



GENERAL ORDER

GENERAL ORDER 322.03

Pre-Hospital 12-Lead ECG and STEMI Alert

EMERGENCY SERVICES BUREAU

Issue Date: June 13, 1997

Revision Date: June 13, 2019

1 APPLICABILITY

2 All ALS Personnel

3 POLICY

- 4 • A critical objective for STEMI patients is to minimize their “Door to Balloon” time. The
- 5 goal is to reduce this time to less than 90 minutes.
- 6 • In order to provide the best possible care to our patients, the Howard County
- 7 Department of Fire and Rescue Services (Department) will maintain a practice of clearly
- 8 notifying the receiving hospital’s Emergency Department when we are treating and
- 9 transporting a STEMI patient.
- 10 • For patients transported to Howard County General Hospital (HCGH), based primarily
- 11 upon the prehospital provider’s clinical impression and 12 lead ECG, the Emergency
- 12 Department will initiate the hospital’s internal cardiac catheterization lab activation
- 13 procedure.
- 14 • For patients transported to designated Cardiac Intervention Center Emergency
- 15 Departments other than HCGH, based primarily upon the prehospital provider’s clinical
- 16 impression and 12 lead ECG, the Emergency Department at the Cardiac Intervention
- 17 Center may initiate the hospital’s internal cardiac catheterization lab activation
- 18 procedure.
- 19 • This policy is not intended to directly conflict with any part of the Maryland Medical
- 20 Protocols. However, it does outline additional measures specific to patients transported
- 21 by the Department, and/or specific to patients transported to HCGH. These measures
- 22 are approved by the Department’s Office of the Medical Director, and are appropriate
- 23 for implementation by Department ALS providers.

24 DEFINITIONS

- 25 ➤ A **Cardiac Intervention Center** is a center approved by the Maryland Healthcare
- 26 Commission to offer primary or emergency angioplasty for patients experiencing an
- 27 acute myocardial infarction (AMI) that manifest ST segment elevation.
- 28
- 29 ➤ **STEMI** is the shorthand medical term for ST-segment elevation myocardial infarction.
- 30 The scientific literature reports that between 34% and 70% of all AMIs present with
- 31 STEMI 12-lead electrocardiogram (ECG) evidence. Providers should note that this



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32 implies that the other 30% to 66% of AMIs do not present with specific 12/15-lead ECG
33 evidence.

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35 ➤ A **STEMI Alert** is a notification by Department EMS providers to their receiving facility
36 that a patient being treated and transported to that facility meets the diagnostic criteria
37 for a ST Elevation Myocardial Infarction, and that preparation for appropriate definitive
38 treatment measures, including assembling the team for emergent coronary reperfusion,
39 should be initiated.

40
41 ➤ The **Sgarbossa Criteria** are a set of electrocardiographic findings that can be used to
42 identify myocardial ischemia and infarction in the presence of a left bundle branch block
43 (LBBB) or a ventricular paced rhythm. Normal **Concordance** is when the ST segment and
44 T wave deflect in an expected direction relative to the baseline for a given ECG lead in
45 LBBB. **Discordance** is when the ST segment and T wave deflect opposite of what is
46 expected for a given ECG lead, and is the relationship that has been found to be
47 predictive of myocardial ischemia in certain cases of LBBB.

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49 ➤ **Return of Spontaneous Circulation (ROSC)** is resumption of sustained and perfusing
50 mechanical cardiac activity associated with adequate blood pressures and significant
51 respiratory effort after cardiac arrest.

52
53 ➤ **Anginal equivalents** are a group of symptoms heralding angina pectoris that does not
54 include chest pain (for example, dyspnea, diaphoresis, profuse vomiting in a diabetic
55 patient, or arm or jaw pain).

56
57 ➤ **Contiguous ECG leads** are “next” to one another anatomically speaking. They view the
58 same general area of the heart.

59 PROCEDURES

60 **12/15-LEAD ECG GUIDELINES:**

- 61 • Acquisition of a 12-lead EKG shall be a priority for potential Acute Coronary Syndrome
62 (ACS) cases, and should be accomplished early in the course of assessment, **under usual**
63 **circumstance prior to moving the patient to the ambulance for transport.**
- 64 • ALS providers shall acquire and interpret a 12/15-lead ECG as indicated by the Maryland
65 Medical Protocols, as well as the following patients:
 - 66 ○ **CHEST PAIN OVER 30:** Any patient over the **age of 30** that presents with
67 discomfort, pain, aching, pressure, dullness, burning from the **umbilicus to the**
68 **nose** without evidence of trauma.
 - 69 ○ **PROVIDER SUSPICION:** Any patient that presents with signs and symptoms that
70 the ALS provider believes may be consistent with a possible AMI.
 - 71 ○ **ANGINAL EQUIVALENTS:** Any patient that either:
 - 72 • Is over age 50.
 - 73 • Has a history of diabetes, cardiac problems, or hypertension.



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- **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:
 - Chest discomfort (pain, aching, pressure, dullness, burning, numbness) or cardiac awareness from the mid-abdomen (umbilicus) to the sternal notch.
 - Pain or numbness in neck, jaw, or either arm or shoulder.
 - Palpitations.
 - Dyspnea.
 - Indigestion, heartburn, vomiting, or nausea.
 - Syncope, near-syncope, dizziness, light-headedness, weakness, or fatigue.
 - Diaphoresis.
 - **BLUNT FORCE TRAUMA WITH SIGNS & SYMPTOMS:** Any patient with blunt force trauma to the chest with signs and symptoms that would be consistent with possible AMI.
 - **TOXIC INGESTION and METABOLIC ABNORMALITY:** Any patient where toxic ingestion or metabolic abnormality is suspected.
 - 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.
 - 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.
 - ALS Providers should consider repeating a 12/15-lead ECG every five to ten minutes or as the patient’s condition changes, if patient care priorities allow.
 - 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 do not allow. In these cases, providers shall document in the patient narrative the rationale for why any indicated procedures were not implemented.
 - 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.
 - Please note that 12/15-lead ECGs should be acquired but are not normally reliable for STEMI evaluation in the following cases:
 - Ventricular Tachycardia
 - High degree AV blocks with a wide QRS
 - Special attention shall be paid to proper skin preparation and ECG lead placement. See **Attachment A** for proper 12/15-lead ECG lead placement.
 - For all patients, 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,



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118 which, if discovered, is predictive of increased risk of left ventricular dysfunction and
119 death. Additionally, three to 11% of STEMI's are isolated to *just* the posterior, which will
120 not be detected on a standard 12-lead ECG, but should still receive coronary
121 reperfusion. See **Attachment B** for a description of the procedure. ALS Providers *shall*
122 perform a 15-lead ECG on all patients exhibiting:

- 123 ○ Inferior ECG changes
- 124 ○ Right and/or posterior ECG changes (ST segment depression in V1 and V2).

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126 **STEMI ALERT CRITERIA:**

- 127 ● A patient will be considered a **STEMI ALERT** patient when the patient manifests any
128 clinical assessment finding consistent with possible AMI, including anginal equivalents
129 and atypical presentations, AND the provider's interpretation of the 12/15-lead ECG
130 determines that **any ONE** of the following conditions are met:
 - 131 ○ **ST segment ELEVATION** where there is a narrow QRS complex (less than 0.12
132 seconds):
 - 133 ■ 1mm in two or more *contiguous* limb and/or precordial leads.
 - 134 ● When evaluating **leads V2 or V3** to diagnose, 1.5mm (female
135 patient) or 2mm (male patient) is required to be considered
136 diagnostic of a STEMI.
 - 137 ■ See **Attachment C** for definition of contiguous leads.
 - 138 ○ **ST SEGMENT DEPRESSION** where there is a narrow QRS complex (less than 0.12
139 seconds):
 - 140 ■ 1mm in leads V1 and V2, **AND**
 - 141 ■ R wave:S wave ratio of greater or equal to one (1)
 - 142 ■ Perform a 15 Lead ECG that includes the right and posterior views (V4R,
143 V8 and V9). When this is done, *clearly mark each changed lead and cross*
144 *out the machine's interpretation* on the ECG printout. This ST depression
145 may give the appearance of a tall R wave in those leads.
 - 146 ○ QRS complexes that are wider than 0.12s are unable to diagnose STEMI without
147 the use of advanced decision-making criteria such as the Sgarbossa Criteria (**See**
148 **Attachment D**).

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152 **STEMI ALERT NOTIFICATIONS:**

- 153 ● **The provider-in-charge shall:**
 - 154 ○ **TRANSMIT ECG:** Immediately, or as soon as patient care priorities allow and
155 network connectivity is available, transmit the ECG from which you have
156 identified STEMI to the receiving Cardiac Intervention Center (also ensure that
157 name, age and gender have been entered). If transmission fails due to network
158 connectivity issues, continue patient care and transmission at the earliest time
159 when connectivity has been re-established.
 - 160 ■ If unable to transmit due to connectivity issues this shall also be relayed
161 to HCGH during Alpha 4 transmission (see below).



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- 162 ▪ For receiving facilities other than HCGH, this information shall be
- 163 transmitted during consultation.
- 164 ▪ For any 15 lead ECG's that are being transmitted, "Right Side" needs to
- 165 be added to the Patient ID on the ECG prior to being transmitted. If a 15
- 166 lead is transmitted an immediate notification shall be made to the
- 167 receiving facility to avoid any confusion or misinterpretation of ECG.
- 168
- 169 ○ **TRANSMIT ALPHA 4 STEMI ALERT:** If transporting to HCGH, initially alert the
- 170 HCGH ED via Alpha 4 of a "STEMI ALERT."
- 171 ○ **CONSULT:** All "STEMI ALERT" patients are Priority 1, and thus require a formal
- 172 EMRC consult with the receiving hospital as soon as possible.
- 173 ▪ During the required consultation, information should be transmitted to
- 174 include:
 - 175 • All associated cardiac symptoms - actual, equivalent, and atypical.
 - 176 • The time of the onset of symptoms.
 - 177 • The timestamp of the EKG from which STEMI was identified.
 - 178 • The patient's vital signs, with emphasis on whether the patient is
 - 179 hypotensive.
 - 180 • Specific 12/15-lead ECG findings.
 - 181 • Ambulance ETA.
- 182 ▪ If the patient is post cardiac arrest with ROSC be sure to include:
 - 183 • Whether or not the arrest was witnessed
 - 184 • Initial rhythm (especially V-Fib or V-Tach)
 - 185 • Approximate time to ROSC (total down time)
- 186
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188 FOLLOW-UP AND QUALITY ASSURANCE:

- 189 • The Department's Emergency Services and Education and Training Bureaus shall, in
- 190 coordination with the Office of the Medical Director, participate in coordinated quality
- 191 assurance efforts with the area's hospital Cardiac Intervention Centers.
- 192 • The Department will receive detailed feedback regarding STEMI patients and their
- 193 course of care, and that feedback will be shared with EMS providers involved in the care
- 194 of those individuals through the quality assurance process.
- 195

196 TRAINING REQUIREMENTS:

- 197 • All Department ALS providers shall complete training in 12/15-Lead ECG acquisition and
- 198 interpretation, and in the use of the current cardiac monitors that are deployed within
- 199 the Howard County EMS system. Prior training shall be verified by demonstration of
- 200 competency.

201 REFERENCES

202 None

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SUMMARY OF DOCUMENT CHANGES

- 205 • Updated STEMI ECG criteria to be consistent with current Maryland Medical Protocols.
- 206 • Updated the required information on transmitted 12 lead ECG's Sgarbossa Criteria.
- 207 • Re-emphasized the need for 12/15-lead transmission earlier in call.
- 208 • Reorganized and clarified information.
- 209 • Added requirement for 15-lead acquisition in certain cases of ECG changes.

210

FORMS/ATTACHMENTS

- 211 • Attachment A: Proper ECG Lead Placement
- 212 • Attachment B: 15-Lead ECG Acquisition Procedure
- 213 • Attachment C: Contiguous Leads
- 214 • Attachment D: Sgarbossa Criteria

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APPROVED

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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 ¹ . DO NOT place these electrodes on the chest wall or abdomen for 12-lead acquisition.
V1	4 th ICS at the right sternal border. Find location by counting intercostal spaces from the 2 nd ICS, orienting by palpating the angle of Louis, which is on the sternum at the level of the 2 nd rib.
V2	4 th ICS at the left sternal border
V3	Midway between V2 and V4
V4	5 th 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"> 1. Do not place electrode over bone, as it does not conduct electricity well. 2. Prepare skin by cleaning and abrading it with alcohol preps. 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 position². 	

¹ 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.

² 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.



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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.

<p style="text-align: center;">Location of leads</p>	
V4R	Move the V4 lead on the RIGHT chest at the right midclavicular line at the 5 th ICS.
V8	Move the V5 lead on the POSTERIOR left chest (the back) at the left midscapular line in straight line from V4-6 (5 th ICS).
V9	Move the V6 lead on the POSTERIOR left chest (the back) at the left paraspinal line in straight line from V8 (5 th 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.	



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Attachment C

RIP-ALS MULTI-LEAD MI CHART

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

2013 ACCF/AHA Guideline for the Management of ST-Elevation Myocardial Infarction-Circulation. 2013;127:e362-e425

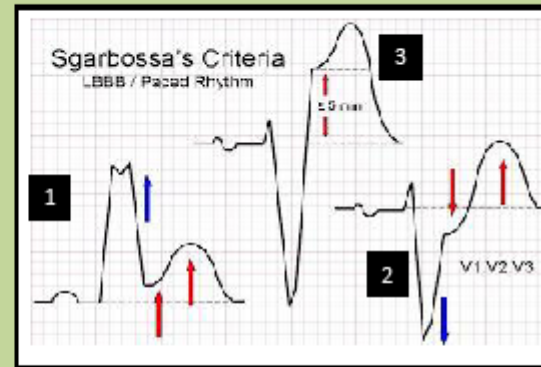
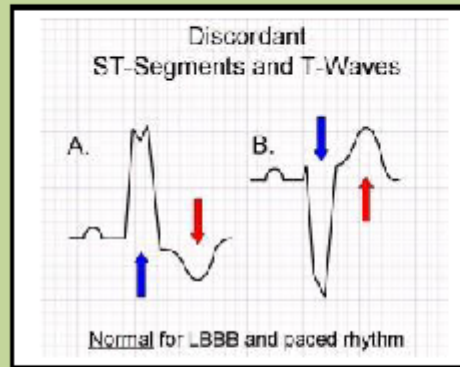
GRV-RIP-ALS 16 LEAD CHART-2016



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Attachment D

Sgarbossa's Criteria for STEMI in LBBB



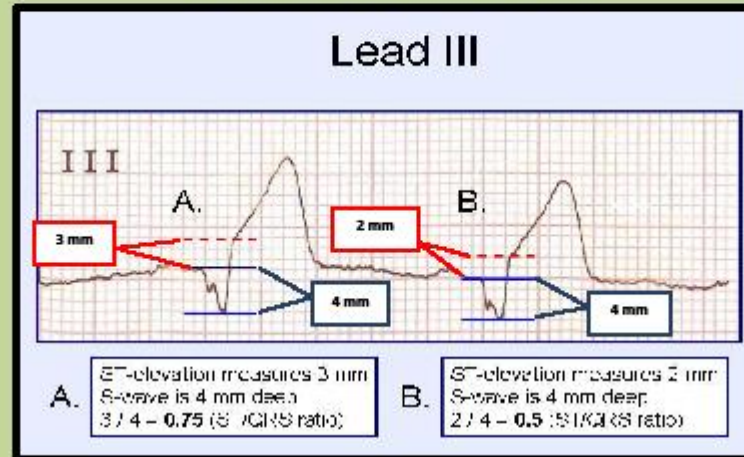
1. Greater than or equal to 1 mm of concordant (same direction as the QRS) ST ↑ (5 points).
2. Greater than or equal to 1 mm of ST ↓ in lead V₁, V₂ or V₃ (3 points).
3. Greater than or equal to 5 mm of discordant ST ↑ in at least one lead, works for both positive & negative QRS complexes (2 points).

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).



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Modified Sgarbossa's Criteria # 3 for STEMI in LBBB



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

Easier method is to look for ST ↑ 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 ↑ (ST/S ratio greater than/ =25%).

Developed by Stephen Smith, M.D.