Benefits of Pre-hospital ECG in Recognition of STEMI

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American Heart Association®

Pre-Hospital STEMI Diagnosis and Cardiac Cath Lab Activation

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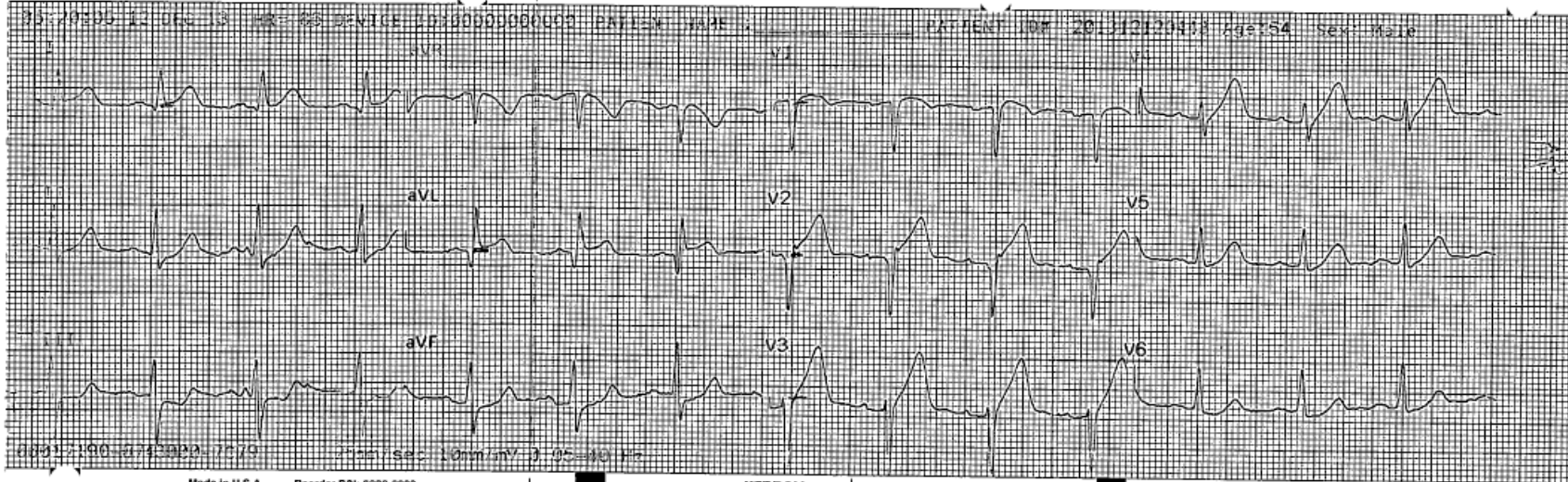Director, Cardiac Catheterization Laboratory
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Disclosures

None

Case

54 year-old male who awoke suddenly at 3 AM with acute, severe sub-sternal chest pain/pressure.

EMS was activated.

Made in U.S.A.   Reorder P/N: 8000-0300   KENDALL MEDI-TRACE

DEVICE ID:00000000000

RECORDED:05:20:05 12 DEC 13

PATIENT NAME :

PATIENT ID#:201312120443

PATIENT AGE: 54

PATIENT SEX: Male

Vent. rate   84

PR interval   166 ms

QRS Duration: 88 ms

QT/QTc   358/423 ms

P-R-T axes   26   14   26

Normal sinus rhythm

Septal infarct , age undetermined

Lateral injury pattern

** ** ** ** * Acute MI * ** ** ** **

Abnormal ECG

*** Unconfirmed ***

Made in U.S.A.   Reorder P/N: 8000-0300   KENDALL MEDI-TRACE

25 mm/sec   10 mm/mV   0.05 - 40 Hz
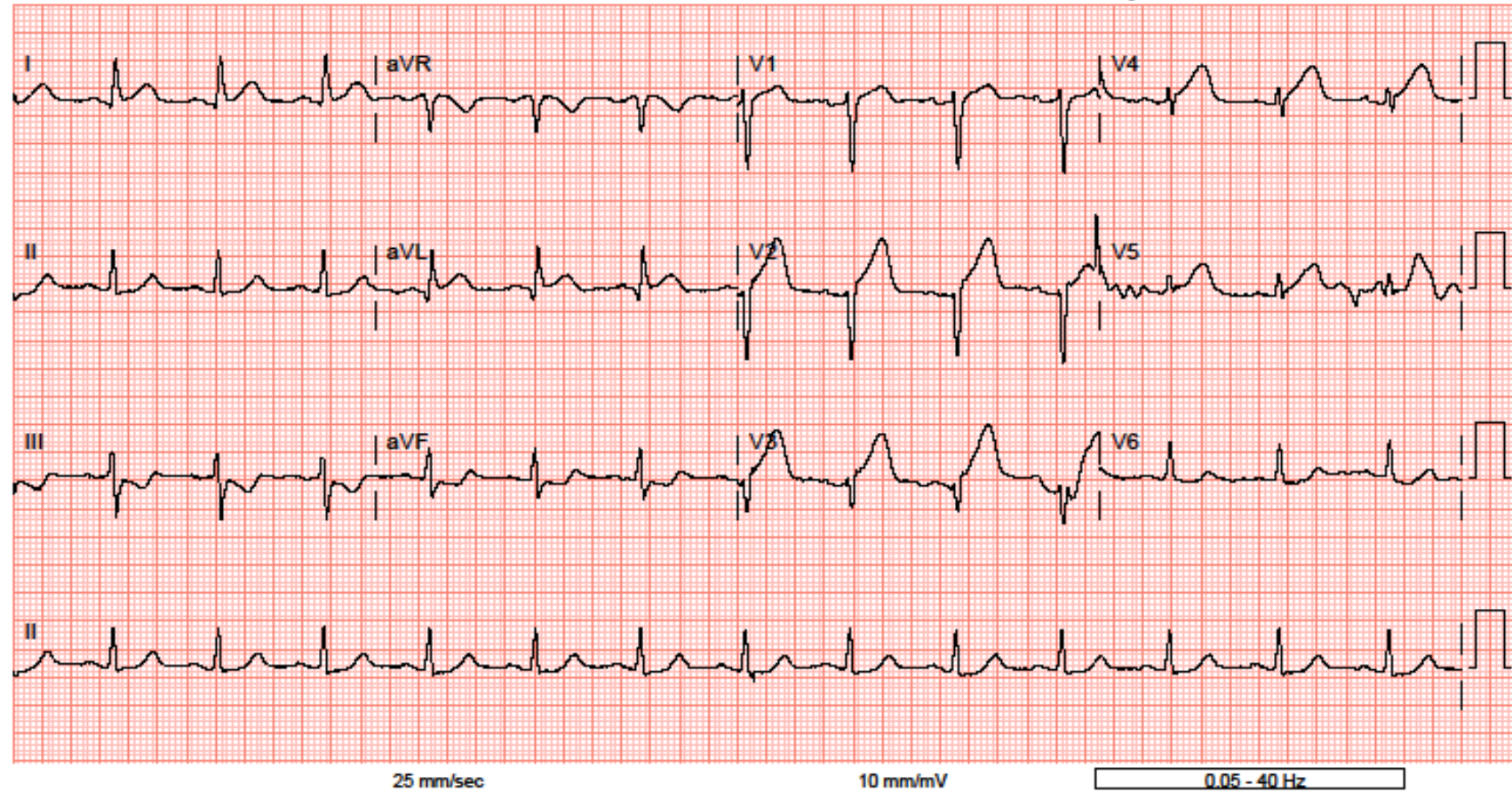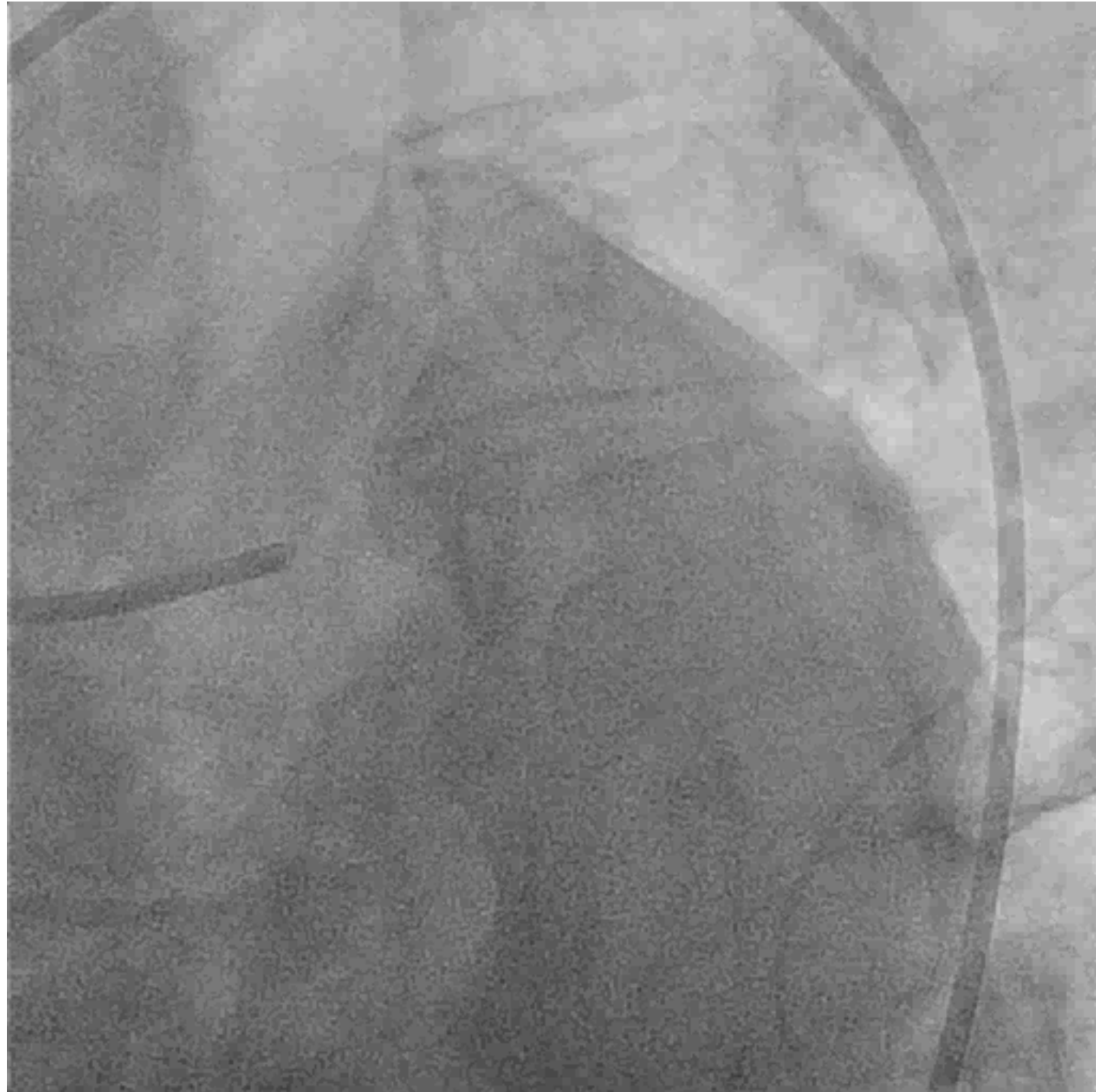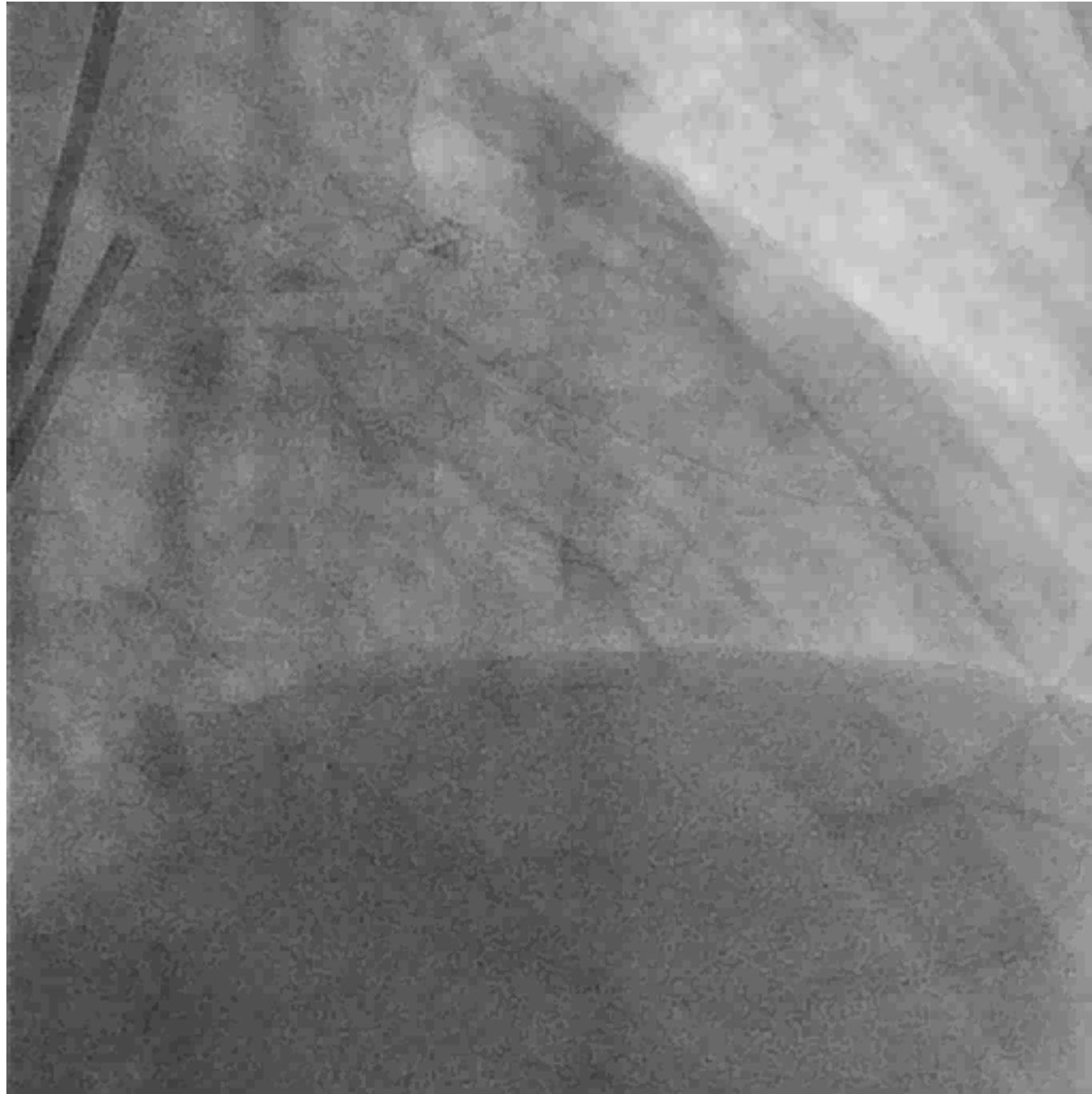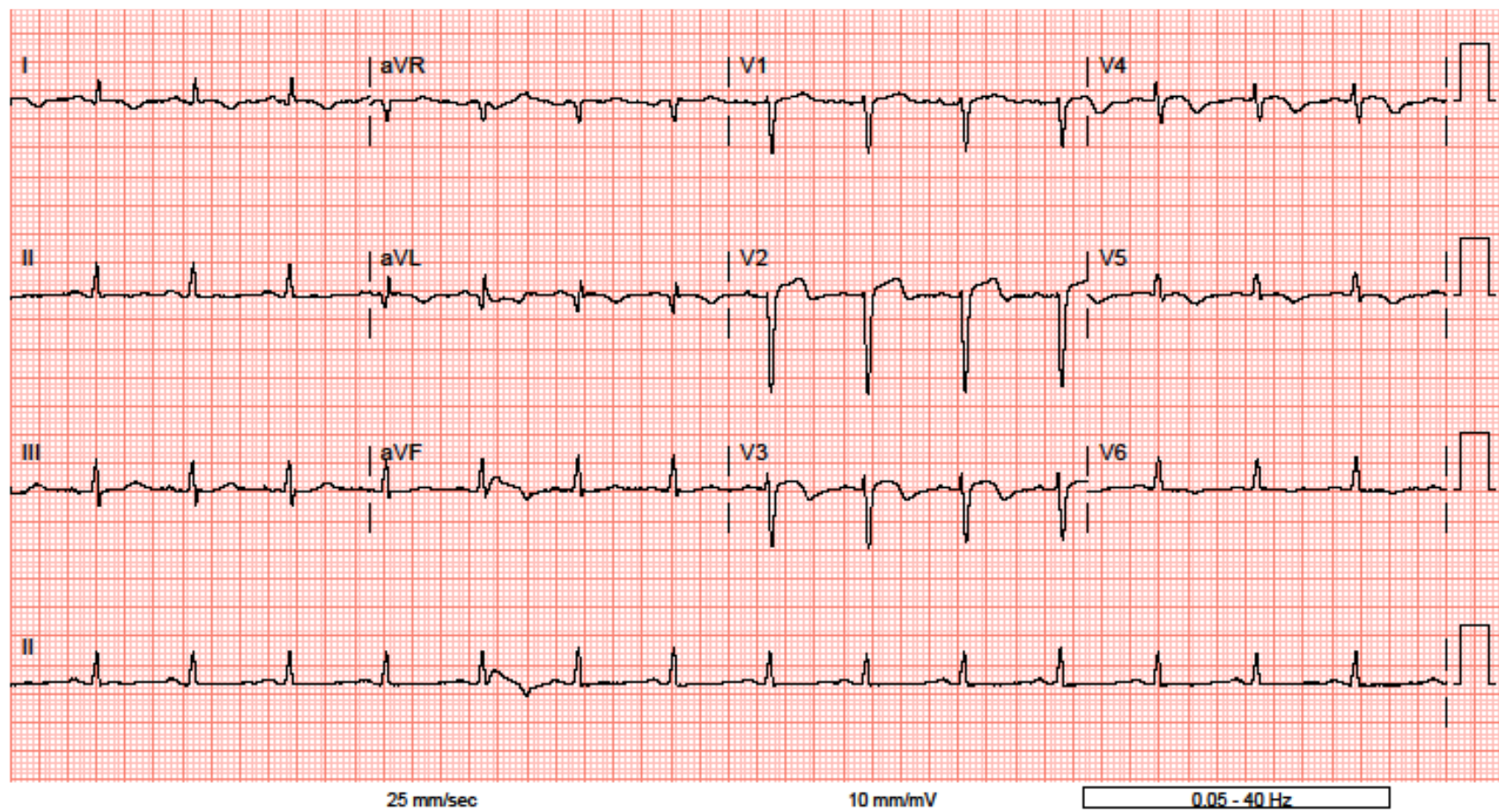
Abbreviations

STEMI = ST-Segment Elevation Myocardial Infarction

PCI = Percutaneous Coronary Intervention

D2B = Door-to-balloon

D2N = Door-to-needle

Outline

- STEMI Definition
- D2B Time Associated Mortality
- 12-Lead ECG Interpretation by EMS
- Door-to-Balloon Time Improvement by EMS Diagnosis
- PreACT Algorithm

STEMI Definition

STEMI Definition

New ST segment elevation at the J-point in at least 2 contiguous leads of ≥ 2mm (0.2mV) in men or ≥1.5mm (0.15mV) in women in leads V2-V3 and/or of ≥1mm (0.1mV) in other contiguous leads or the limb leads.

STEMI

Rate	55	SUPRAVENTRICULAR RHYTHM
PR	0	BORDERLINE RIGHT AXIS DEVIATION [QRS AXIS > 90]
QRSD	113	MODERATE INTRAVENTRICULAR CONDUCTION DELAY [110+ ms QRS DURATION]
QT	371	MARKED ST ELEVATION, CONSIDER INFERIOR INJURY [MARKED ST ELEVATION W/O NORMALLY
QTc	360	INFLECTED T WAVE IN II/aVF]
--AXIS--		***ACUTE MI***
P		INTERPRETATION BASED ON A DEFAULT AGE OF 40 YEARS
QRS	93	
T	92	

Req MD: Jonathan Shultz MD
Visit #: VS0002651028
Order #: 1502903.001SLK
Scanned VS#:
Field4:

Unconfirmed Study
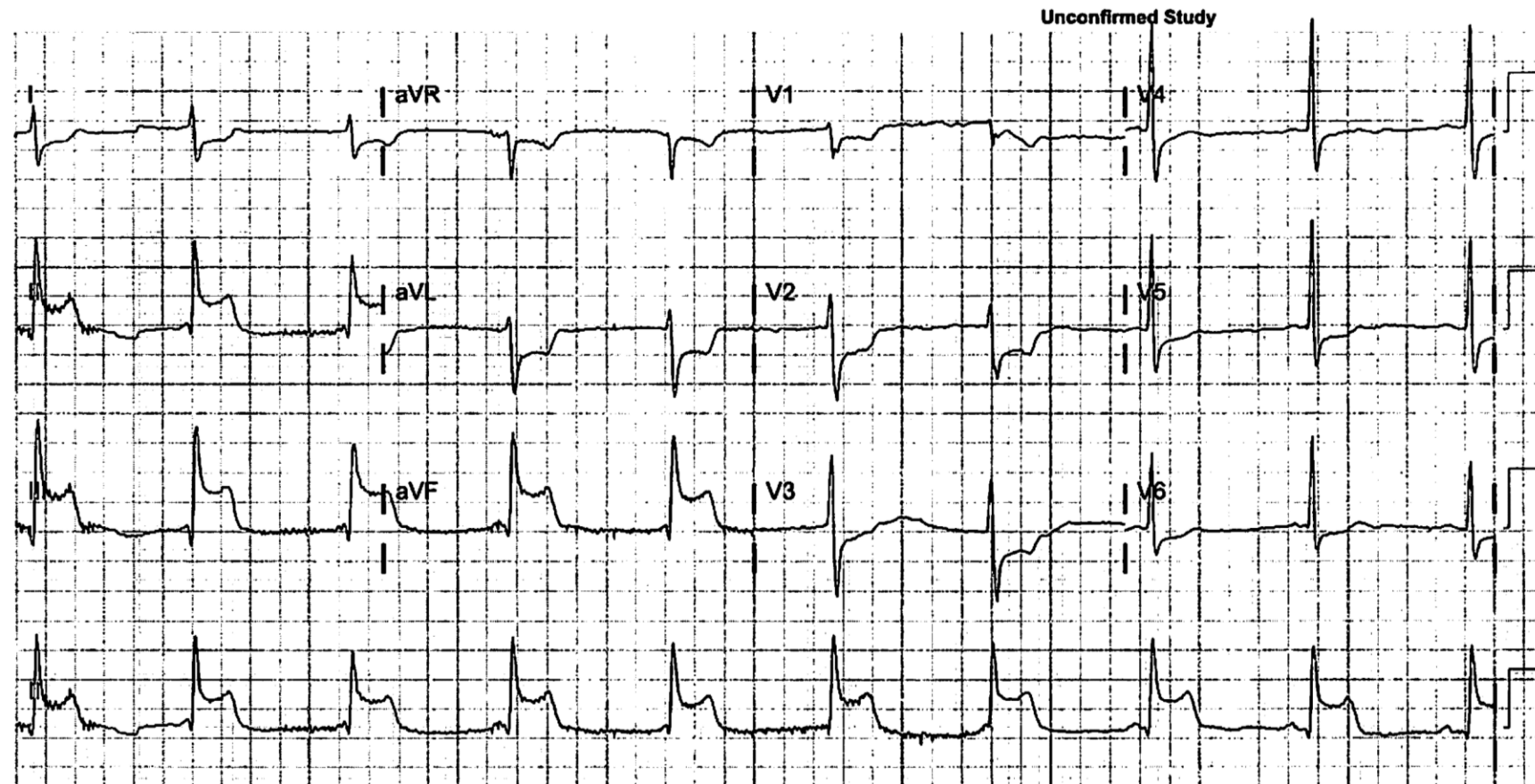
STEMI

Rate 78
PR 161
QRSD 151
QT 335
QTc 368

--AXIS--

P 90
QRS -61
T 86

SINUS RHYTHM
NONSPECIFIC INTRAVENTRICULAR CONDUCTION BLOCK [130+ MS QRS DURATION]

Gotta love it !
JM

- ABNORMAL ECG -

Unconfirmed Study

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Visit #: VS0002423233
Order #: 1344985.001SLK
Scanned VS#:
Field4:
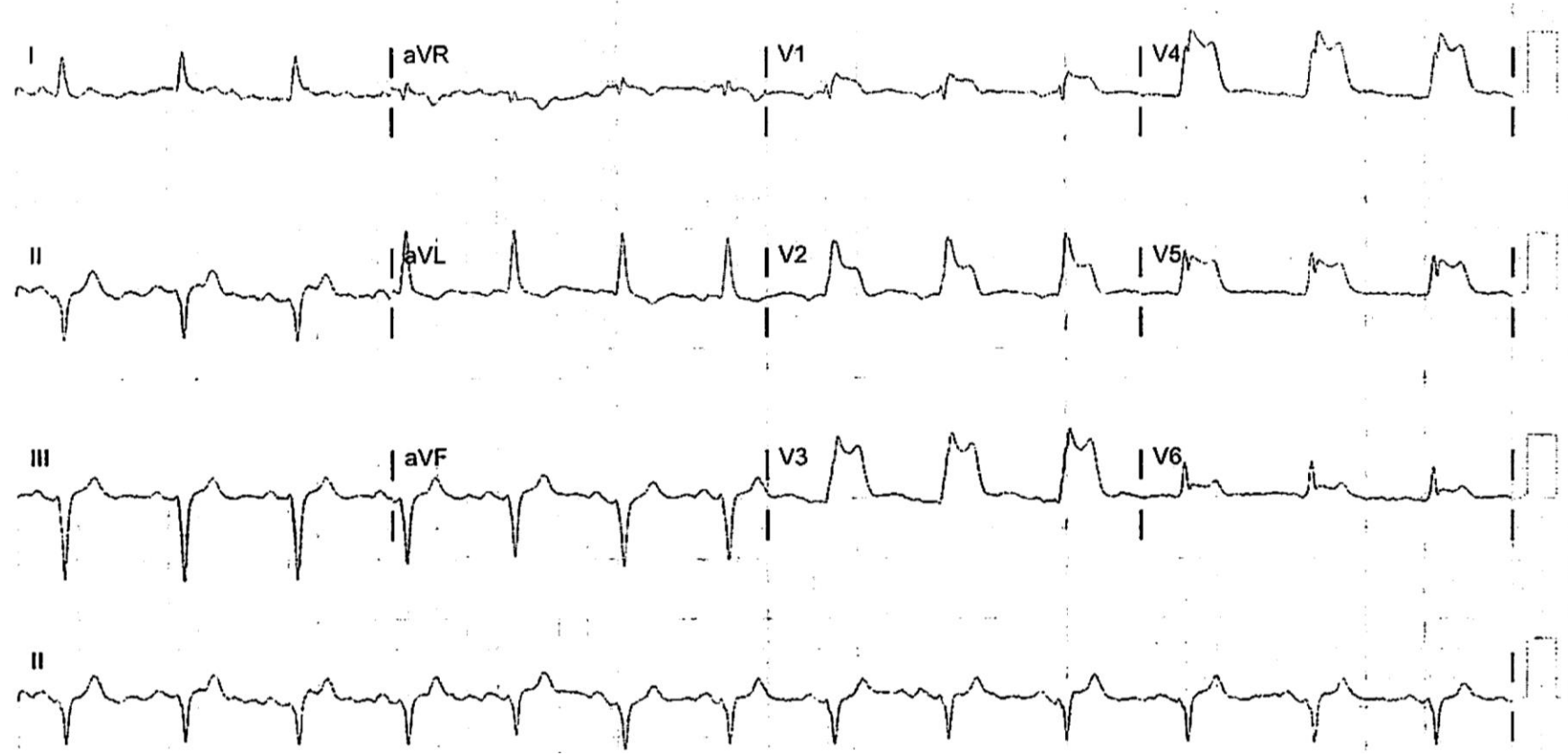
D2B Time Associated Mortality

Microscopic morphologic changes evolve over time as follows:

Time from Onset - Microscopic Morphologic Finding
1 - 3 Hours - Wavy myocardial fibers
2 - 3 Hours - Staining defect with tetrazolium or basic fuchsin dye
4 - 12 Hours - Coagulation necrosis with loss of cross striations, contraction bands, edema, hemorrhage, and early neutrophilic infiltrate
18 - 24 Hours - Continuing coagulation necrosis, pyknosis of nuclei, and marginal contraction bands
24 - 72 Hours - Total loss of nuclei and striations along with heavy neutrophilic infiltrate
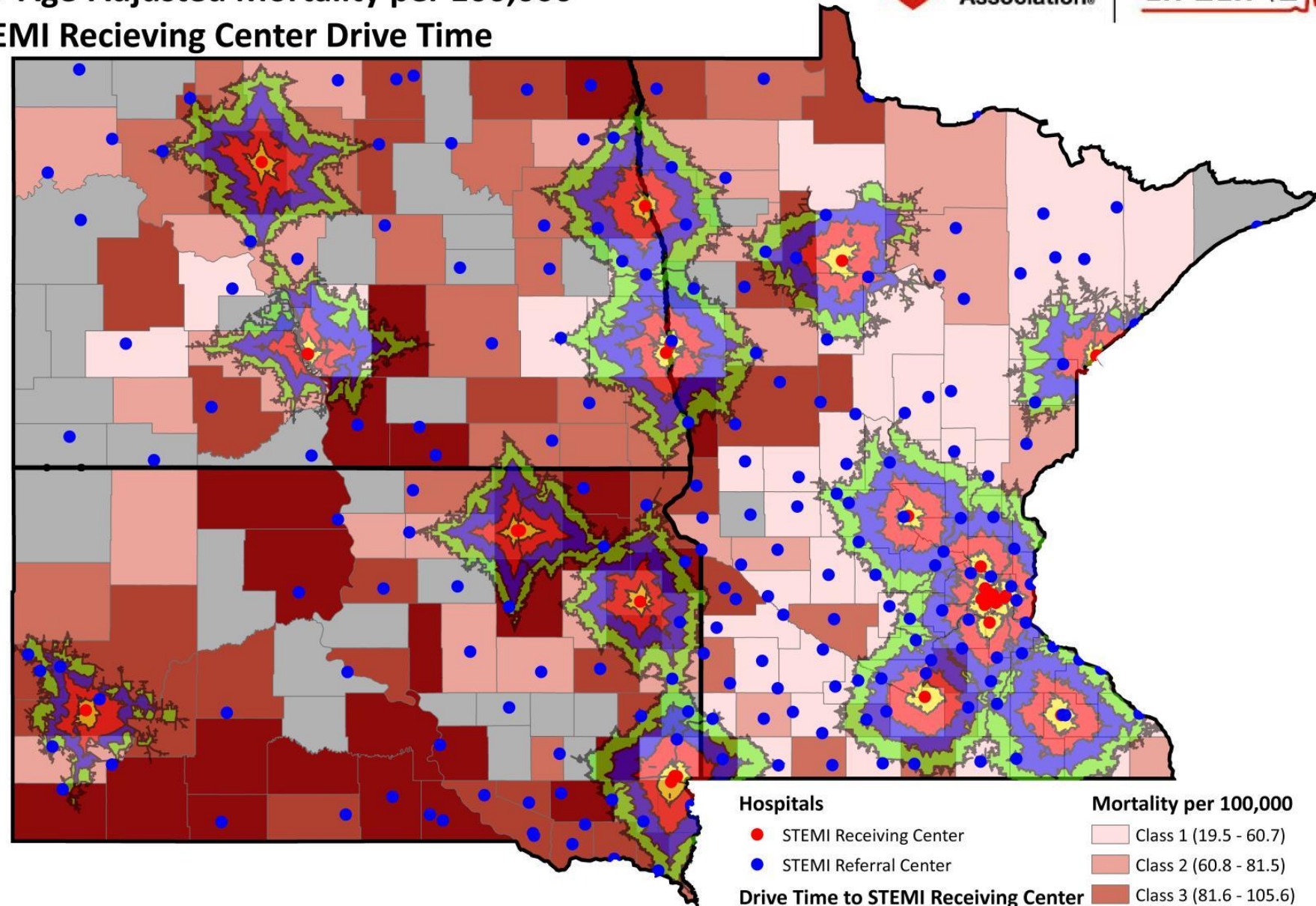3 - 7 Days - Macrophage and mononuclear infiltration begin, fibrovascular response begins
10 - 21 Days - Fibrovascular response with prominent granulation tissue
7 Weeks - Fibrosis

2007-2010 Acute Myocardial Infarction (ICD10 I21 & I22)
35+ Age-Adjusted Mortality per 100,000
STEMI Recieving Center Drive Time

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Source: CDC/NCHS Compressed Mortaltiy File 2007-2010.

0 25 50   100   150   200
Miles

Created: 4/1/14

Hospitals
- ● STEMI Receiving Center
- ● STEMI Referral Center

Drive Time to STEMI Receiving Center
- 15 minutes
- 30 minutes
- 45 minutes
- 60 minutes

Mortality per 100,000
- Class 1 (19.5 - 60.7)
- Class 2 (60.8 - 81.5)
- Class 3 (81.6 - 105.6)
- Class 4 (105.7 - 146.9)
- Class 5 (147.0 - 480.4)
- Insufficient Data

Ischemic Time, Myocardial Salvage and Mortality
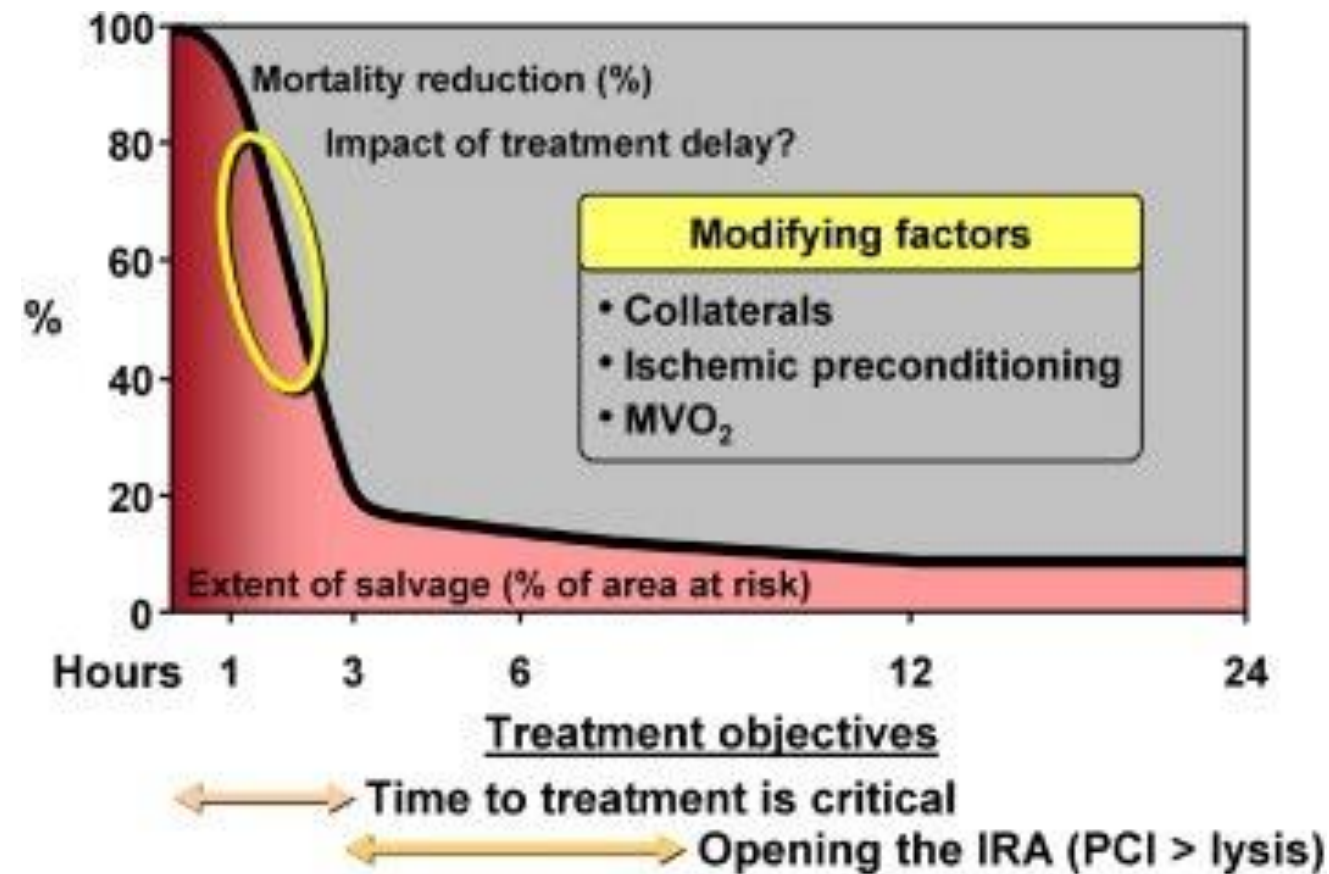
Principals

- Quicker D2B times are associated with improved CA patency
- Quicker D2B times are associated with higher rates of TIMI III flow
- Slower D2B times are associated with increased mortality
- Slower D2B times are associated with increased rates of CHF

D2B Time and Mortality
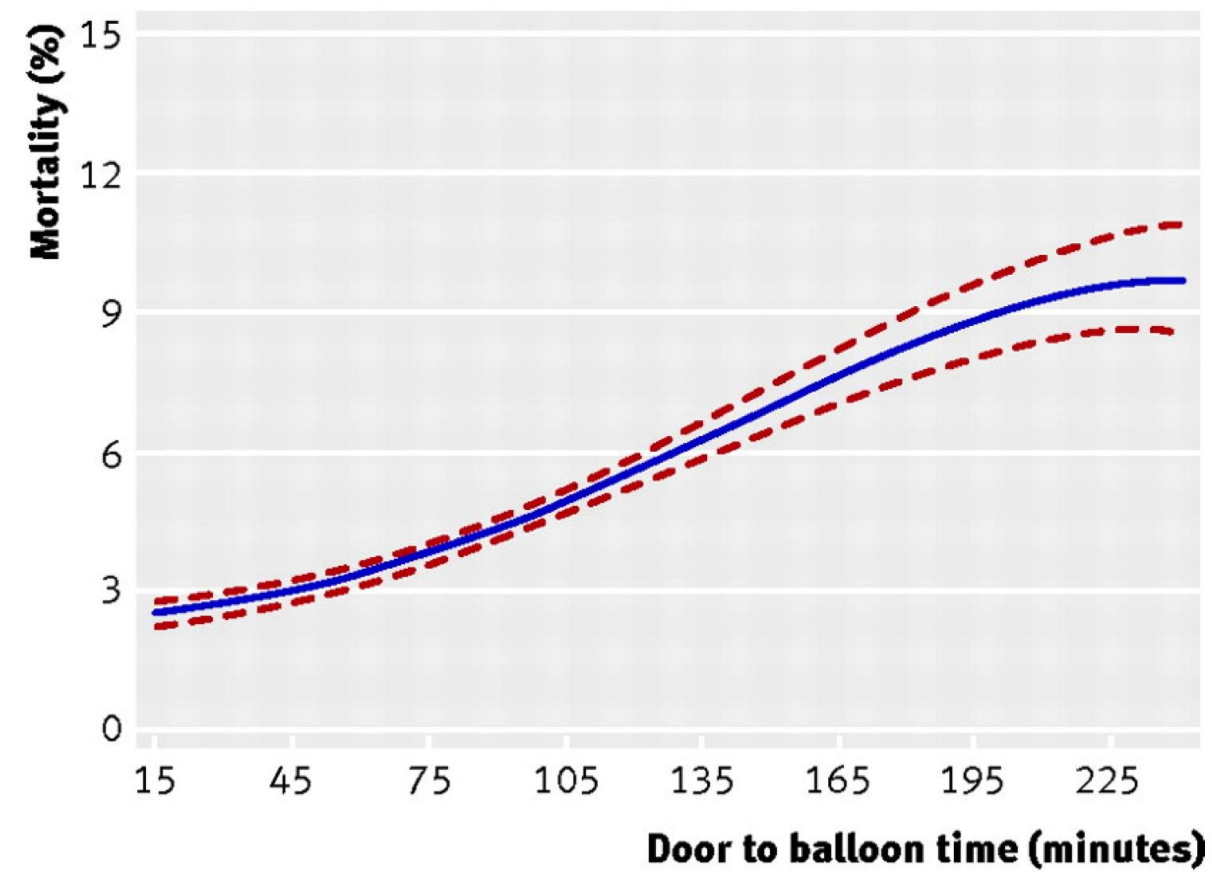
43801 patients

D2B Time and Mortality

Y = 2.86 ($\pm$ 1.46) + 0.0045X^1 + 0.000043X^2

p < 0.001
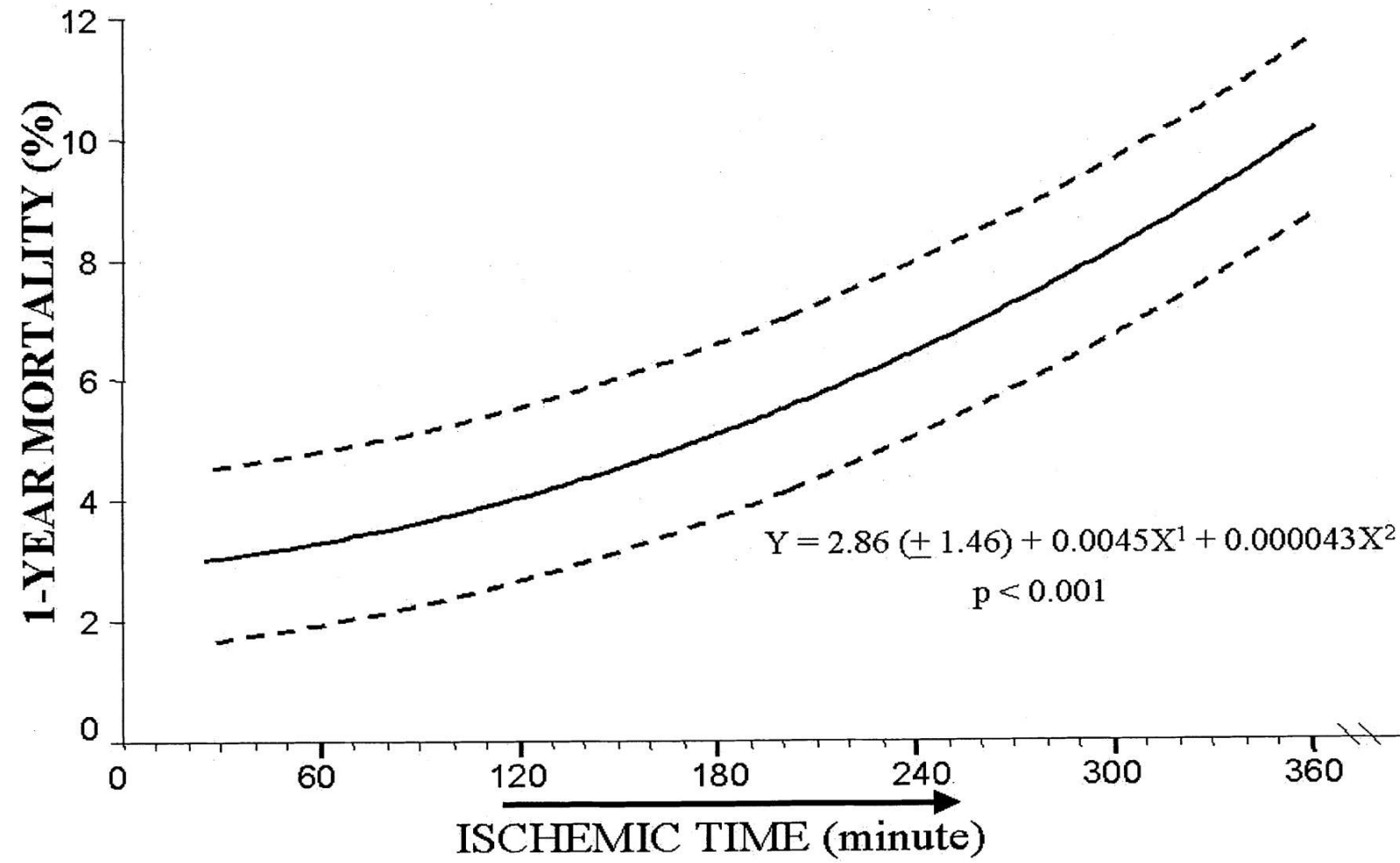
1791 patients

Twelve-Lead ECG Interpretation by EMS

Potential Challenges

- Equipment costs/maintenance
- Training costs
- Accuracy/False-positive rates

Accuracy/False Positive Activations

- 107 paramedics; Written test with 5 chest pain scenarios
- Diagnosis – Sensitivity = 92.6%; Specificity = 85.4%
- Cath Lab activation – Sensitivity = 88%; Specificity = 88.3%; False-positive rate = 8.1%
- STEMI Cases – 94.1% correct dx; 91% appropriate activation
- Non-STEMI Cases – 14.9% called STEMI; 12.0% inappropriate activations
- "Chest pain alert" not different than activating the Cardiac Cath Lab

Real World Performance

- 2014 – 1,933 patients from Los Angeles from 2008–2009 – 7.8% false-positive activations
- 2007 – 1,335 patients from Minneapolis 2003-2006 – 9.2% false-positive activations
- 2012 – 411 patients; 411 STEMI activations by emergency physicians……

Real World Performance

….. 36% false-positive activations. What?!!!

Reasons –
1. Structural heart disease
2. CHF
3. LVH
4. Hx of CAD
5. Prior illicit drug use
6. High BMI
7. Angina

Real World Performance

2012 – 2008-2009 in North Carolina

3,973 Cardiac Cath Lab activations (29% by EMS, 71% by emergency physicians)

85% were deemed appropriate with 76.9% receiving PCI

Re-interpretations – 15% (6% of EMS)

Not a CCL candidate – 28%

Delay at the Scene?

- 21,742 patients evaluated for CP in the field
- Scene times increased from 19 min 10s to 19 min 20s with a pre-hospital 12-lead ECG
- Transport time was increased by 12 s
- In STEMI patients, a pre-hospital 12-lead ECG shortened scene time from 19 min 31 s to 17 min 51 s and transport time from 13 min 31 s to 12 min 34s

D2B Time Improvement with EMS Diagnosis

San Diego

- Consecutive patients from 1/2005 – 6/2006 with field activation were evaluated
- Control group consisted of consecutive STEMI patients who presented to the ED
- D2B times EMS Activation – 73 +/- 19 minutes
- D2B times ER Activation – 141 +/- 49 minutes
- Patients who achieved D2B < 90 minutes = 80% field STEMI, 25% ER STEMI

Before and After - Canada

- 24-month period; 95 patients pre- and 80 patients post-implementation
- E2B was <90 minutes increased from 28.4% to 91.3% post-implementation
- False-positive activation = 12.4%

ACTION Registry

- From 1/2007 – 12/2007 a total of 12,097 STEMI patients were logged
- 7,098 utilized EMS; 1,941 of these patients received a pre-hospital 12-lead ECG
- D2N times were 19 min vs 29 min
- D2B times were 61 min vs 75 min
- Mortality was trending towards significant with an OR of 0.80 (CI 0.63 to 1.01)

Direct Transfer to a PCI Center

- Between 5/2005 – 4/2006, 344 consecutive STEMI patients were enrolled
- 135 directly from the field and 209 from the ERs (transfer)
- Median D2B time for field patients = 69 minutes (43-87 min)
- Median D2B time for ER patients (transfer) = 123 minutes (101-153 min)
- D2B <90 minutes achieved in 79.7% of field patients and 11.9% of ER patients (transfer)
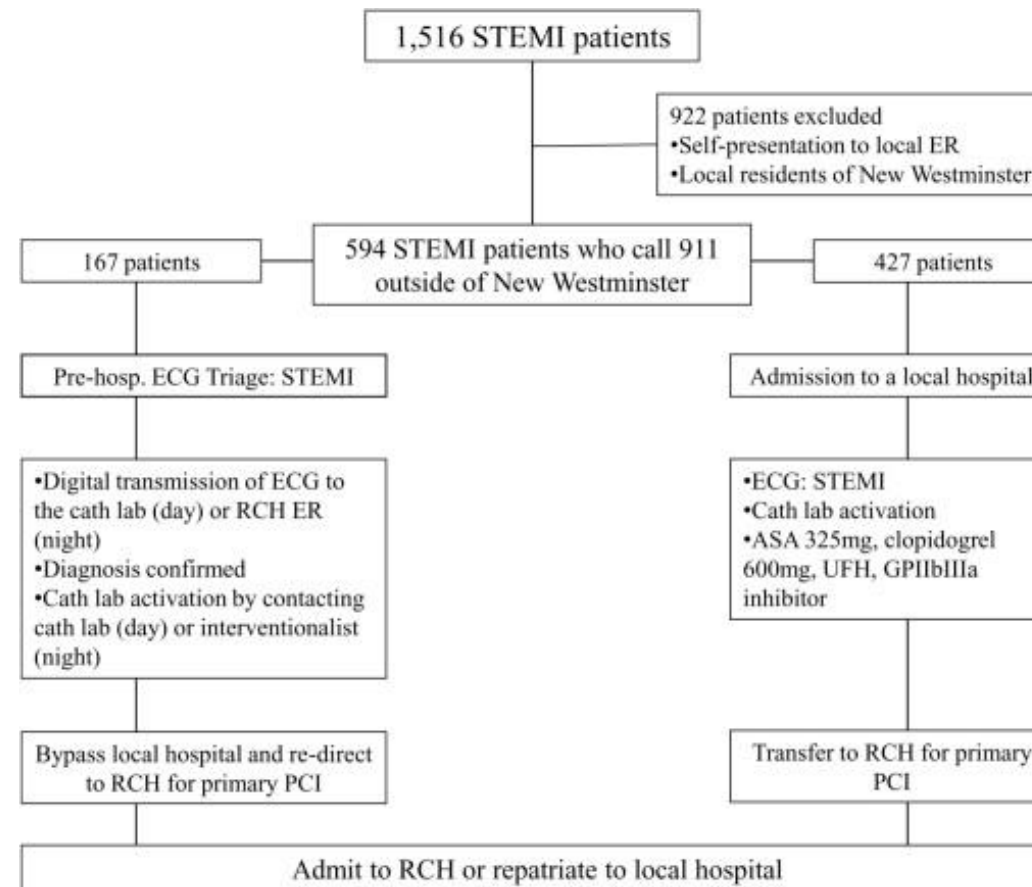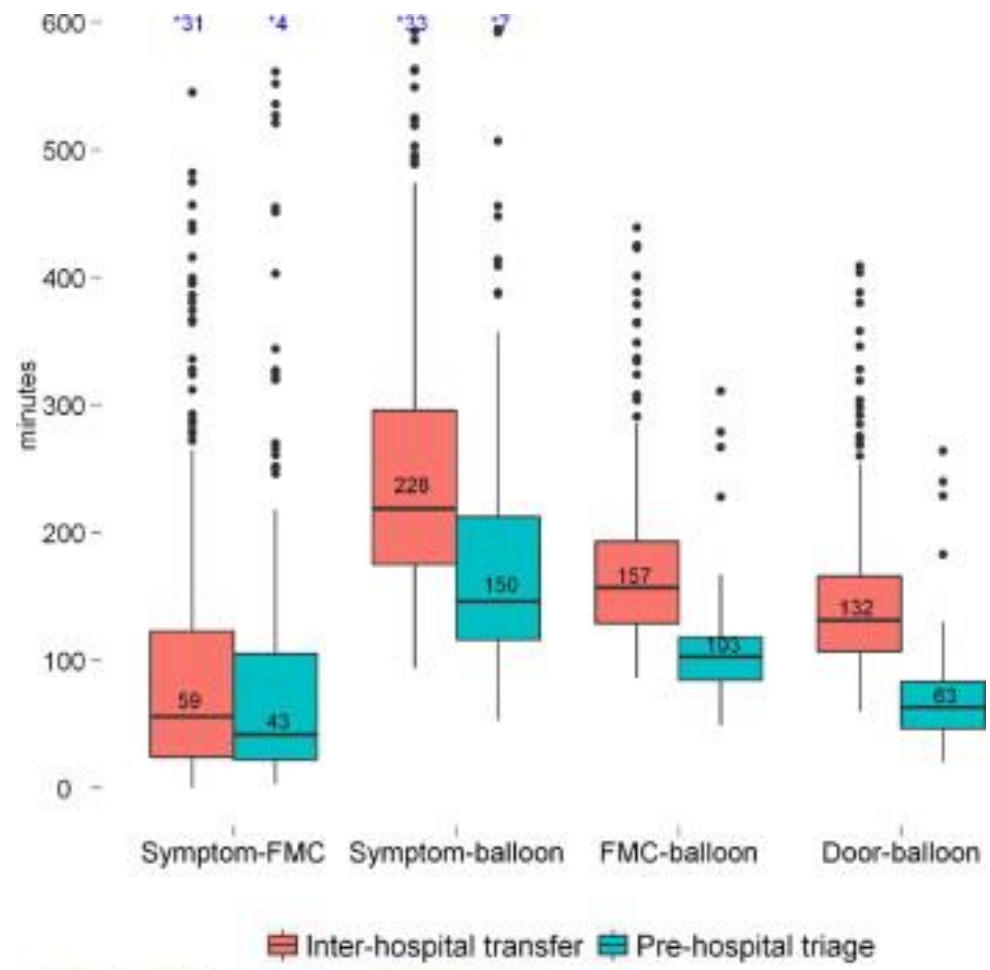
30-Day MACE

Multivariate Analysis (n=267)

Predictors 30-day MACE MACE	Univariate Analysis	Multivariate Anlalysis	Pts 30-day MACE
Age>80 years	2.6	4.9	
Killip Class 4	13.4	18.5	
S2DT (mins)			
Quartile 1=77−133	1.0	1.0	1.6%
Quartile 2=134−171	4.8	6.8	7.1%
Quartile 3=172−242	9.6	17.6	13.2%
Quartile 4=243−1567	7.6	13.9	10.8%

Mortality Improvement?
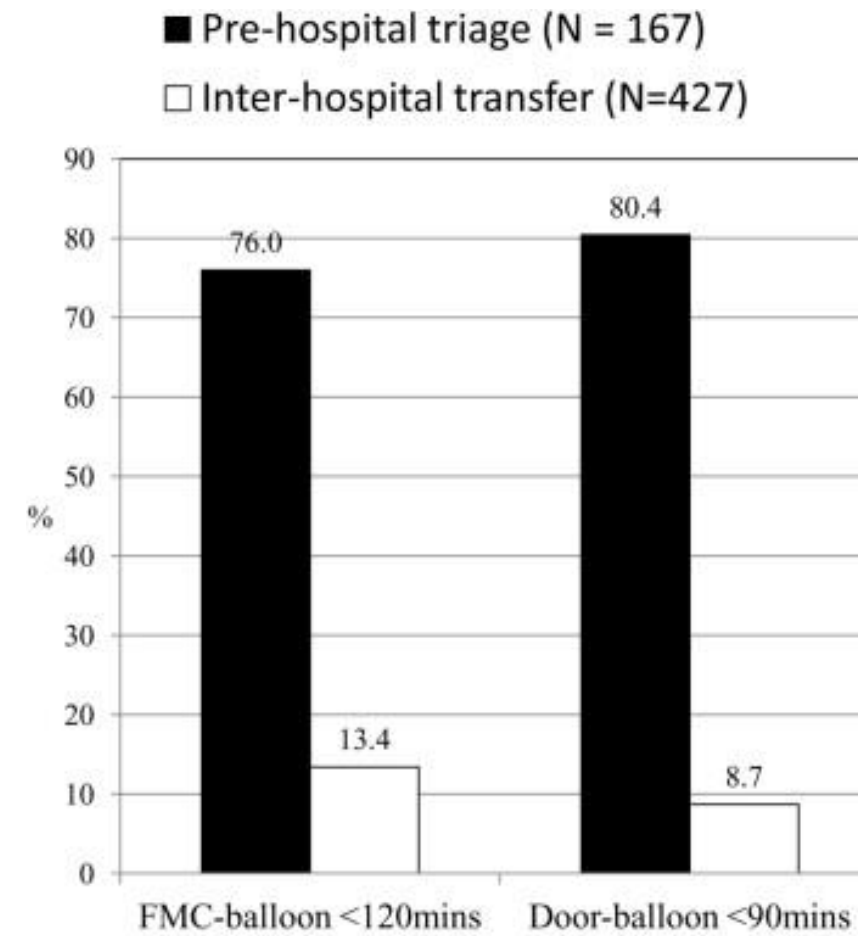
Mortality Improvement?
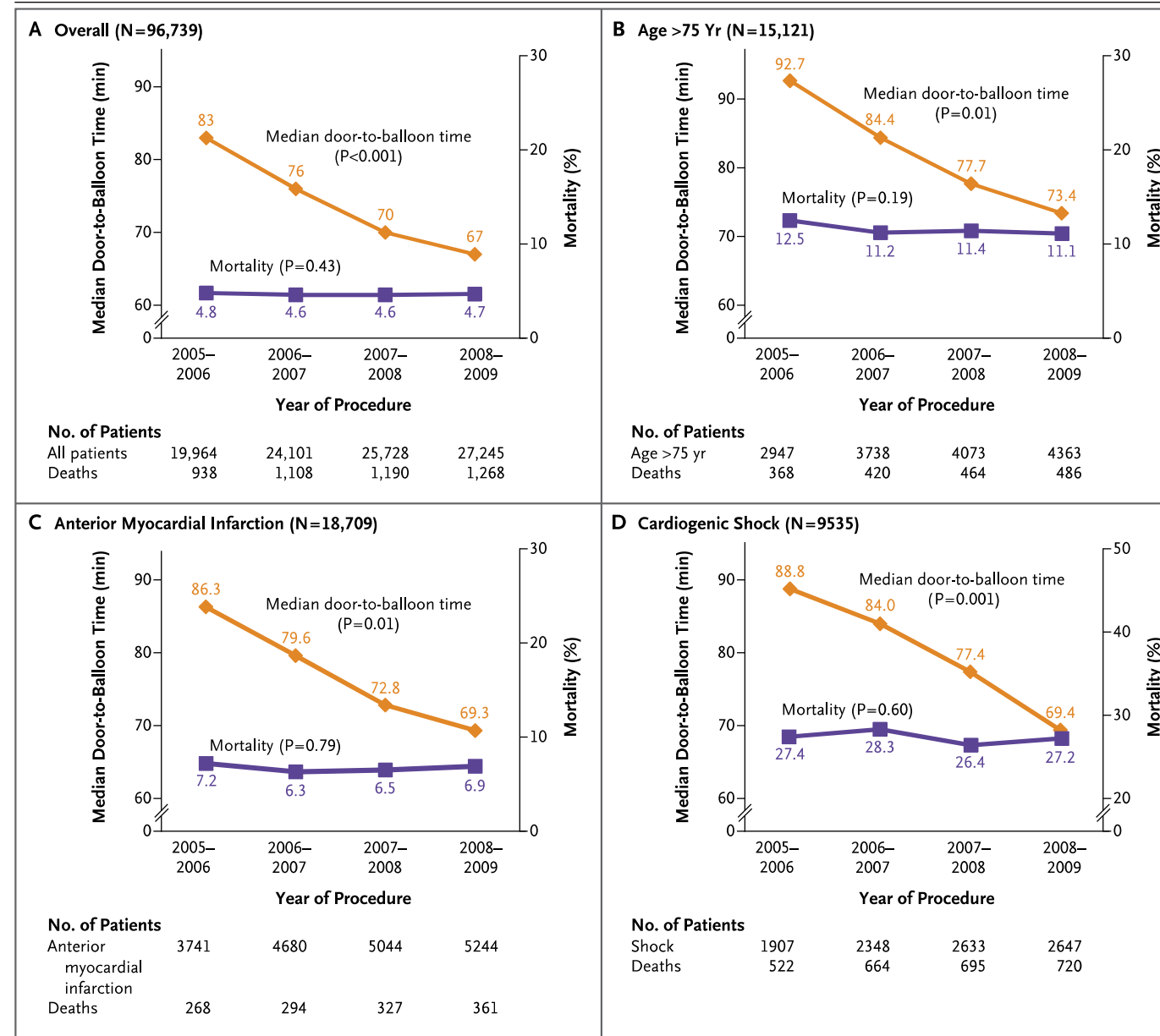
Mortality Improvement?
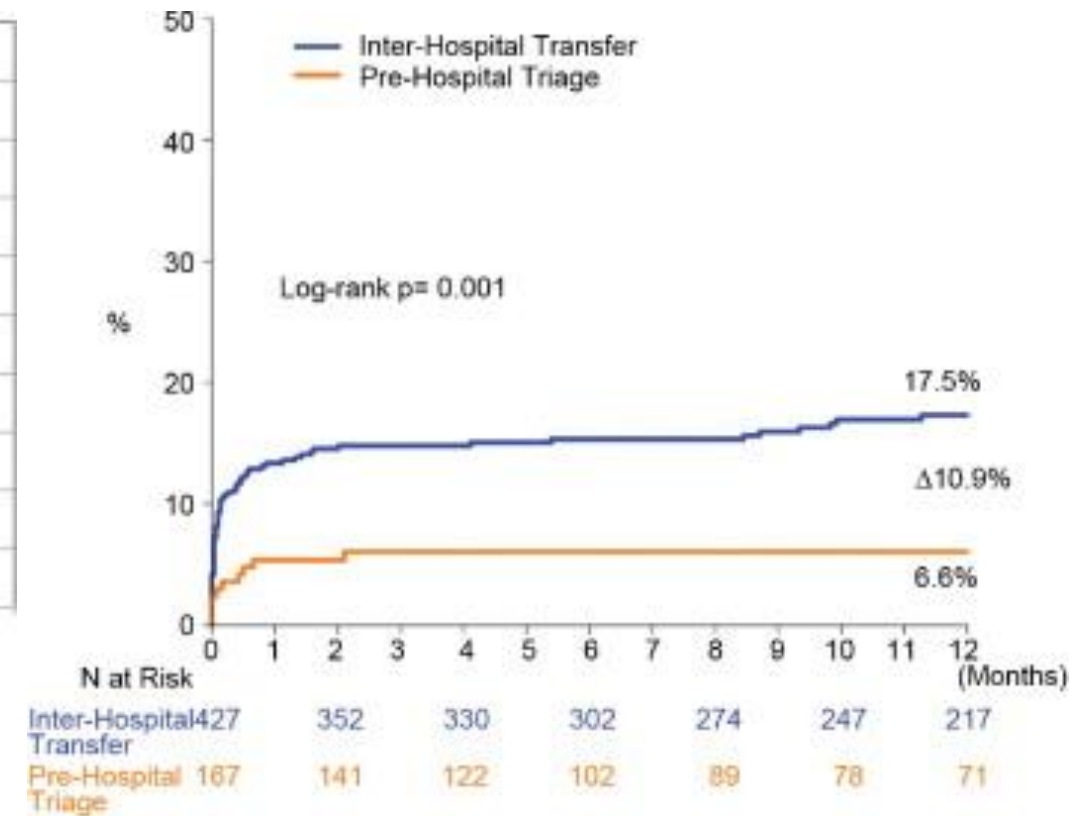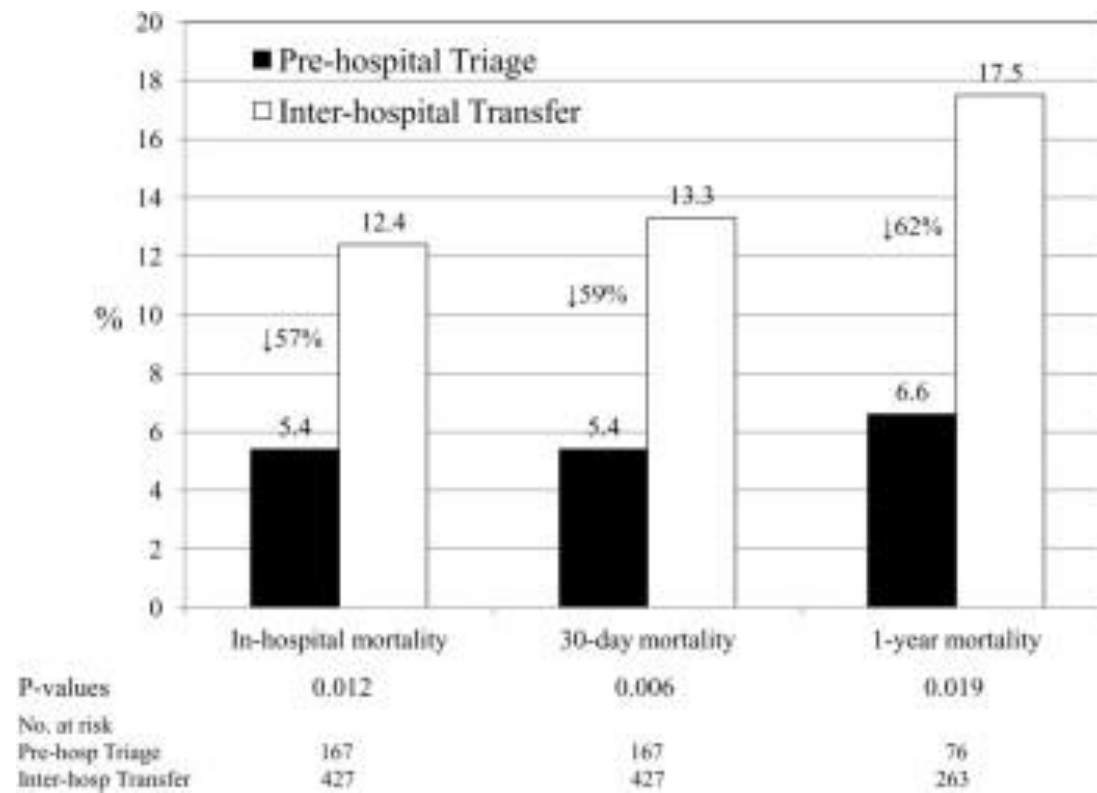
A Potential Limit...

D2B Time and Mortality
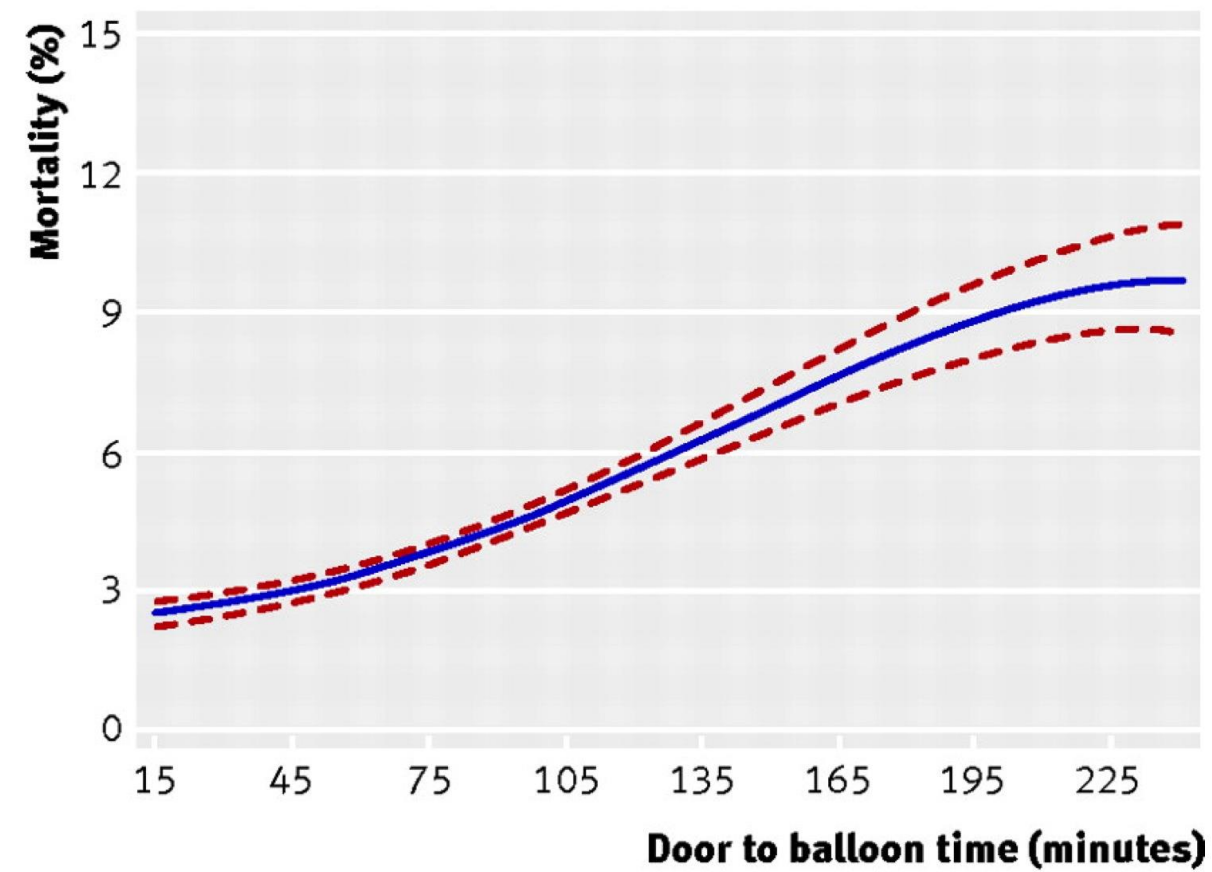
43801 patients

British Registry

Registry Specifics

- 288,990 total ACS patients from 2005-2009
- Pre-hospital ECG in 145,247
- None in 91,827
- Unknown 51,916

Registry Outcomes

	Prehospital ECG (n = 102,831)	No Prehospital ECG (n = 51,715)	Adjusted OR (95% CI)
All Patients	7.4%	8.2%	0.94 (0.91-0.96)
STEMI Patients	8.6%	11.4%	0.94 (0.90-0.98)
Reperfused STEMI Patients	7.3%	9.4%	0.94 (0.89-1.00)
Non-STEMI Patients	5.9%	6.5%	0.84 (0.81-0.88)

Home Grown Evidence

Mission:Lifeline SD/ND/MN

- From 2012-2015, ACTION-GTWG STEMI patients were reviewed who received PPCI
- 1,101 Interfacility Transfer, 376 Direct Transport
- 1,078 Pre-hospital ECG, 308 w/o pre-hospital ECG
- D2B in DT vs. IT – 79 vs. 145 min.
- Transfer time in PH ECG vs. No ECG – 40 vs. 55 min.
- The DT and PH groups had a statistically significant less risk of in-hospital CGS, CHF, cardiac arrest and death.

Polish Experience

Nationwide Registry

- Direct Transfer patients demonstrated a lower 1-year mortality rate, 9.6% vs. 10.4% for IF Transfer patients.

PreACT

PreACT Algorithm
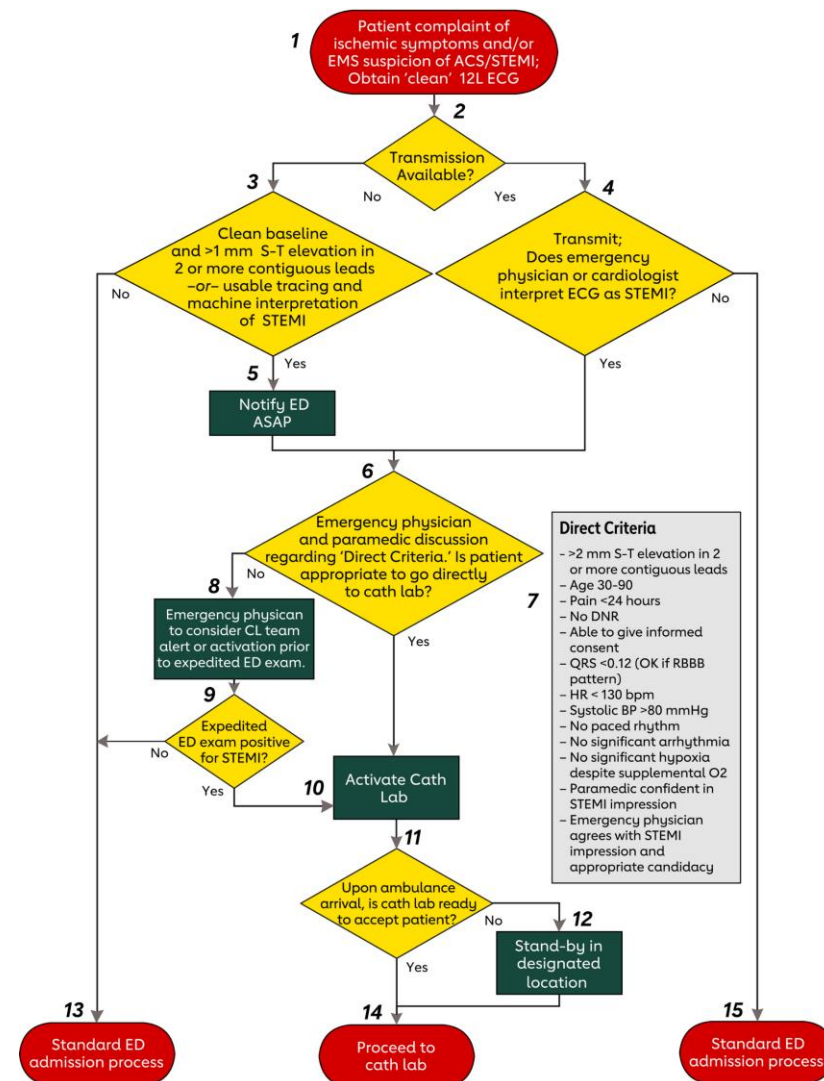
PreACT Direct Inclusion/Exclusion

- Paramedic confident in STEMI diagnosis
- ER physician and/or cardiologist is confident in the STEMI diagnosis
- Patient ability to consent
- No do not resuscitate
- ECG meets stringent STEMI criteria; QRSd <0.12 ms; No ventricular pacing; No dysrhythmias
- Patient age evaluation (very young versus very old)
- Chest pain <24 hours
- SBP >80 mmHg; HR <130; No significant hypoxia

THANK YOU

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