



## Optimal STEMI System Specification By Point Of Care Operations Manual

The Steering Committee of the Reperfusion  
of Acute Myocardial Infarction in Carolina Emergency  
Departments (RACE) Project

Version 3.0 September 2008

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## Introduction

The **Reperfusion of Acute Myocardial Infarction in Carolina Emergency Departments (RACE)** project is a statewide system for providing rapid coronary artery reperfusion for patients with ST-elevation myocardial infarction (STEMI). Established in 2003, the RACE system incorporates quality improvement efforts of over 100 hospitals, 700 emergency medical systems and thousands of health care professionals working in a coordinated manner to provide timely reperfusion.

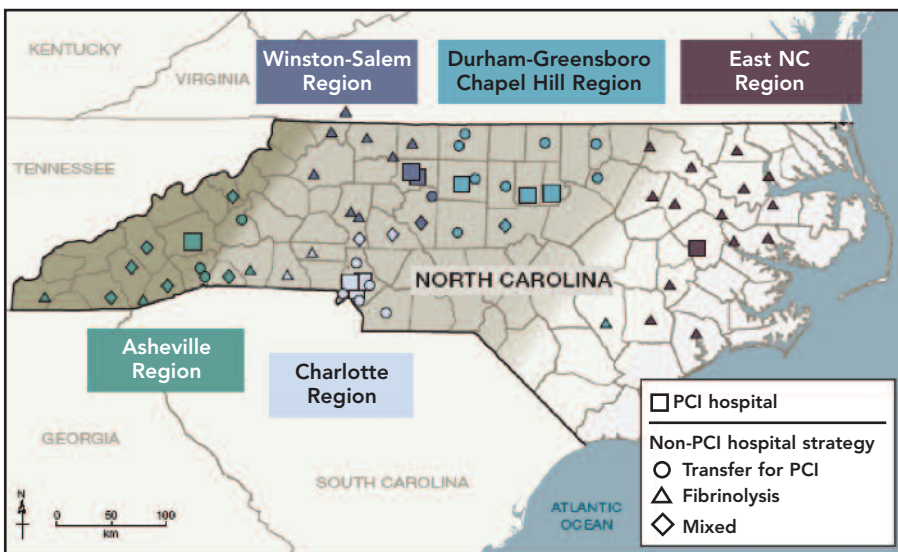
The key elements of the system include regional organization and coordination, institution of the single best plan for treatment at every point of care, ongoing measurement and prompt feedback, and the establishment of teams of health professionals that span all aspects of STEMI care.

The results of the initial implementation of the RACE system were published in the Journal of the American Medical Association. One year after implementation of the RACE system, treatment rates and times significantly improved

according to every measure [first door-to device - transferred to PCI hospital 165 to 128 minutes,  $P < .001$  - presenting to PCI hospital 85 to 74 minutes,  $P < .001$ ; door-to-needle in non-PCI hospitals 35 to 29 minutes,  $P = .002$ , and door-in to door-out for patients transferred from non-PCI hospitals 120 to 71 minutes,  $P < .001$ . Non-reperfusion rates decreased from 23% to 11% in the PCI hospitals].

This operations manual represents an integral element of the RACE system, outlining strategies to overcome systematic barriers to rapid reperfusion. These strategies are based upon established guidelines, evidence from clinical trials, and the knowledge and experience of numerous professionals specializing in acute myocardial infarction care.

[Jollis JG, Roettig ML, Aluko AO, Anstrom KJ, Applegate RJ, Babb JD, Berger PB, Bohle DJ, Fletcher SM, Garvey JL, Hathaway WR, Hoekstra, JW, Kelly RV, Maddox WT, Jr., Shiber JR, Valeri FS, Watling BA, Wilson, BH, Granger CB. Implementation of a statewide system for coronary reperfusion for ST-segment elevation myocardial infarction. JAMA 2007; 298: 2371-2380.]



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## Optimal System Specification By Point Of Care

The following basic and advanced recommendations represent features of systems of ST-elevation MI care likely to increase the rate and speed of coronary artery reperfusion.

### EMS: Dispatch

#### Basic recommendations

- Establish a STEMI Plan: Coordinated regional plan focused on providing the most expedient EMS response and transfer in collaboration with all hospitals and emergency medical systems in the region. This plan should require early notification of the receiving hospital on all STEMI patients prior to arrival that includes communication with the physician capable of activating a reperfusion plan. EMS units may cross county lines when necessary for reperfusion.
- 911 operator trained to recognize potential acute cardiac symptoms and dispatch appropriate EMS resources.
- ECG equipment and personnel dispatched to allow for a 12 lead ECG with a total scene time of less than 15 minutes.
- Use of the EMS Performance Improvement Center Acute Cardiac Toolkit ([www.EMSPIC.org](http://www.EMSPIC.org))

#### Advanced recommendations

- EMS unit identifying STEMI patients has the ability to bypass the closest non-PCI hospital and to go directly to a primary PCI capable hospital:
  - a. if first medical contact to balloon inflation can be achieved within 90 minutes.and/or
  - b. if reperfusion checklist shows contraindication to fibrinolysis

## EMS: Initial Contact EMT Basic or Intermediate Provider

### Basic recommendations

- ECG acquisition to be extended to basic providers including EMT basic and first responders.
- ECG obtained on all patients with typical acute coronary symptoms age 30 and older, and patients with atypical symptoms (epigastric pain, arm pain, diaphoresis, shortness of breath, syncope) age 50 and older.
- In the field ECG (to be interpreted by receiving physician on arrival or by transmission).
- Documentation of symptom onset.
- Scene time of less than 15 minutes.
- Patient stays on ambulance stretcher for STEMI evaluation in hospitals that routinely transfer all or some patients by the same ambulance.

## EMS: Initial Contact EMT-Paramedic

### Basic recommendations

- Training to diagnose ST-elevation MI by symptoms and ECG.
- ECG obtained on all patients with typical acute coronary symptoms age 30 and older, and patients with atypical symptoms (epigastric pain, arm pain, diaphoresis, shortness of breath, syncope) age 50 and older.
- Documentation of symptom onset.
- Scene time of less than 15 minutes.
- Patient stays on ambulance stretcher for STEMI evaluation in hospitals that routinely transfer all or some patients by same ambulance.
- In the field ECG with a goal scene time of less than 15 minutes (An ECG machine should be dispatched to all potential STEMI calls to meet this 15 minute window).
- Administer reperfusion checklist (fibrinolytic screen) (p.17) in situations where a patient may be taken to a hospital using fibrinolytic therapy.
- If patient is fibrinolytic ineligible, EMS notifies and diverts to a primary PCI capable hospital.
- Early notification of the receiving hospital on all STEMI patients prior to arrival that includes direct communication with the physician capable of activating a reperfusion plan regarding symptom onset, ECG findings, and reperfusion checklist as appropriate.
- Administer aspirin (162 to 325 mg chewed) to chest pain patients suspected of having ST-elevation MI unless contraindicated or an adequate dose of immediate-release aspirin can be verified as taken.

- Make EMS run sheets immediately available to receiving hospitals. Approaches include providing adequate time for EMS crews to complete run sheets before hospital departure and providing paper or electronic format that is readily accessible to hospital personnel. Essential run sheet data should include EMS unit identification, dispatch time, scene arrival time, symptom onset time, description of symptoms, hospital pre-notification time, scene departure time, hospital arrival time, medications and procedures, and complications in transfer. Leave copy of ECG tracing that includes acquisition time.
- Use of the EMS Performance Improvement Center Acute Cardiac Toolkit ([www.EMSPIC.org](http://www.EMSPIC.org))

#### **Advanced recommendations**

- EMS unit identifying STEMI patients has the ability to bypass the closest non-PCI hospital and to go directly to a primary PCI hospital capable of first medical contact to balloon inflation within 90 minutes (Prehospital destination protocol).
- EMS has same IV tubing as receiving hospitals.
- Prehospital fibrinolysis system as appropriate for local resources and needs.
- Transmission of 12-lead ECG if technically feasible and reliable and if system in place to have tracing immediately interpreted. This may be most helpful for ECGs for which EMS interpretation is uncertain.
- EMS data linked to hospital data in an electronic format.
- Certification procedure for paramedics for ECG diagnosis of STEMI.

## **EMS: Interfacility Transfer EMT Basic, Intermediate or Paramedic**

#### **Basic recommendations**

- Transfer of STEMI patients for reperfusion has same priority as 911 call and trauma.
- Local EMS ambulance, staffed by a paramedic, should generally be used for the transport of hemodynamically stable STEMI patients if available and less than 30 minute transportation time to destination hospital.
- Patient stays on stretcher for myocardial infarction evaluation if hospital transfer possible or likely.
- Establish transfer plan including preferred transport modality and backup transport modality.
- Transport directly to catheterization laboratory when laboratory is staffed and available.
- When possible, minimize or avoid continuous IV infusions such as nitroglycerin or heparin continuous infusions.
- Transfer protocol should focus on rapid transport to catheterization laboratory rather than pain relief with medications.
- Transfer patients to PCI hospital with similar consideration to patient registration, bed availability, and accepting physician as trauma patients (use of dummy registration numbers, acceptance of all STEMI patients regardless of bed availability, and reliance on a single accepting physician that is on call 24 hours per day / 7 days per week).
- When transporting a patient treated with fibrinolysis who has continued chest pain and/or < 50% ST resolution 60 to 90 minutes after the initiation of fibrinolysis, notify the receiving hospital about the potential need for rescue angioplasty.
- Hospital records should be faxed to the receiving catheterization laboratory, so as not to delay patient pickup.
- EMTALA/COBRA/medical necessity of transfer form should be completed as soon as possible after the decision to transfer.
- Advance life support units serving a hospital should be willing to transfer patient to any available PCI facility in cases where another transport option is not immediately available.

## EMS: Transfer Helicopter

### Basic recommendations

- Local EMS ambulance, staffed by a paramedic, should generally be used for the transport of hemodynamically stable STEMI patients if available and less than 30 minute transportation time to destination hospital.
- ST-elevation myocardial infarction patient for reperfusion (“STEMI medical scene”) has same priority as 911 and trauma calls.
- Helicopter transport protocols should include EMS and ED protocols capable of launching helicopters to medical scenes and establishment of helicopter landing zones (LZ). Patients transported to LZ’s adjacent to hospitals should not require medical evaluation by that hospital unless deemed necessary by the EMS crew.
- 10-minute pick up time (of accessing, loading, and lift off).
- Streamlined transfer of care process.
- Transport directly to catheterization laboratory.
- When possible minimize or avoid IV infusions such as nitroglycerin or heparin drips.
- Transfer protocol should focus on rapid transport to catheterization laboratory rather than pain relief with medications.
- Helicopter capable of transporting patients on ten minutes notice 24 hours per day / 7 days per week.
- Consider helicopter transport when alternate transport options unavailable.
- Immediately activate helicopter transport during initial communication with receiving hospital regarding the need for reperfusion.
- Transfer patients to PCI hospital with similar consideration to patient registration, bed availability, and accepting physician as trauma patients (use of dummy registration numbers, acceptance of all STEMI patients regardless of bed availability, and reliance on a single accepting physician that is on call 24 hours per day / 7 days per week).
- When transporting a patient treated with fibrinolysis who has continued chest pain and/or less than 50% ST resolution 60 to 90 minutes after the initiation of fibrinolysis, notify the receiving hospital about the potential need for rescue angioplasty.
- Hospital records should be faxed to the receiving catheterization laboratory, so as not to delay patient transfer.
- EMTALA/COBRA/medical necessity of transfer form should be completed as soon as possible after the decision to transfer.
- Advance life support units serving a hospital should be willing to transfer patient to any available PCI facility in cases where another transport option is not immediately available.

## EMS Protocols: Chest Pain Suspected Cardiac Event

### History:

- Age
- Medications
- Viagra, Levitra, Cialis
- Past medical history (MI, Angina, Diabetes)
- Allergies (Morphine, Aspirin)
- Recent physical exertion

### Signs and Symptoms:

- Chest discomfort (pain, pressure, aching, vice like tightness)
- Time of onset, quality, location, radiation, severity, palliation / provocation
- Pale, diaphoresis
- Shortness of breath
- Nausea, vomiting, dizziness

### Differential:

- Trauma vs. Medical
- Angina vs. Myocardial infarction
- Pericarditis
- Pulmonary embolism
- Asthma / COPD
- Pneumothorax
- Aortic dissection or aneurysm
- GE reflux or Hiatal hernia
- Esophageal spasm
- Chest wall injury or pain
- Pleural pain
- Overdose (Cocaine)

### Pearls:

- Obtain ECG on all patients with typical acute coronary symptoms age 30 and older, and all patients with atypical symptoms (epigastric pain, arm pain, diaphoresis, shortness of breath, syncope) age 50 and older.
- Goal for ST elevation myocardial infarction patients is to "Load and Go."
- Exam: Mental Status, Skin, Neck, Lung, Heart, Abdomen, Back, Extremities, Neuro.
- Avoid Nitroglycerin in any patient who has used Viagra or Levitra in the past 24 hours or Cialis in the past 36 hours due to potential severe hypotension.
- If patient has taken nitroglycerin without relief, consider potency of the medication.
- If conditions prevent indicated doses of SL NTG from being administered, move to NTG paste after 1st SL spray
- If positive ECG changes, establish a second IV while en route to the hospital.
- Monitor for hypotension after administration of nitroglycerin and morphine.
- Patients with chest pain but who do not have ST-segment elevation on their ECG should be transported to the hospital of their choice. Only STEMI patients should be encouraged to go to emergency interventional cardiac catheterization laboratory facility.
- Diabetics and geriatric patients often have atypical pain, or only generalized complaints.
- Document 12-lead and transmission status using "12-lead ECG" procedure in the call reporting system.

*(Continued on page 8)*



## EMS Protocols: Chest Pain Suspected Cardiac Event

(Continued from page 7)

Emergency Interventional Cardiac Catheterization Laboratory Facility is designated by the EMS Director and has all of the following features:

1. 24/7 capability within 30 minutes of notification (including interventional cardiologist present at the start of the case).
2. Single call activation capability by paramedic.
3. Accept all patients regardless of bed availability.
4. Hospital has on-site cardiac surgery back up and meets procedural volume standards of at least 200 PCIs and 36 primary PCIs per year.
5. Interventional cardiologist volume of at least 75 PCIs per year and 11 primary PCIs per year.
6. Ongoing data monitoring in ACTION-GWTG and participation in Catheterization Laboratory Activation Registry.
7. Concurrent feedback to the EMS (including cardiologist to EMS call at the end of case, quarterly meetings to review cases, and data exchange with the EMS)

ST Elevation Myocardial Infarction (STEMI) is diagnosed by

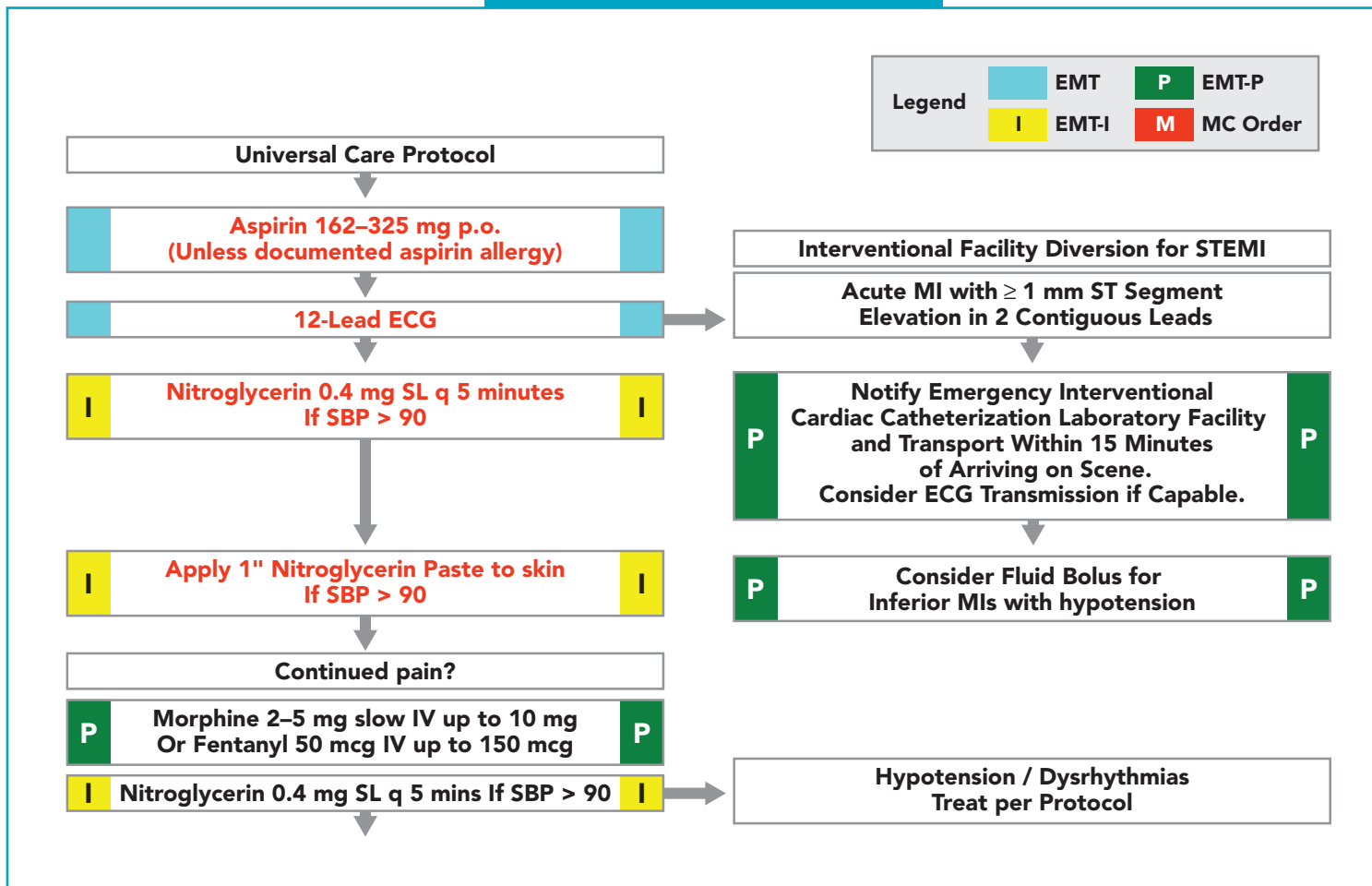
- Cardiac symptoms greater than 15 minutes and less than 12 hours

and

- ECG criteria of 1 mm ST elevation in 2 or more leads or LBBB not known to be old in a patient with typical symptoms.

The preferred method of diagnosis is paramedic read. ECGs are transmitted to the receiving hospital when possible during transfer. Emergency Interventional Cardiac Catheterization Laboratory Facilities have agreed to activate the catheterization laboratory on EMT-P read alone.

### Chest Pain Suspected Cardiac Event



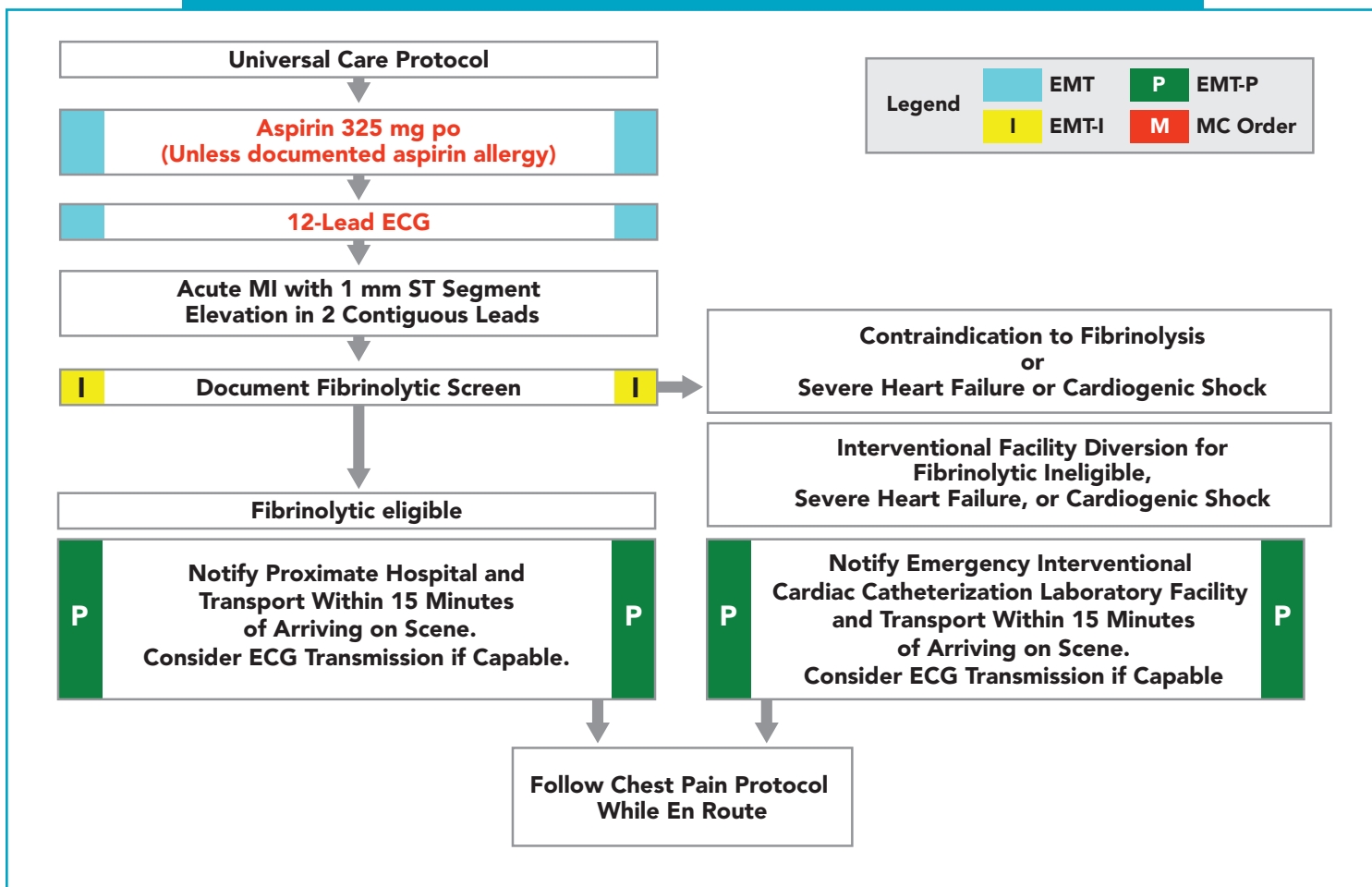


## Diversion for Fibrinolytic Ineligible Patients (for a system that designates fibrinolysis as primary method of reperfusion)

### Interventional Facility Diversion Transport Time Considerations

If ground transport to a proximate Interventional Facility is greater than 50 minutes, or ground ambulance transport is not feasible, establish an Air Medical Helicopter Transport Plan. This plan should include simultaneous notification of Air Medical Dispatch and the Interventional Facility by an EMT-P, proceeding to a designated Helicopter Landing Zone, and packaging the patient for air transport according to the Air Medical Helicopter Protocol.

## Diversion for Fibrinolytic Ineligible Patients (for a system that designates fibrinolysis as primary method of reperfusion)



## Non-PCI Hospital

### Basic recommendations

- Senior management commitment to best STEMI care and demonstration of this commitment through the provision of adequate resources to establish an optimal system.
- Establish a STEMI team composed of emergency department, cardiology, emergency transport, communications, quality assurance, nursing, and senior management involved in acute myocardial infarction care. Periodic meetings of team to review and revise system.
- Establish a predetermined, institution-specific, written protocol for rapid reperfusion (see Reperfusion Regimens A: Primary PCI, p.15 or B: Fibrinolysis, p.16) agreed upon by all cardiology and emergency department physicians and staff that includes:
  - Emergency physician on duty activates the reperfusion plan according to established local guidelines / care pathways.
  - All patients presenting to ED with possible symptoms of ST-elevation MI to undergo ECG within 10 minutes regardless of room or nurse availability (all patients age 30 and older with typical symptoms of acute coronary syndrome, and all patients age 50 and older with atypical symptoms including epigastric pain, arm pain, diaphoresis, shortness of breath, syncope)
  - Prompt identification of patients requiring ECG through nurse interview prior to registration ("nurse first") or through training of registration personnel.
  - Specify system for rapidly acquiring ECG including having ECG equipment in the ED and specifying a location that affords prompt access and adequate patient privacy.
  - Reperfusion checklist for hospitals with a predetermined plan for fibrinolysis
  - Door to needle time within 30 minutes for hospitals with a predetermined plan for fibrinolysis or in the event that PCI is not available within 90 minutes.
  - Door in door out time within 30 minutes for hospitals with a predetermined plan for transfer for PCI, and for patients ineligible for fibrinolysis or in cardiogenic shock.
- Overall system goal of first medical contact to balloon within 90 minutes.

- Standard pharmacologic regimen for all STEMI patients agreed upon by all cardiology and emergency department physicians.
  - Fibrinolytic agent stored in the emergency department and the intensive care unit.
  - Ability to reconstitute and administer fibrinolytic in emergency department.
  - If contraindication to fibrinolysis or uncertain diagnosis, expedited transfer plan to primary angioplasty facility.
  - Ongoing training and assessment program.
  - Data collection and rapid feedback within 24 hours to all care providers
- Establish transfer plan including preferred transport modality and backup transport modality.
- Patient registration should be treated in a fashion similar to trauma patients with the ability to fast-track critical labs, such as creatinine and PT/INR. Also similar to trauma, waiting time in the ED should be minimized with provision of reperfusion or rapid transfer to the catheterization laboratory as soon as possible.

### Advanced recommendations

- Data collection and feedback to emergency department and medical staff regarding performance and quality of reperfusion of ST-elevation MI patients.
- Participation in a regional or national myocardial infarction registry.
- Use "improvement science" to increase quality of care (e.g. process mapping, team organization, multidisciplinary team work, cause analysis, report cards, measures of dispersion, continuous quality improvement, and data collection, measurement, and feedback).

## Primary PCI Hospital

### Basic recommendations

- Senior management commitment to best STEMI care and demonstration of this commitment through the provision of adequate resources to establish an optimal system.
- Establish a STEMI team composed of emergency department, cardiology, emergency transport, intensive care unit, cardiac catheterization laboratory communications, quality assurance, and senior management involved in acute myocardial infarction care. Periodic meetings of team to review and revise system.
- Establish a predetermined, institution-specific, written protocol for rapid primary PCI agreed upon by all cardiology and emergency department physicians and staff that includes:

### Emergency Department

- Emergency physician on duty activates the reperfusion plan according to established local guidelines / care pathways.
- All patients presenting to ED with possible symptoms of ST-elevation MI to undergo ECG within 10 minutes regardless of room or nurse availability (all patients with typical acute coronary symptoms age 30 and older, and patients with atypical symptoms including epigastric pain, arm pain, diaphoresis, shortness of breath, syncope age 50 and older).
- Prompt identification of patients requiring ECG through nurse interview prior to registration ("nurse first") or through training of registration personnel.
- Specify system for rapidly acquiring ECG including having ECG equipment in the ED and specifying a location that affords prompt access and adequate patient privacy.
- Door to balloon time within 90 minutes.
- Overall system goal of first medical contact to balloon within 90 minutes.
- Standard pharmacologic regimen for all STEMI patients agreed upon by all cardiology and emergency department physicians.
- Ongoing training and assessment program.

### Catheterization Laboratory

- Emergency physicians or suitably trained paramedics authorized to activate the catheterization laboratory.
- Single contact / one telephone call to activate primary angioplasty team 24 hours per day / 7 days per week. This call may be answered by a non-interventional cardiologist.
- Immediately accept all patients regardless of bed availability.
  - When beds are not available, predetermined protocols for accommodating transferred patients may include care by the catheterization laboratory, emergency department, or intensive care unit staff, and housing the patient in an emergency, procedure, or recovery room until an appropriate hospital bed is available.
- Establish a daily primary PCI operator schedule that is coordinated between all cardiologists, and involves a single rotating physician.
- Interventional cardiologist is present and directs the entire procedure from catheterization laboratory arrival.
- Catheterization laboratory team in the laboratory and ready in 30 minutes on a 24 hours per day / 7 days per week basis.
  - Strategies to accelerate readiness including provision of sleeping quarters proximate to hospital, designation of STEMI team parking arrangements, and/or requiring staff to stay within 30 minutes of the hospital when on call.
- Back-up reperfusion plan if catheterization laboratories are down or filled with cases that cannot be delayed or moved. Back-up plans may include rapid activation of an additional catheterization laboratory team, diversion of second patient to a nearby primary PCI hospital or rapid fibrinolysis (first medical contact to needle within 30 minutes).
- Receive referral transfers directly from EMS transport to lab when the lab is staffed and available. If laboratory is not yet available on patient arrival to hospital, prep patient in the emergency department or intensive care unit.
- Establish cross-training and multi-disciplinary teams to expedite catheterization laboratory readiness and patient care that may include intensive care unit and/or emergency department staff.
- Update history and physical on transfer to catheterization table.

(Continued on page 12)

## Primary PCI Hospital

(Continued from page 11)

### Basic recommendations

#### Catheterization Laboratory

- Provide a single telephone number that is available 24/7 to activate primary angioplasty and initiate transfer of patients from outside hospitals.
- Establish a dedicated fax machine for receiving medical records from Non-PCI Hospitals
- Prompt data feedback that includes a call by the interventional cardiologist immediately following procedures to the referring emergency department physician or emergency medical technician.
- Email generated the day following primary PCI to all personnel involved in care outlining performance including following times (call to decision, decision to arrival in catheterization laboratory, arrival in catheterization laboratory to device deployment) catheterization results, false activations, deaths in transfer, and systematic delays.
- Data collection and feedback to emergency department, catheterization laboratory, and transferring facility regarding primary angioplasty performance and quality. Focus attention on variation in performance, rather than average performance.
- Expedite balloon time by whatever means are appropriate including using a guide catheter to initially image the suspected infarct related artery and delaying ventriculography until after coronary flow is restored.
- Patient registration should be treated in a fashion similar to trauma patients with the ability to fast-track critical labs, such as creatinine and PT/INR. Also similar to trauma, waiting time in the ED should be minimized with provision of reperfusion or rapid transfer to the catheterization laboratory as soon as possible.

### Advanced recommendations

- Provide 24 hours per day / 7 days per week telephone ('hotline') and fax support of reperfusion decision for referring hospitals by a cardiologist on call.
- Calls to catheterization laboratory referral line should be recorded and reviewed on a routine basis.
- Use "improvement science" to increase quality of care (e.g. process mapping, team organization, multidisciplinary team work, cause analysis, report cards, measures of dispersion, continuous quality improvement, and data collection, measurement, and feedback).

## Government: Local (including EMS providers)

### Basic recommendations

- Equip ambulances responding to potential ST-elevation myocardial infarction (STEMI) patients with ECG machines and providers who can perform ECG's.
- ST-elevation myocardial infarction patient for reperfusion ("STEMI medical scene") has same priority as 911 and trauma calls.
- Transfer patients across county lines to the nearest facility for primary angioplasty if reperfusion cannot be performed in the county.
- If vehicle transfer to remote counties not feasible, consider alternatives including cross-coverage of county by adjacent county EMS, transfer of patients to county line for transfer to receiving ambulance, or establishment of medical scene helicopter transport protocols. Helicopter transport protocols should include EMS and ED protocols capable of launching helicopters to medical scenes and establishment of helicopter landing zones (LZ). Patients transported to LZ's adjacent to hospitals should not require medical evaluation by that hospital unless deemed necessary by the EMS crew.
- Support continuing education programs for STEMI care, including 12 lead ECG training.
- Arrange for EMS IV tubing that matches that of receiving hospitals.
- Make EMS run sheets immediately available to receiving hospitals. Approaches include providing of adequate time for EMS crews to complete run sheets before hospital departure and provide paper or electronic format that is readily accessible to hospital personnel. Essential run sheet data should include EMS unit identification, dispatch time, scene arrival time, symptom onset time, description of symptoms, hospital pre-notification time, scene departure time, hospital arrival time, medications and procedures, and complications in transfer. Leave copy of ECG tracing that includes acquisition time.

### **Advanced recommendations**

- Provide all first responders with AED's.
- Respond to all potential ST-elevation myocardial infarction patients with ACLS providers.
- Selectively provide facilities and training for pre-hospital fibrinolysis.
- Equipment on ACLS response vehicle to transmit ECG to predetermined medical control facility and/or receiving hospital.

## **Government: State and Federal**

### **State Basic recommendations**

- State and local government policy to support treatment of all patients with ST-elevation myocardial infarction to include:
  - Uniform, statewide implementation of EMS care of ST-elevation myocardial infarction care according to the EMSPIC Acute Cardiac Care Toolkit. This implementation should include training, data support, and funding.
  - Provision of regional STEMI care coordinators similar to that of the North Carolina Trauma Regional Advisory Committee (RAC) system.
  - Extend performance of ECGs to all EMT levels (interpretation should remain with EMT-P).
- Require private ambulance and helicopter providers to meet regional standards and fully participate in regional systems of ST-elevation myocardial infarction care before responding to potential STEMI calls or transporting STEMI patients.
- Direct existing agencies with data collection capability to measure, monitor, and provide feedback regarding ST-elevation myocardial infarction care on a regular basis.
- Feature statewide ST-elevation myocardial infarction education for residents, communities, emergency medical services, physicians, and hospitals.

### **Advanced recommendations**

- Change policies such that there are no actual or perceived financial or administrative barriers for patients seeking care from the emergency medical service or the nearest hospital for the possibility of a myocardial infarction, even if the subsequent medical evaluation is negative.
- Link State, EMS, hospital, and vitals status data, making patient level data available to all entities participating in regional STEMI systems. These data should be updated and made available on a quarterly or more frequent basis.

*(Continued on page 14)*

## Government: State and Federal

(Continued from page 13)

### Federal Basic recommendations

- Use federal resources to promote the development and institution of national standards whereby every person suffering an ST elevation myocardial infarction is treated in a systematic and coordinated manner that includes diagnosis within 10 minutes of presentation, early notification and direct activation of coronary reperfusion by emergency medical system and emergency department personnel, and provisions for rapid coronary angioplasty (PCI) by regional centers. These standards should be established promptly with a priority similar to that of the trauma system, given that three to four times as many Americans die from myocardial infarction each year compared to motor vehicle accidents.
- Establish designated leadership within the Office of Emergency Medical Services or other pertinent agency within the Department of Health and Human Services for regional “medical scene” care than includes ST elevation myocardial infarction care.
- Remove financial barriers related to optimal emergency ST-elevation MI care for patients and hospitals.
  - Change policies such that there are no actual or perceived financial or administrative barriers for patients seeking care from the emergency medical service or the nearest hospital for the possibility of ST-elevation MI, even if the subsequent medical evaluation is negative.
  - ST-elevation MI patients should be included when in calculations for Medicare hospital case-mix adjustment.
- Add “reperfusion rate for eligible patients” to current reperfusion quality measures.
- Establish a uniform national definition of “first medical contact” that can be applied at the earliest possible point in the evolution of an ST-elevation myocardial infarction.
- Provide adequate funding and direction for the infrastructure required for STEMI systems including specification of regional protocols pertinent to urban or rural settings, establishment of uniform algorithms for ECG transmission and archiving, and expansion of the National Emergency Medical System Information System (NEMSIS). NEMSIS should be expanded to include elements pertinent to ST elevation myocardial infarction care, development of an interface to allow for the efficient electronic exchange of corresponding hospital data, and rapid deployment to all emergency medical systems responding to potential STEMI patients.

## Payers

### Basic recommendations

- Remove financial barriers related to optimal emergency ST-elevation MI care for patients and hospitals.
  - Change policies such that there are no actual or perceived financial or administrative barriers for patients seeking care from the emergency medical service or the nearest hospital for the possibility of ST-elevation MI, even if the subsequent medical evaluation is negative.
- Provide adequate reimbursement to fund regional emergency responses to ST elevation myocardial infarction that takes into account EMS funding, rural and critical access hospitals, interhospital transport, and 24 hours per day / 7 days per week operations.
- Add “reperfusion rate for eligible patients” to current reperfusion quality measures.

■

**Regimen A – Primary PCI**  
**Preferred if able to meet time goals of PCI within 90 minutes of 1<sup>st</sup> medical contact and for all patients who are fibrinolysis ineligible or with cardiogenic shock.**

*(To be used with institution specific standing orders/protocols for ST-elevation myocardial infarction patients)*

**Eligible Patients**

- Within 12 hours of symptom onset.
- ST-segment elevation in 2 or more contiguous leads  $\geq 1$ mm or left bundle branch block.
- Primary angioplasty is also the best option for:
  - Cardiogenic Shock; Killip class  $\geq$  III.
  - Possible ST-elevation MI but uncertain of diagnosis.
  - Contraindication to fibrinolysis.

**Goal is first device deployment within 90 minutes of first medical contact**

(emergency medical service scene arrival or emergency department registration arrival).

- Emergency department physician makes the decision about need for primary angioplasty, if possible. Consultation should be limited to situations of uncertainty.
- Activate catheterization laboratory immediately using single call activation.
- Complete EMTALA form as a priority.
- Fax patient records including ECG to receiving hospital WHILE PATIENT IN TRANSFER.
- Continuous IV infusions should only be used if required for stability during transfer.

**Other Medications**

1. Anticoagulation with heparin or bivalirudin. Heparin bolus at 70 IU/kg IV bolus. No maintenance infusion during transfer. Bivalirudin bolus 0.75 mg/kg IV (if prior UFH administered, start 30 minutes after last bolus); infusion 1.75 mg/kg/h, not titrated to ACT; terminated at procedure end unless prolonged antithrombin needed (0.25 mg/kg/hr infusion).
2. Aspirin 162–325 mg chewed.
3. Clopidogrel loading dose 300 to 600 mg p.o. times 1 dose, followed by 75 mg per day. Clopidogrel to be administered on presentation.

**PRN Medications:**

1. Nitroglycerin paste 1 to 2 inches topically PRN chest pain.
2. Morphine Sulfate 2-10mg IV for chest pain unrelieved by Nitroglycerin PRN.



## Reperfusion Regimen B – Fibrinolysis

(To be used with institution specific standing orders/protocols for ST-elevation myocardial infarction patients)

### Eligible Patients

- Within 12 hours of symptom onset.
- ST-segment elevation in 2 or more contiguous leads  $\geq 1$ mm or left bundle branch block.
- Absence of contraindications (see below).

### Fibrinolytic [tenecteplase (TNK) or reteplase (rPA)]

#### Tenecteplase (TNK) regimen Single IV bolus over 5 seconds

Use TNK dose chart below to determine dose.

Patient weight \_\_\_\_\_ kg

Patient-specific dose \_\_\_\_\_ mg  
(NOT TO EXCEED 50mg)

Patient Weight (kg)	TNK (mg)	Volume TNK to be administered (ml)
< 60	30	6
60 to 69	35	7
70 to 79	40	8
80 to 89	45	9
$\geq 90$	50	10

OR

#### Reteplase (rPA) regimen

10 units IV over 2 minutes given twice at 30-minute intervals. In nurses' notes and medication administration record, please note EXACT TIME of fibrinolytic administration, and obtain ECG 30 minutes after fibrinolytic administered.

### Other Medications:

1. Anticoagulation with Heparin or Enoxaparin. Enoxaparin generally preferred. (see DOSING GUIDELINES FOR OTHER ANTICOAGULANTS below).
2. Aspirin 162–325 mg chewed p.o. times 1 dose.
3. Clopidogrel 300 mg p.o. loading dose followed by 75 mg per day. If age over 75, omit loading dose.

### Rescue Angioplasty Strategy for Fibrinolysis:

Initiate urgent rescue PCI for failed reperfusion according to less than 50 percent ST-segment resolution within 60 to 90 minutes of the initiation of fibrinolysis (with or without chest pain).

### Contraindications to Fibrinolysis

#### Absolute contraindications

- Any prior intracranial hemorrhage
- Known structural cerebral vascular lesion (for example arteriovenous malformation)
- Known malignant intracranial neoplasm (primary or metastatic)
- Ischemic stroke within 3 months EXCEPT acute ischemic stroke within 3 hours
- Suspected aortic dissection
- Active bleeding or bleeding diathesis (excluding menses)
- Significant closed head or facial trauma within 3 months

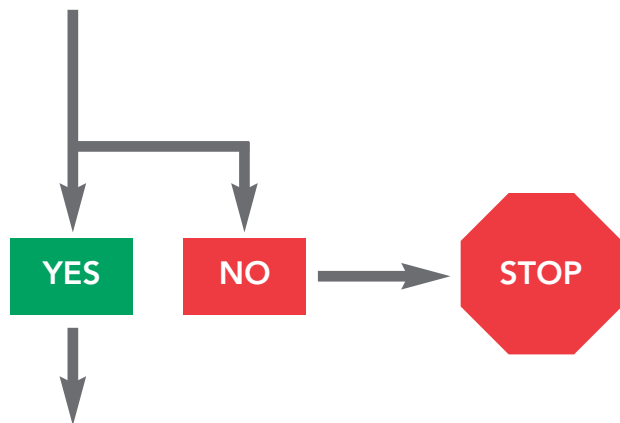
#### Relative contraindications

- History of chronic severe, poorly controlled hypertension
- Severe hypertension on presentation (systolic blood pressure greater than 180 mm Hg or diastolic blood pressure greater than 110 mm Hg)
- History of prior ischemic stroke greater than 3 months, dementia, or known intracranial pathology not covered in contraindications
- Traumatic or prolonged (greater than 10 minutes) CPR or major surgery (less than 3 weeks)
- Recent (within 2 to 4 weeks) internal bleeding
- Noncompressible vascular punctures
- Pregnancy

## Reperfusion Checklist for Evaluation of the Patient with ST-elevation MI

### Step One

Has the patient experienced chest discomfort for greater than 15 minutes and less than 12 hours?



### Step Two

Are there contraindications to fibrinolysis?  
If ANY of the following are CHECKED "YES",  
fibrinolysis MAY be contraindicated.

- Systolic BP greater than 180 mm Hg  Yes  No
- Diastolic BP greater than 110 mm Hg  Yes  No
- Right vs. left arm systolic BP difference greater than 15 mm Hg  Yes  No
- History of structural central nervous system disease  Yes  No
- Significant closed head/facial trauma within the previous 3 months  Yes  No
- Recent (within 6 wks) major trauma, surgery (including laser eye surgery), GI/GU bleed  Yes  No
- Bleeding or clotting problem or on blood thinners  Yes  No
- CPR greater than 10 min  Yes  No
- Pregnant female  Yes  No
- Serious systemic disease (e.g., advanced/terminal cancer, severe liver or kidney disease)  Yes  No

### Step Three

Does the patient have severe heart failure or cardiogenic shock such that PCI is preferable?

- Pulmonary edema (rales greater than halfway up)  Yes  No
- Systemic hypoperfusion (cool, clammy)  Yes  No

**STEMI** = ST-elevation myocardial infarction;  
**BP** = blood pressure;  
**GI** = gastrointestinal;  
**GU** = genitourinary;  
**CPR** = cardiopulmonary resuscitation;  
**PCI** = percutaneous coronary intervention.

From ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction.  
J Am Coll Cardiol 2004;44:671-719.  
Used by permission.

## Dosing Guidelines for Other Anticoagulants Direct Thrombin Inhibitor

### Bivalirudin (Angiomax®)

#### Dosing for PCI:

- Give bolus of 0.75 mg/kg (TBW) IV prior to PCI followed by continuous infusion of 1.75 mg/kg/h for the duration of the procedure. If prior UFH administered, start bivalirudin 30 minutes after last bolus.
- Measure ACT 5 min after initial bolus and give additional bolus of 0.3 mg/kg if needed.
- Terminate at procedure end unless prolonged antithrombin is needed (in which case a dose of 0.25 mg/kg/h may be given)

Continuous infusion dosing for patients with renal insufficiency: See below.

CrCl (ml/min)	Infusion Dose(mg/kg/hr)
≤ 30 ml/min	No change
< 30 ml/min	1.0 mg/kg/hr
Dialysis dependent	0.25 mg/kg/hr

## Dosing Guidelines for Other Anticoagulants Glycoprotein IIb/IIIa Receptor Blockers

### Abciximab (ReoPro®)

#### Dosing for PCI:

- 0.25 mg/kg IV over 5 minutes, followed by an IV infusion 0.125 mcg/kg/minute (Maximum 10 mcg/min) continued for 12 hours after PCI.

#### Weight adjusted low dose heparin

(target ACT ≥ 200 seconds):

ACT < 150 seconds: 70 U/kg heparin  
 ACT 150 – 199 seconds: 50 U/kg heparin  
 ACT ≥ 200 seconds: no heparin

### Eptifibatide (Integrilin®)

#### Dosing for PCI:

- Normal renal function (Creatinine clearance ≥ 50 ml/min):
  - Bolus dose of 180 µg/kg IV (maximum: 22.6 mg) over 1-2 minutes followed by 2.0 µg/kg/min continuous infusion (maximum: 15 mg/hour) and a second 180 µg/kg bolus (maximum: 22.6 mg) 10 minutes after the first bolus. Continue infusion for 24 hours after PCI
- Impaired renal function (Creatinine clearance <50 mL/min):
  - Bolus dose of 180 µg/kg IV (maximum: 22.6 mg) over 1-2 minutes followed by 1.0 µg/kg/min continuous infusion (maximum: 7.5 mg/hour) and a second 180 µg/kg bolus (maximum: 22.6 mg) 10 minutes after the first bolus. Continue infusion for 18 to 24 hours after PCI.
- Dialysis-dependent patients: contraindicated

#### Weight adjusted low dose heparin

(target ACT 200-300 seconds):

ACT < 150 seconds: 70 U/kg heparin  
 ACT 150 – 199 seconds: 50 U/kg heparin  
 ACT ≥ 200 seconds: no heparin

## Dosing Guidelines for Other Anticoagulants Heparin

### Unfractionated heparin

#### Dosing with fibrinolysis:

Continued for 48 hours in the absence of an ongoing indication for anticoagulation

- Bolus at initiation of t-PA, TNK, or rPA - 60 IU/kg IV bolus (maximum 4,000 IU).
- Continuous infusion 12 IU/kg/h (maximum initial rate of 1,000 IU) to achieve activated partial thromboplastin time (APTT) 1.5 to 2 times control, maintained for 48 hrs.

#### Dosing for PCI:

- Bolus at 70 IU/kg if patient did not receive a bolus en route to the catheterization laboratory
- Additional boluses of 2000 to 5000 IU to achieve an ACT of 250 to 300 (target ACT 200 for patients treated with glycoprotein IIb/IIIa receptor blockers)

## Dosing Guidelines for Other Anticoagulants Enoxaparin (Lovenox®)

### Dosing with fibrinolysis:

Continued for the duration of the index hospitalization up to 8 days

#### Age < 75

- Normal renal function (Creatinine clearance  $\geq$  30 ml/min):
  - 30 mg IV plus 1 mg/kg SC, followed by 1 mg/kg SC q 12 hours (maximum 100 mg for the first two doses only)
- Impaired renal function (Creatinine clearance < 30 ml/min)
  - 30 mg IV plus 1 mg/kg SC, followed by 1 mg/kg SC daily

#### Age $\geq$ 75

- Creatinine clearance  $\geq$  30 ml/min
  - No initial bolus
  - 0.75 mg/kg SC every 12 hours
- Creatinine clearance < 30 ml/min
  - No initial bolus
  - 0.75 mg/kg SC daily

### Dosing for PCI:

If last subcutaneous dose was administered greater than 8 hours earlier, give an additional 0.3mg/kg IV dose.

### Cockcroft-Gault equation with actual body weight to calculate Creatinine clearance (CrCl):

#### Males:

$$\frac{[(140 - \text{age}) \times (\text{actual body wt in kg})]}{72 \times (\text{serum creatinine})}$$

#### Females:

$$\frac{[(140 - \text{age}) \times (\text{actual body wt in kg}) \times (0.85)]}{72 \times (\text{serum creatinine})}$$

### General Contraindications to Anticoagulation other than Fibrinolysis:

- Active internal bleeding
- Recent (within six weeks) gastrointestinal (GI) or genitourinary (GU) bleeding of clinical significance.
- History of stroke within 30 days or any history of hemorrhagic stroke.
- Bleeding diathesis
- Administration of oral anticoagulants within seven days unless prothrombin time is  $\leq$  1.2 times control
- Thrombocytopenia (< 100,000 cells/ $\mu$ L)
- Recent (within six weeks) major surgery or trauma
- Intracranial neoplasm, arteriovenous malformation, or aneurysm
- Severe uncontrolled hypertension (systolic blood pressure > 200 mm Hg or diastolic blood pressure > 110 mm Hg)

## Glossary of Terms

**Automatic External Defibrillator (AED)** – A device that can be used by anyone with a minimal amount of training to defibrillate someone whose heart has stopped.

**Cardiogenic shock** – inadequate tissue perfusion due to low heart output. This condition is frequently a precursor to death, and can be recognized by the presence of hypotension (systolic blood pressure of 90 mmHg or less) in the setting of a myocardial infarction.

**Contraindication** – a specific situation in which a drug or procedure should NOT be used, because it may be more harmful than beneficial to the patient.

**Coronary arteries** – arteries that originate in the aorta immediately above the heart that supply oxygenated blood to the muscular tissue of the heart.

**Electrocardiogram (ECG)** – a recorded tracing of the electrical activity of the heart.

**Emergency Medical Service (EMS)** – a system of health care professionals, facilities and equipment providing pre-hospital emergency care.

**Emergency Medical Technician (EMT)** – an emergency responder trained to provide pre-hospital emergency medical services (EMS) to the critically ill and injured.

**Emergency Medical Treatment and Active Labor Act (EMTALA)** – a statute that governs when and how a patient may be (1) refused treatment or (2) transferred from one hospital to another when in unstable condition. The EMTALA was passed as part of the Comprehensive Omnibus Budget Reconciliation Act of 1986, and is sometimes referred to as "the COBRA law".

**Fibrinolysis** – the breakdown of fibrin, usually by the enzymatic action of plasmin. Fibrin is a protein necessary for blood clotting that forms a web-like mesh that traps red blood cells and platelets and holds clots together. In the case of myocardial infarction, the administration of drugs that facilitate fibrin breakdown is referred to as "fibrinolysis."

**Fibrinolytic** – an agent used to facilitate fibrin breakdown by activating plasminogen.

**Door-to-Needle Time** – the time elapsed from hospital arrival or emergency department registration arrival to the initial infusion of fibrinolytic medication.

**First medical contact-to-Balloon Time** – the time elapsed from the first medical contact including emergency medical service scene arrival or emergency department registration arrival to the first inflation of the PCI balloon.

**Killip Class** – a system for estimating the risk of death with myocardial infarction according to four classifications:

- **Class 1:** Absence of rales over the lung fields and absence of S3
- **Class 2:** Rales over 50% or less of the lung fields or the presence of an S3
- **Class 3:** Rales over more than 50% of the lung fields
- **Class 4:** Cardiogenic shock.

**Left Bundle Branch Block (LBBB)** – an electrocardiographic pattern when the left bundle fails to conduct to the left ventricle, manifested by deep S waves in lead V1, predominant R waves in lead V6 and I, and a wide QRS complex. ST-segment elevation with a myocardial infarction cannot be reliably detected in the setting of left bundle branch block.

**Myocardial Infarction (MI)** – sudden onset of myocardial necrosis due to the formation of a blood clot in the coronary arterial system obstructing arterial blood flow to the area of cardiac muscle supplied by that artery. This condition is often manifested by symptoms of coronary insufficiency and electrocardiographic changes of ST-segment elevation. (Commonly known as a heart attack.)

**Percutaneous Coronary Intervention (PCI)** – a procedure used to open or widen narrowed or blocked blood vessels supplying the heart. Usually, the blood vessels are accessed through the skin over the leg (femoral) or arm (radial or brachial) arteries. A thin catheter is advanced over a soft-tipped guide-wire through the arterial tree to the base of the heart where the coronary arteries arise. A smaller guide-wire is then advanced into the coronary artery and across the blockage, followed by balloon-dilation catheters, stents, and other artery opening devices as needed.

**Primary Percutaneous Coronary Intervention** – the use of percutaneous coronary intervention to open an occluded coronary artery in the setting of an ST-elevation myocardial infarction.

**Reperfusion** – the restoration of blood flow to an organ or tissue that has had its blood supply cut off, as after a myocardial infarction.

**ST-Elevation Myocardial Infarction (STEMI)** – a myocardial infarction for which the ECG shows ST-segment elevation, usually associated with a recently closed coronary artery. Patients suffering this type of myocardial infarction are more likely to survive if their coronary artery is opened within 12 hours of onset.

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