



# Optimal System Specification by Point of Care Operations Manual

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

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# Introduction

**The RACE project and all associated materials represent a quality assurance activity of North Carolina hospitals.**

This operations manual is the product of the Reperfusion of Acute Myocardial Infarction in Carolina Emergency Departments (RACE) project with the goals of increasing the rate and speed of acute myocardial infarction care in North Carolina. This document is based upon established guidelines, published data, and the knowledge and experience of numerous individuals specializing in acute myocardial infarction care.

## 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.

**Door-to-Balloon Time** – the time elapsed from the entry of a patient through the emergency department door to the first inflation of the PCI balloon.

**Door-to-Needle Time** – the time elapsed from the entry of a patient through the emergency department door to the initial infusion of fibrinolytic medication.

**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".

# Glossary of Terms (continued)

**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.

**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.

## REFERENCES

Antman EM, Anbe DT, Armstrong PW, Bates ER, Green LA, Hand M, Hochman JS, Krumholz HM, Kushner FG, Lamas GA, Mullany CJ, Ornato JP, Pearle DL, Sloan MA, Smith SC Jr. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction: executive summary: a report of the ACC/AHA Task Force on Practice Guidelines (Committee to Revise the 1999 Guidelines on the Management of Patients With Acute Myocardial Infarction). J Am Coll Cardiol 2004;44:671–719.

# Optimal System Specification By Point Of Care

The following basic and advanced recommendations represent potential modifications to the current system of ST-elevation MI care likely to increase the rate and speed of coronary artery reperfusion. They are presented as checklists so that each provider or organization may consider these recommendations as they apply to local or regional conditions.

## EMS: Initial Contact EMT Basic or Intermediate Provider

### Basic recommendations

- ECG acquisition to be extended to basic providers.
- In the field ECG (to be interpreted by receiving physician on arrival or by transmission).
- Patient stays on ambulance stretcher for STEMI evaluation for hospitals that routinely transfer all or some patients by same ambulance.

# EMS: Initial Contact EMT-Paramedic

## Basic recommendations

- In the field ECG.
- Training to recognize ST-elevation MI on ECG.
- Review reperfusion checklist (p.17).
- Relay the ECG (or at least its findings) and checklist findings to a predetermined medical control facility and/or receiving hospital.
- 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.
- Patient stays on ambulance stretcher for STEMI evaluation for hospitals that routinely transfer all or some patients by same ambulance.

## Advanced recommendations

- Direct communication with Emergency Department physician, Cardiology, Catheterization Lab., or Coronary Care Unit to activate reperfusion plan.
- Prehospital fibrinolysis system as appropriate for local resources and needs.
- Divert and transport ST-elevation MI patients with contraindication to fibrinolysis or cardiogenic shock to a facility capable of performing primary angioplasty. (Prehospital destination protocol.)
- EMS has same IV tubing as predominate receiving hospitals.

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

## Basic recommendations

- ST-elevation myocardial infarction (STEMI) patient for reperfusion has same priority as 911 call and trauma.
- Patient stays on stretcher for myocardial infarction evaluation for hospital transfer.
- Transfer plans in place, including 2 alternatives.
- Transport directly to catheterization laboratory.
- When possible minimize or exclude IV infusions such as nitroglycerin or heparin drips.
- Transfer protocol should focus on rapid transport to catheterization lab 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.
- Hospital records should be faxed to the receiving catheterization lab, 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

- ST-elevation MI patient for reperfusion has same priority as 911 call and trauma.
- 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 exclude IV infusions such as nitroglycerin or heparin drips.
- Transfer protocol should focus on rapid transport to catheterization lab rather than pain relief with medications.
- Whenever possible, helipad adjacent to emergency department.
- Helicopter capable of transporting patients on ten minutes notice 24/7.
- When not available alternate transport options identified.
- Immediately activate helicopter transport during initial communication between ED and receiving hospital regarding the need for reperfusion.
- Establish a system whereby all patient transfers of any type can be specified as time critical within one hour versus diversion possible.
- Transfer patients to PCI hospital with similar consideration to patient registration, bed availability, and accepting physician as trauma patients.
- Hospital records should be faxed to the receiving catheterization lab, 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.

# Emergency Department Initial Hospital / Non-PCI Facility

## Basic recommendations

- All patients presenting to ED with possible symptoms of acute myocardial infarction to undergo ECG within 10 minutes regardless of room or nurse availability.
  - Specify system for rapidly acquiring ECG including specific location in the ED, ECG equipment in ED, and personnel.
- ED personnel trained to interpret ECG for ST-elevation MI.
- Establish a predetermined, institution-specific, written protocol for rapid reperfusion (see Reperfusion Regimens A (p.15) & B (p.16) that includes:
  - ECG within 10 minutes of door.
  - Door to needle within 30 minutes.
  - Door to balloon within 90 minutes.
  - Reperfusion checklist.
  - Standard pharmacologic regimen.
  - Fibrinolytic agent stored in the emergency department.
  - Ability to reconstitute and administer fibrinolytic in emergency department.
  - If contraindication to fibrinolysis or uncertain diagnosis, expedited transfer plan to primary angioplasty facility.
  - Care pathway/algorithm/standing orders developed by key stakeholders.
  - Ongoing training and assessment program.
  - When possible there should be a single protocol per institution agreed upon by all cardiology and emergency department physicians.
- The choice of initial ST-elevation MI treatment should be made by the emergency medicine physician on duty according to established local guidelines / care pathways.

# Emergency Department Initial Hospital / Non-PCI Facility (continued)

## Basic recommendations

- Establish initial and backup plan for transfer / transport to a PCI facility.
- 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. It is important to quickly obtain an ECG so as not to delay care. 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.
- Establish compatible intravenous tubing and pumps for potential transfer patients. May be changed to established hospital system if admitted.
- 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

- All patients presenting to ED with possible symptoms of ST-elevation MI to undergo ECG within 10 minutes regardless of room or nurse availability.
  - Specify system for acquiring ECG including specific location in the ED, ECG equipment in ED, and personnel.
- ED personnel trained to interpret ECG for ST-elevation MI.
- Establish a predetermined, institution-specific, written protocol for rapid primary PCI (see Reperfusion Regimen A on p.15) that includes:
  - ECG within 10 minutes of door.
  - Door to needle time within 30 minutes.
  - Door to balloon time within 90 minutes.
  - Back-up reperfusion plan if catheterization labs down or filled with cases that cannot be delayed or moved.
  - Single contact to activate primary angioplasty team 24/7.
  - Establish a daily primary PCI operator schedule that is coordinated between all cardiologists, and involves a single rotating physician.
  - Lab staffed and present within 30 minutes of activation, best practice- staffed on site 24/7.
  - Standard pharmacologic regimen.
  - Strive for a single protocol per institution agreed upon by all cardiology and emergency department physicians.
- Receive referral transfers directly from EMS transport to lab.
  - Update history and physical on transfer to catheterization table.
- Provide a single telephone number that is available 24/7 to activate primary angioplasty and initiate transfer of patients from outside hospitals.
  - Fax machine for receiving medical records from facility should be immediately available for catheterization lab staff with the number published in hospitals likely to transfer patients.

# Primary PCI Hospital (continued)

## Basic recommendations

- Following catheterization interventional cardiologist immediately calls referring emergency department physician or delegate.
- 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.

## Advanced recommendations

- Image infarct related artery first and open if appropriate. Follow with other arteries and ventriculogram if appropriate.
- Facilitate transferring hospitals use of “reperfusion kits” that include standing orders, pre-angioplasty medications and dosing including aspirin, heparin, and clopidogrel, blood vials, calculator, physician certification for transfer, transfer data sheet, directions to family, contact numbers.
- Provide 24/7 telephone (‘hotline’) and fax support of reperfusion decision for referring hospitals by a cardiologist on call.
- Calls to catheterization lab referral line should be recorded and reviewed on a routine basis.
- Email generated the day following angioplasty to all personal involved in care outlining performance including following times (call to decision, decision to arrival in catheterization lab, arrival in catheterization lab to balloon inflation, catheterization results) and systematic delays.
- Direct transfers from EMT to tertiary PCI center.
  - Receive transfers directly from EMS to catheterization lab after EMT-P call case directly to hotline/receiving cardiologist.
  - Update history and physical on transfer to catheterization table.
  - 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

## Basic recommendations

- Provide the same priority to ST-elevation MI transfer for reperfusion 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.
- Support continuing education programs for STEMI care, including 12 lead ECG.
- Equip ambulances responding to potential ST-elevation MI patients with ECG machines and providers who can perform ECG's.
- Arrange for IV tubing that matches that of receiving hospitals.
- Distribute and educate providers regarding the reperfusion checklist (p.17).

## Advanced recommendations

- Provide all first responders with AED's.
- Respond to all potential ST-elevation MI 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

- Legislation to support treatment of all patients with ST-elevation MI to include:
  - Statewide approach and protocol to triage, management, and transfer.
  - Statewide coordination center(s).
  - Training and support of the EMS system to appropriately respond to ST-elevation MI.
  - Extend performance of ECGs to all EMT levels (interpretation should remain with EMT-P).
- Establish ECG ST-elevation MI interpretation certification including training and testing.
- Require private ambulance providers to meet regional standards and fully participate in regional systems of ST-elevation MI care before responding to potential ST-elevation MI calls or transporting ST-elevation MI patients.
- Direct existing agencies with data collection capability to measure, monitor, and provide feedback regarding ST-elevation MI care in North Carolina on a regular basis.
- Feature statewide ST-elevation MI education for residents, communities, emergency medical services, physicians, and hospitals.

## Federal Basic recommendations

- Remove all financial barriers for patients and hospitals regarding ST-elevation MI care.
  - Change policies such that there are no actual or perceived financial or administrative barriers to 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.
  - Medicare hospital case-mix adjustment remains unchanged regardless of whether ST-elevation MI patient is admitted or transferred from the Emergency Department.
- Transfers of ST-elevation MI patients for PCI should not be subject to an EMTALA-based physician certification process.

# Payers

## Basic recommendations

- ❑ Remove all financial barriers for patients regarding ST-elevation MI care.
  - ❑ Change policies such that there are no actual or perceived financial or administrative barriers to 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.
  - ❑ Remove all financial and administrative barriers for hospital transfer of ST-elevation myocardial infarction patients to the most expedient PCI facility.

# Regimen A – Primary PCI

## Preferred if able to meet time goals

*(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 >1mm or left bundle branch block.
- Primary angioplasty is also the best option for:
  - Cardiogenic Shock; Killip class III or >.
  - Possible ST-elevation MI but uncertain of diagnosis.
  - Contraindication to fibrinolysis.
  - Physician or patient preference.

**Goal is to open artery with angioplasty balloon within 90 minutes of arrival to first hospital or first medical contact.**

- Emergency department physician makes the decision about need for primary angioplasty, if possible. Consultation should be limited to situations of uncertainty.
- Notify PCI hospital of an ST-elevation MI in need of primary angioplasty.
- 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. **Heparin:** Bolus at 70 IU/kg IV bolus. No maintenance infusion during transfer.
2. **Aspirin:** 325 mg chewed.

#### 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 >1mm 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 at right to determine dose. →

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

Patient-specific dose \_\_\_\_\_ mg

(NOT TO EXCEED 50mg)

**OR**

### Retepase (rPA) regimen

10 units IV over 2 minutes given twice at 30-minute intervals.

Patient Weight (kg)	TNK (mg)	Volume TNK to be administered (ml)
< 60	30	6
≥ 60 to < 70	35	7
≥ 70 to < 80	40	8
≥ 80 to < 90	45	9
≥ 90	50	10

In nurses' notes and MAR, please note EXACT TIME of fibrinolytic administration, and obtain ECG 30 minutes after fibrinolytic administered.

## OTHER MEDICATIONS:

### 1. Heparin:

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

### 2. Aspirin 325 mg chewed.

### 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

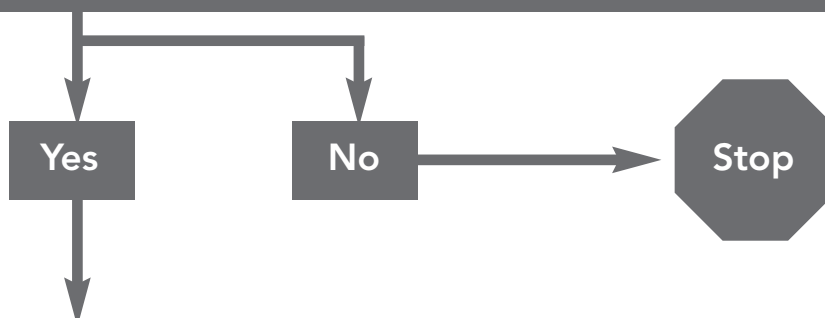
### Relative contraindications

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

# RACE Emergency Department ST-elevation MI Poster



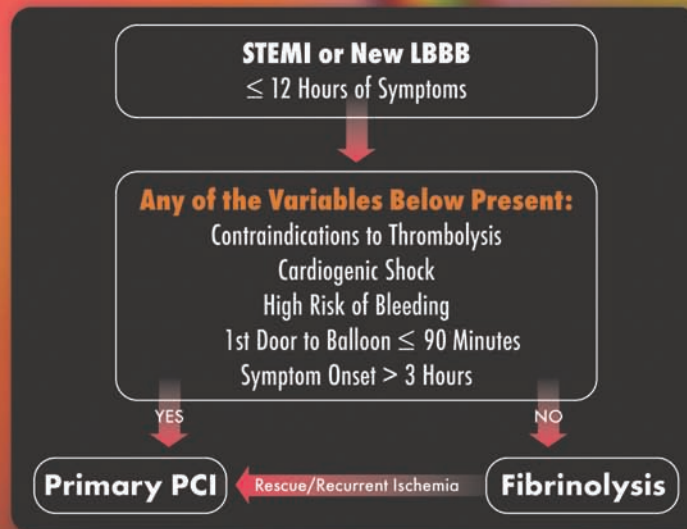
Reperfusion of Acute MI  
in Carolina Emergency  
Departments

**More than 20%** of North Carolina's eligible patients **don't get reperfusion therapy.**



**Reperfusion** of all eligible patients is regarded as **the most important variable** for improving outcomes in patients with STEMI/new LBBB.

**Our goal** is to **reperfuse more than 90%** of all eligible patients.



Hospital Protocol for  
STEMI/New LBBB:

Options for Emergency Transfer for Primary  
Angioplasty or for Thrombolytic-ineligible Patients: