heart Association. *Circulation* 1975;52:1131.

<sup>2</sup> Rautaharju PM, Park L, Rautaharju FS, Crow R. A standardized procedure for locating and documenting ECG chest electrode positions: consideration of the effect of breast tissue on ECG amplitudes in women. *J Electrocardiol*. 1998 Jan;31(1):17-29.

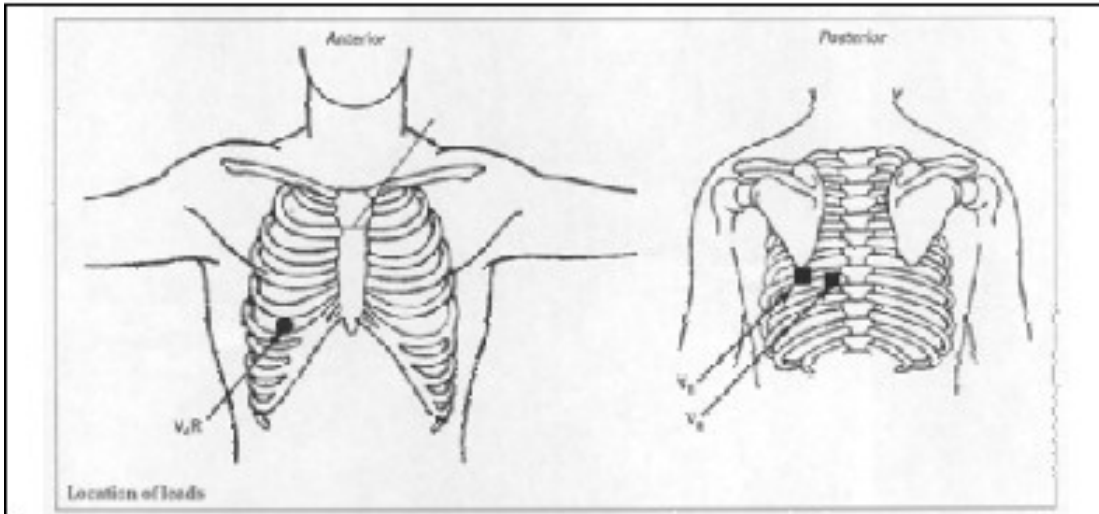


# Carroll County Department of Fire and EMS

## Pre-Hospital 12-Lead ECG & STEMI Alert

### Attachment B

Providers should consider performing a 15-lead ECG that includes the right and posterior views (V4R, V8, V9) on all patients. In particular, a 15-lead ECG should be performed on all patients exhibiting inferior ECG changes (ST elevation of 1 mm or more in two or more of leads II, III, aVF) or ST segment depression in V1 and V2, as right and posterior changes are often associated in these cases.



V4R	Move the V4 lead on the RIGHT chest at the right midclavicular line at the 5 <sup>th</sup> ICS.
V8	Move the V5 lead on the POSTERIOR left chest (the back) at the left midscapular line in straight line from V4-6 (5th ICS).
V9	Move the V6 lead on the POSTERIOR left chest (the back) at the left paraspinal line in straight line from V8 (5th ICS).
1. Acquire and print ECG as normal.	
2. Clearly mark V4R, V8, and V9 on that ECG printout (next to where the ECG automatically labels the leads V4, V5, and V6).	
3. Cross out the machine interpretation on that ECG printout. The interpretation will be inaccurate as there is no way to input to the LP12 that those leads are not the standard V4-6.	



# Carroll County Department of Fire and EMS

## Pre-Hospital 12-Lead ECG & STEMI Alert

Attachment C

### RIP-ALS MULTI-LEAD MI CHART

I	LATERAL	aVR LMCA, LAD, LCX, 3 VESSEL DISEASE	V <sub>1</sub> SEPTAL	V <sub>4</sub> ANTERIOR	V <sub>4</sub> R/V <sub>7</sub> RIGHT
II	INFERIOR	aVL LATERAL	V <sub>2</sub> SEPTAL	V <sub>6</sub> LATERAL	V <sub>8</sub> POSTERIOR
III	INFERIOR	aVF INFERIOR	V <sub>3</sub> ANTERIOR	V <sub>6</sub> LATERAL	V <sub>9</sub> POSTERIOR
	<b>INFARCTION</b>	<b>WAVE ABNORMALITY</b>	<b>EKG SEGMENTS</b>	<b>ARTERY OCCLUSION</b>	
	Right	ST ↑	V <sub>4</sub> R/V <sub>7</sub> & V <sub>1</sub> <small>Most sensitive ECG marker of RVI (AHA)</small>	Right Coronary (RCA)	
	Inferior	ST ↑	II, III, aVF	RCA	
	Posterior	ST ↑	V <sub>8</sub> , V <sub>9</sub>	RCA and/or Left Circumflex (LCX)	
	Anterior	ST ↑	V <sub>3</sub> , V <sub>4</sub>	Left Anterior Descending (LAD)	
	Lateral	ST ↑	I, aVL, V <sub>5</sub> , V <sub>6</sub>	LCX	
	Septal	ST ↑	V <sub>1</sub> , V <sub>2</sub>	LAD	
	High Septal/Anterior Lateral (top of heart)	ST ↑	aVR + widespread ST ↓, aVR & aVL, aVR greater than V <sub>1</sub>	Left Main Coronary (LMC), LAD, LCX or (3 vessel disease)	
Hyperacute T-waves (DeWinter ST/T-wave changes-NEJM 359:2071, 2008) are a <b>very early indicator</b> of a STEMI before the development of ST ↑. 1-3 mm of upsloping J-point ST depression in one or more precordial leads (especially leads V <sub>3</sub> , V <sub>4</sub> ) that continues into tall, positive symmetrical T waves (acute proximal LAD occlusion).					

2015 ACCF/AHA Guideline for the Management of ST-Elevation Myocardial Infarction-Circulation. 2013;127:e362-425

GRV-RIP-ALS 12 LEAD CHART-2016

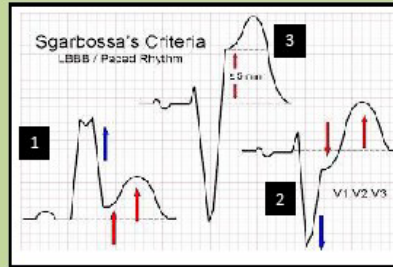
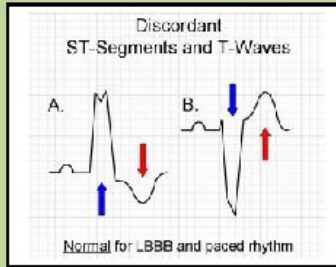


# Carroll County Department of Fire and EMS

## Pre-Hospital 12-Lead ECG & STEMI Alert

Attachment D

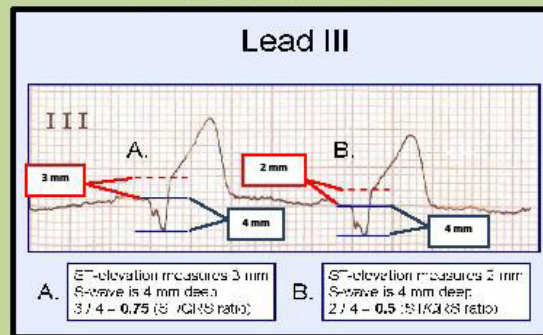
### Sgarbossa's Criteria for STEMI in LBBB



1. Greater than or equal to 1 mm of concordant (same direction as the QRS) ST  $\uparrow$  (5 points).
2. Greater than or equal to 1 mm of ST  $\downarrow$  in lead V<sub>1</sub>, V<sub>2</sub> or V<sub>3</sub> (3 points).
3. Greater than or equal to 5 mm of discordant ST  $\uparrow$  in at least one lead, works for both positive & negative QRS complexes (2 points).

The more of these criteria that are met, the higher the probability of AMI. A meta-analysis of studies exploring the utility of the Sgarbossa's criteria demonstrated that a score greater than or equal to 3 had a specificity of 98% for AMI, but a score of 0 did NOT rule out STEMI (ACCF/AHA-2013).

### Modified Sgarbossa's Criteria # 3 for STEMI in LBBB



Criteria # 3. Greater than or equal to 5 mm of discordant ST  $\uparrow$  in at least one lead, works for both positive & negative QRS complexes (2 points).

Easier method is to look for ST  $\uparrow$  that is greater than 0.25 or 1/4 the depth of the S wave (ST/QRS ratio).

"Rule of thumb" to use, for every 4 mm of S wave depth, we allow 1 mm of ST  $\uparrow$  (ST/S ratio greater than/=25%).

Developed by Stephen Smith, M.D.