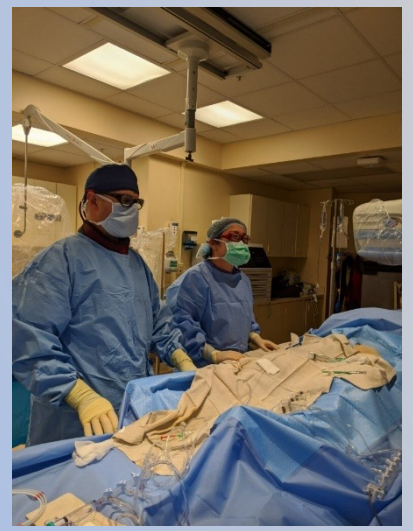
The Dramatic History of Evolving Acute STEMI Treatment

And or OHCA and future possibilities



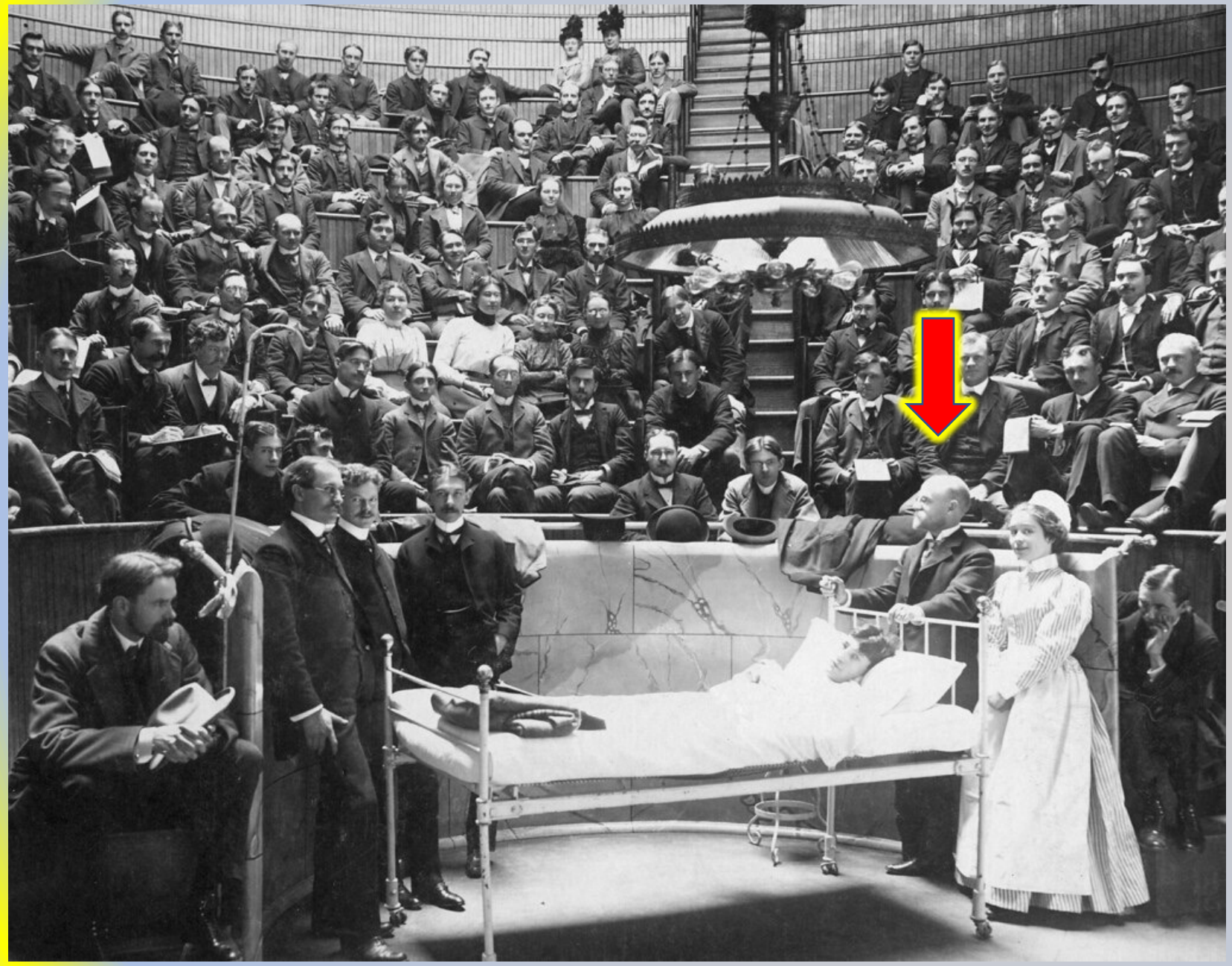
STATE OF JEFFERSON
OR
CA
STEMI System

Brian W. Gross, MD, FACC, FAHA

March 3, 2023


AK
YT
NT
NU
Canada
BC
AB
SK
MB
WA
OR
MT
ID
ND
ON
QC
NL
WY
SD
MN
CA
UT
WI
United States
MI
NB
AZ
ME
NS
NY
NM
MO
IN
OH
PA
MA
OK
AR
KY
WV
DE
TX
TN
NC
LA
AL
GA
Mexico
FL
Cuba
Guatemala
Puerto Rico
Nicaragua
Venezuela
Colombia
Guyana
RR
AP
CE
PB
Greenland
Iceland
Sweden
Norway
Ukraine
United Kingdom
Austria
Ireland
Italy
Spain
Tunisia
Libya
Portugal
Algeria
Niger
Western Sahara
Mali
Mauritania
Ghana
Guinea
State of Jefferson STEMI Program
aka ASSET (Acute ST Segment Elevation Taskforce)

1912



JAMES B. HERRICK, MD

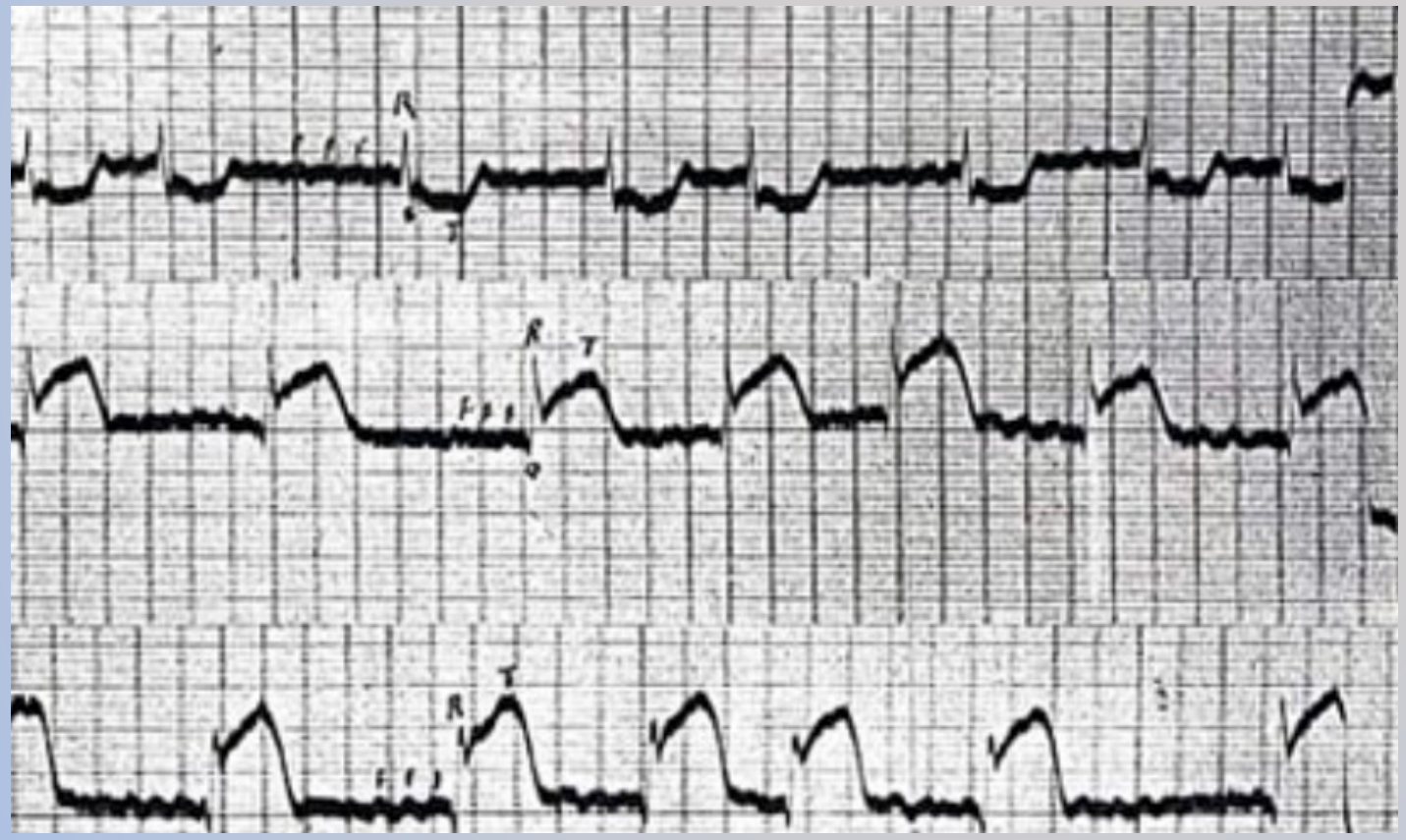
1910
SICKLE CELL DISEASE

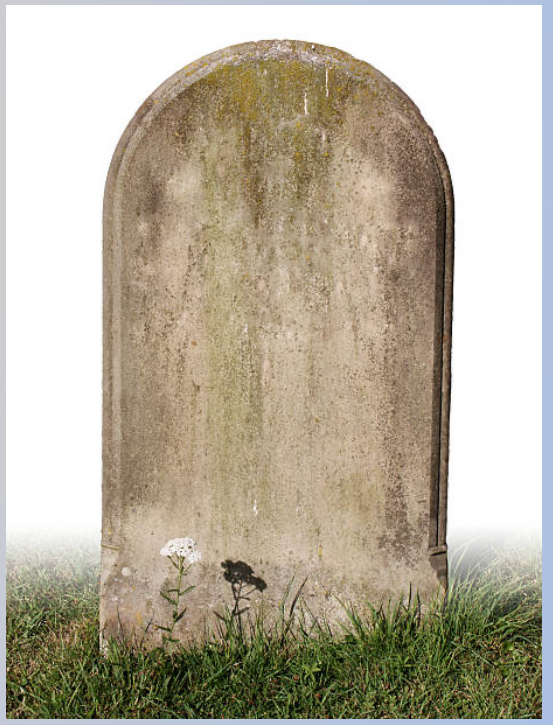
1912 JAMA
MI ACUTE THROMBOSIS

The Evolution of STEMI Care

1920

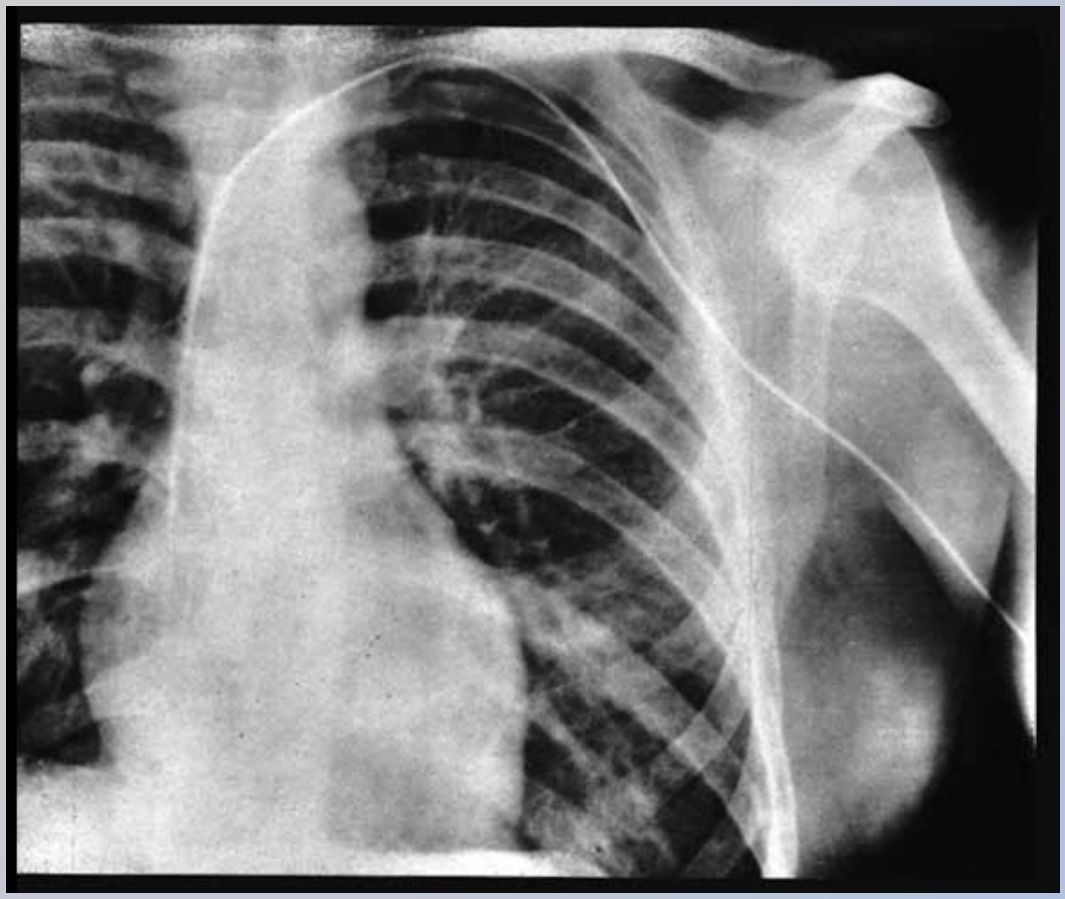
Harold Pardee: An electrocardiographic sign of coronary artery obstruction. Arch Int Med 1920;26:244-257





The Evolution of STEMI Care

1929 Werner Forssmann



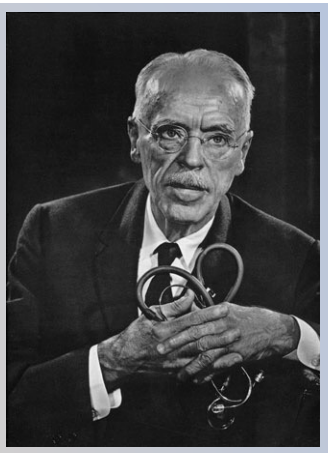
1955

The NEW ENGLAND JOURNAL of MEDICINE
NEJM 2005;353:1205-7

PERSPECTIVE

Eisenhower's Billion-Dollar Heart Attack — 50 Years Later

Franz H. Messerli, M.D., Adrian W. Messerli, M.D., and Thomas F. Lüscher, M.D.



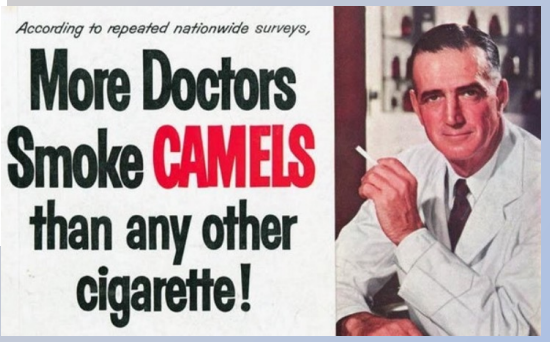
Dr. Paul Dudley White

Sept 1955…
12 hours of "Heart Burn…" then 12 more hours of same Dx after initial eval before MI Dx and admission to Fitzsimmons Hosp… 6 week hospitalization

The President who warned us of the Military Industrial Complex, sewed the seeds of the Medical Industrial Complex

Wall Street panicked. The Dow Jones

plunged 6.5%, 32 points… to 455



The Evolution of STEMI Care

1950's + 1960's

OCT. 30, 1958:
MEDICAL OOPS
LEADS TO FIRST
CORONARY
ANGIOGRAM

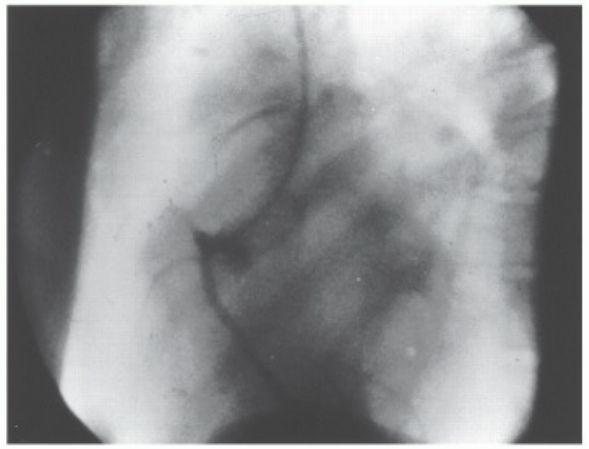
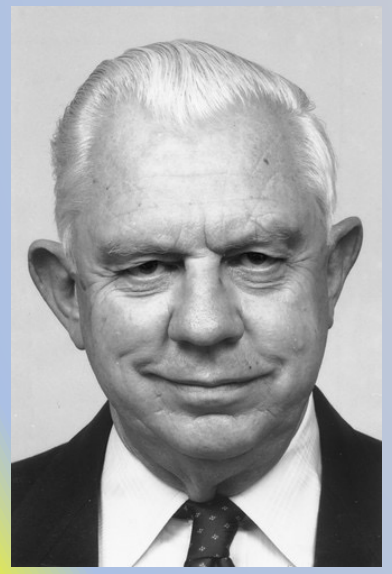


Figure 15.1 Cine frame from the first selective coronary arteriogram taken by F. Mason Sones, MD, on October 30, 1958. (Reprinted with permission from Ryan TJ. The coronary angiogram and its seminal contribution to cardiovascular medicine over five decades. *Circulation* 2002;106:752-756.)

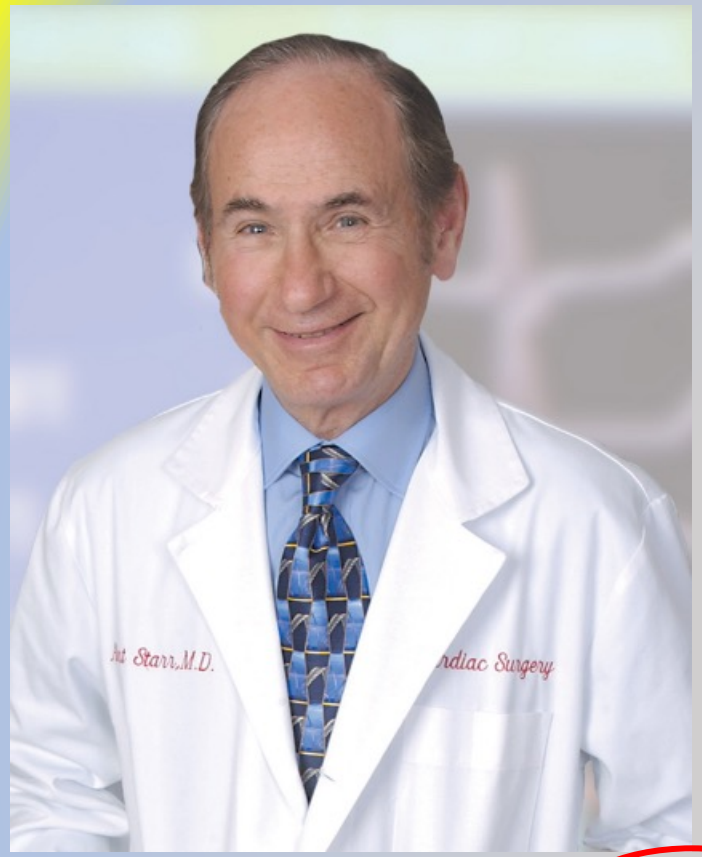


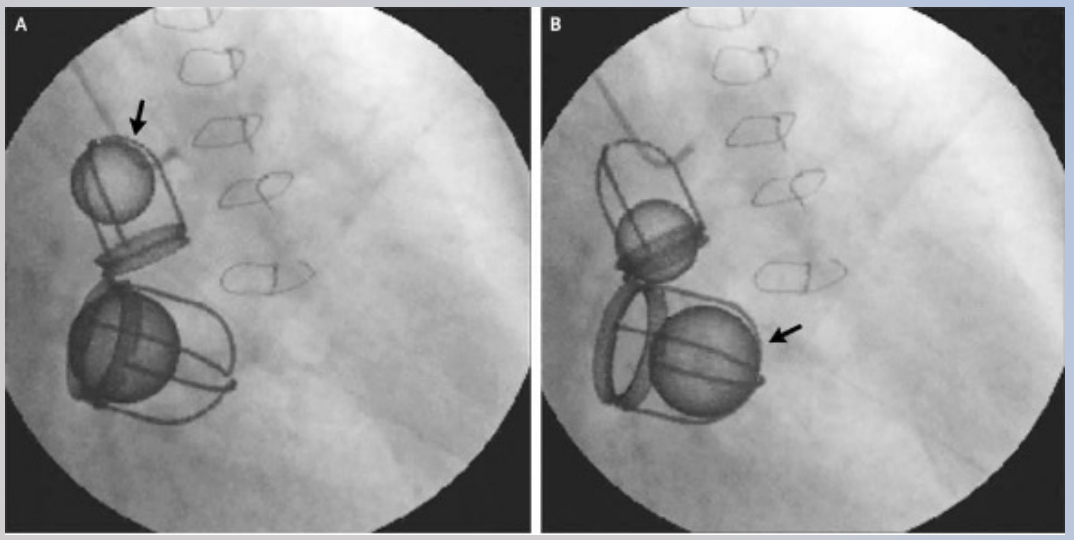
Dr Harold Dodge
1950's-60's
LV volumes, SV, EF, & LV Mass

Dr. Mason Sones

The Evolution of STEMI Care

1960





Dr. Albert Starr

By 1960, after a series of modifications, Edwards and Starr had perfected an effective and durable prosthetic valve. Starr developed the surgical procedure for inserting the prosthesis, and he performed the first successful mitral valve replacement in September 1960. Within a year, he and Edwards had invented and successfully inserted aortic valve prostheses into patients. The Starr-Edwards prosthetic valve was a revolutionary breakthrough that would remain the standard for over three decades.

The Evolution of STEMI Care

Robert H. Goetz: The Surgeon Who Performed the First Successful Clinical Coronary Artery Bypass Operation

1960

Igor E. Konstantinov, MD

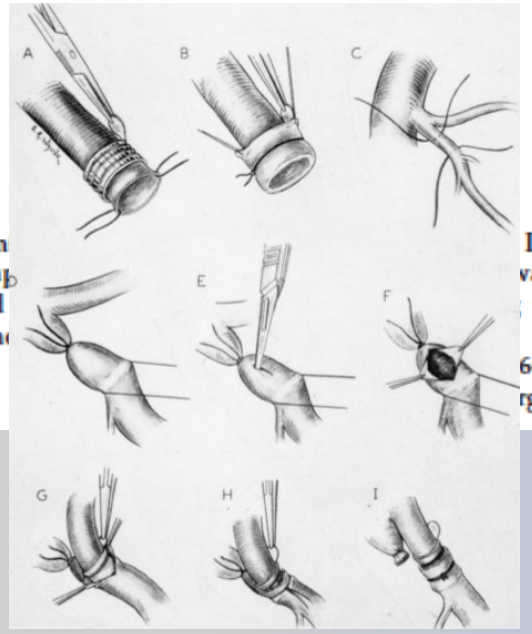
Division of Cardiovascular Surgery, Mayo Clinic, Rochester, Minnesota

Robert H. Goetz performed the first successful clinical coronary artery bypass operation on May 2, 1960. He used a nonsuture technique to connect the right internal thoracic artery to the coronary artery by means of a modified Payr's cannula made of tantalum. The patency of the anastomosis was demonstrated angiographically and the

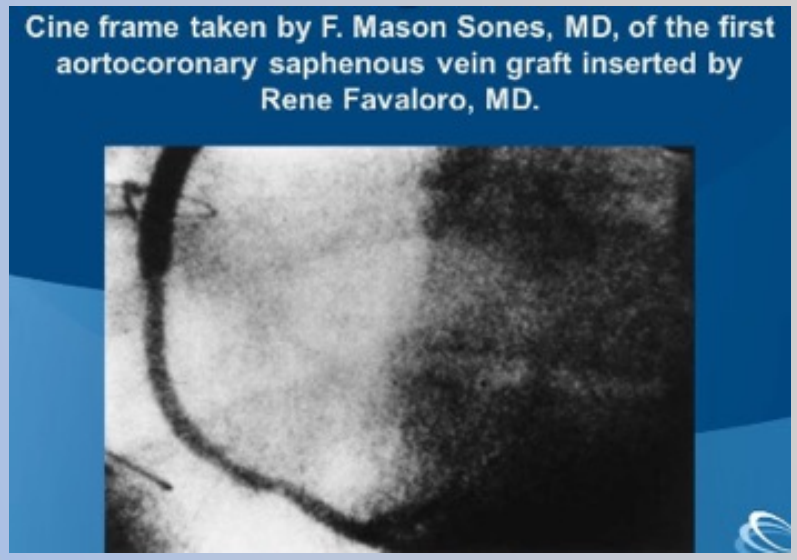
patien
an imp
ahead
was n

It was
vas far
work

66–72)
rgeons



RIMA to LAD



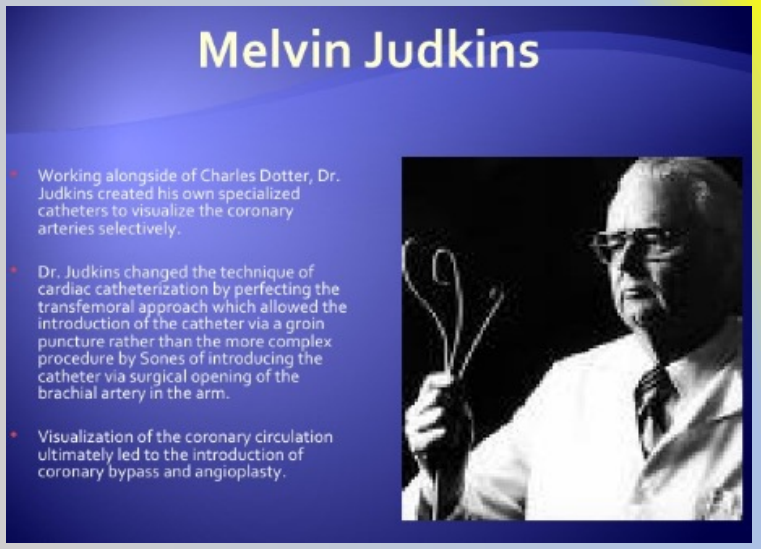
Dr. Kolesov 1964
Russia

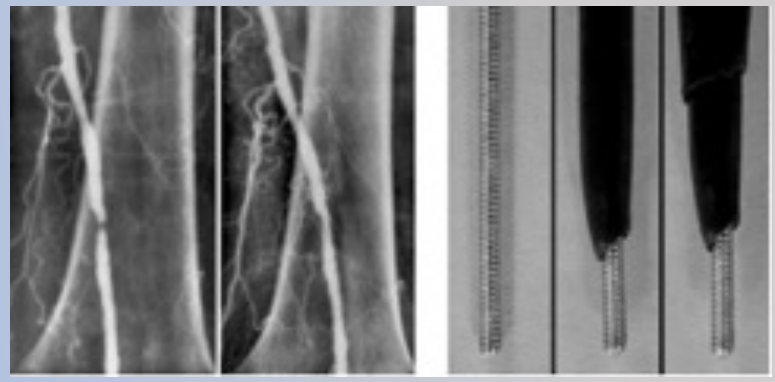
Dr Favaloro (Argentinian at Cleveland Clinic Nov 30, 1967 SVG to RCA

1960's

Charles Dotter, MD in LIFE Magazine, August 1964

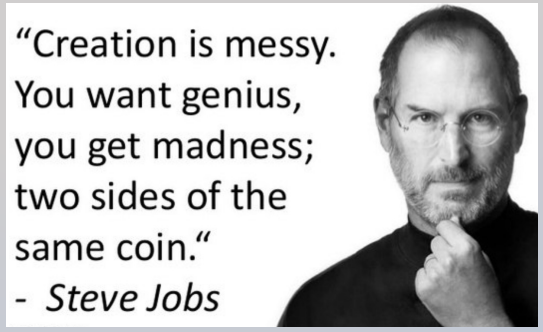
The Evolution of STEMI Care





Before After

82 yo woman at OHSU with gangrenous toes.
She refused foot amputation at OHSU.
He utilized Teflon tubing



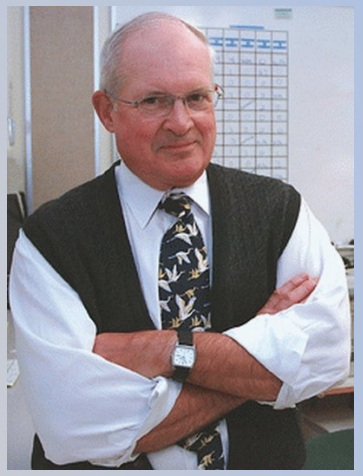
1960's + 1970's

The Evolution of STEMI Care

CCUs and Mobile CCUs

1969 Seattle's First Medic 1

Dr. Leonard Cobb



Dr. Michael Copass

1964

1979

The New England Journal of Medicine

Volume 301 JULY 12, 1979 Number 2

NONOPERATIVE DILATATION OF CORONARY-ARTERY STENOSIS

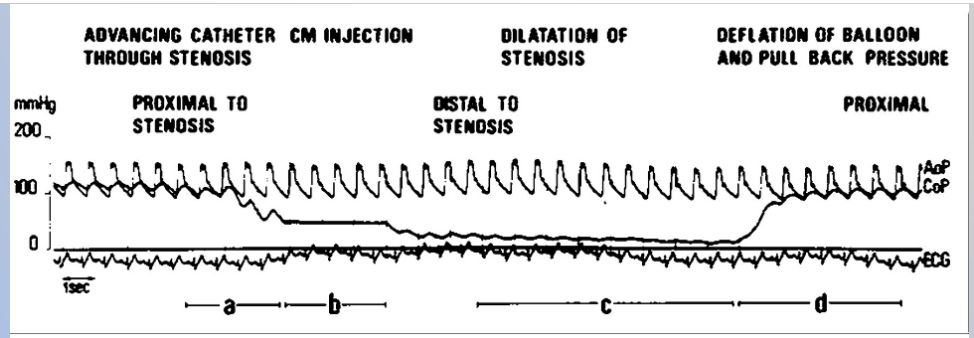
Percutaneous Transluminal Coronary Angioplasty

ANDREAS R. GRÜNTZIG, M.D., ÅKE SENNING, M.D., AND WALTER E. SIEGENTHALER, M.D.

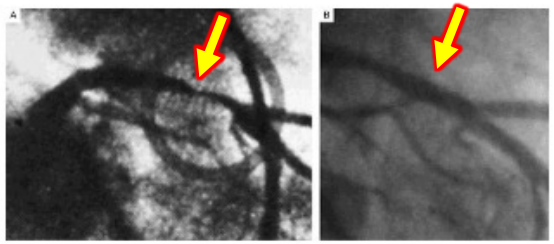
Abstract In percutaneous transluminal coronary angioplasty, a catheter system is introduced through a systemic artery under local anesthesia to dilate a stenotic artery by controlled inflation of a distensible balloon.

Over the past 18 months, we have used this technic in 50 patients. The technic was successful in 32 patients, reducing the stenosis from a mean of 84 to 34 per cent ($P<0.001$) and the coronary-pressure gradient from a mean of 58 to 19 mm Hg ($P<0.001$). Twenty-nine patients showed improvement in cardiac function during follow-up examination. Because of acute deterioration in clinical status, emergency bypass was later necessary in five patients; three showed electrocardiograpic evidence of infarcts.

Patients with single-vessel disease appear to be most suitable for the procedure, and a short history of pain indicates the presence of a soft (distensible) atheroma likely to respond to dilatation. We estimate that only about 10 to 15 per cent of candidates for bypass surgery have lesions suitable for this procedure. A prospective randomized trial will be necessary to evaluate its usefulness in comparison with surgical and medical management. (N Engl J Med 301:61-68, 1979)

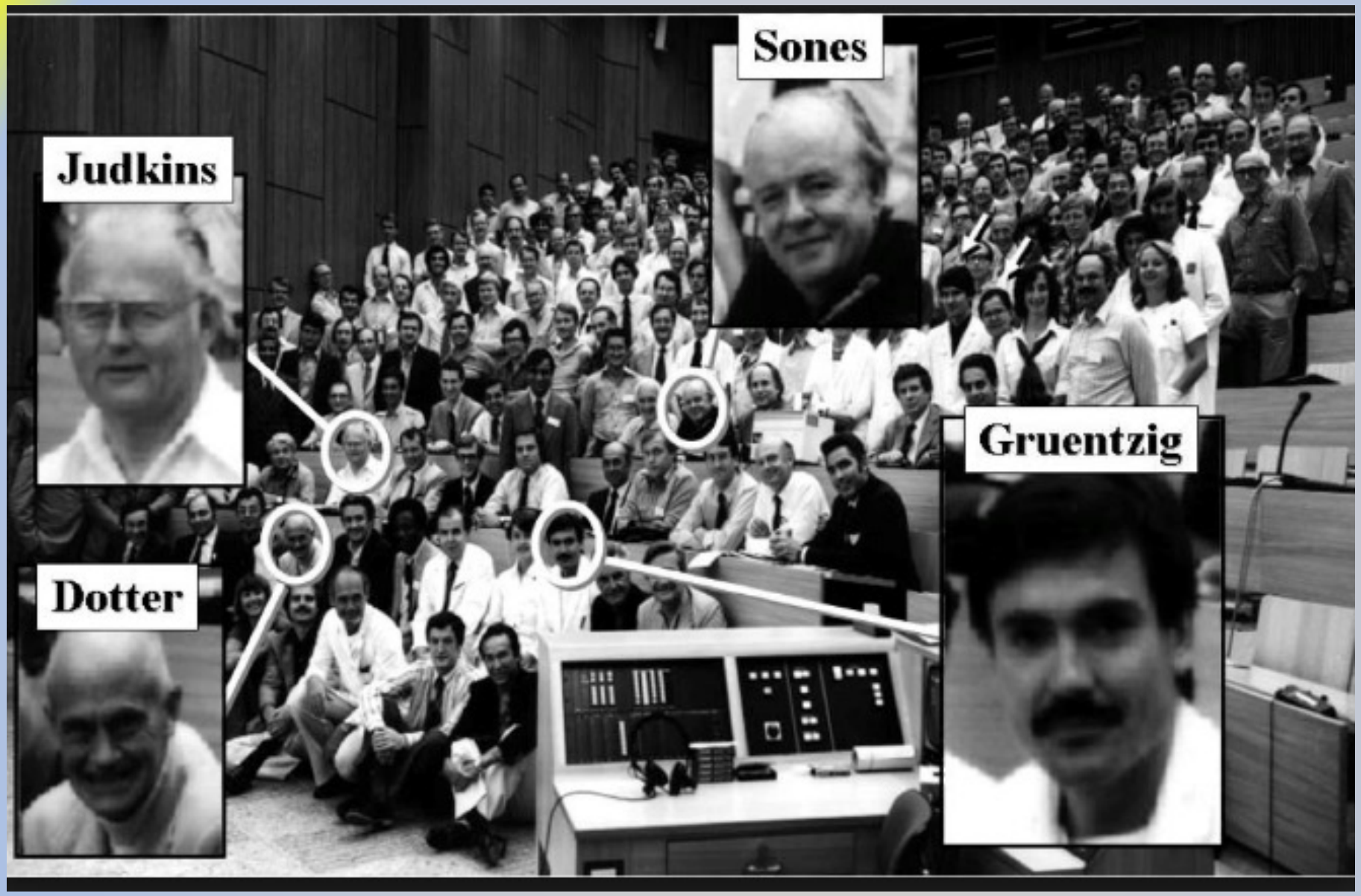


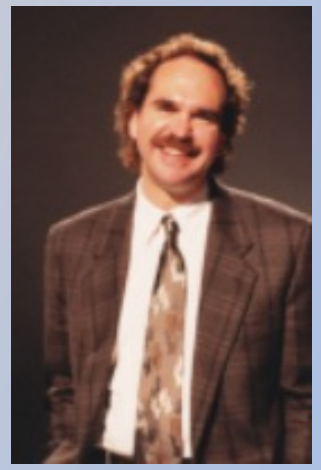
Andreas Gruntzig



Coronary Angiograms Obtained in a Patient before Coronary Angioplasty, in 1977 (Panel A), and in 2000 (Panel B).

Early 1980's





Geoff Hartzler MD

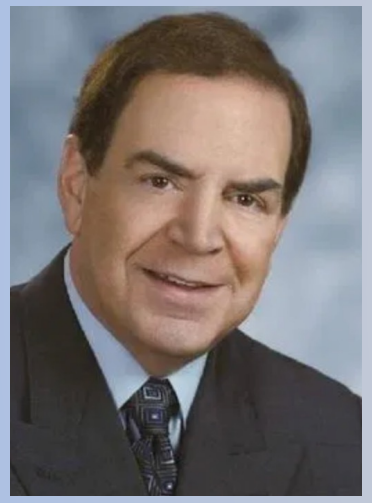
1980

ORIGINAL ARTICLE ARCHIVE

Prevalence of Total Coronary Occlusion during the Early Hours of Transmural Myocardial Infarction

The NEW ENGLAND JOURNAL of MEDICINE

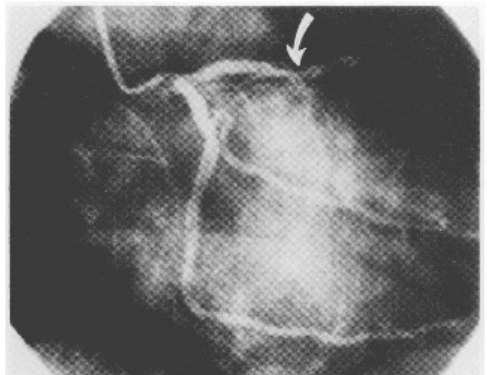
Marcus A. DeWood, M.D., Julie Spores, C.R.N.A., Robert Notske, M.D., Lowell T. Mouser, M.D., Robert Burroughs, M.D., Michael S. Golden, M.D., and Henry T. Lang, M.D.



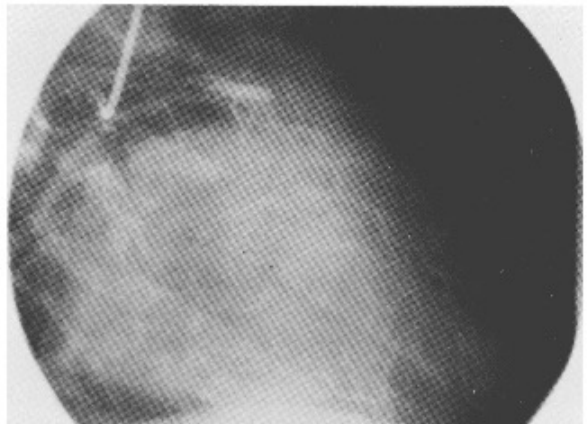
Abstract

To define the prevalence of total coronary occlusion in the hours after transmural myocardial infarction, we used coronary arteriography to study the degree of coronary obstruction in 322 patients admitted within 24 hours of infarction. Total coronary occlusion was observed in 110 of 126 patients (87 per cent) who were evaluated within four hours of the onset of symptoms; this proportion decreased significantly, to 37 of 57 (65 per cent), when patients were studied 12 to 24 hours after the onset of symptoms. Among 59 patients with angiographic features of coronary thrombosis, the thrombus was retrieved by Fogarty catheter in 52 (88 per cent) but was absent in seven (12 per cent false positive). Among an additional 20 patients without angiographic features of thrombosis, a thrombus was discovered in five (25 per cent false negative). Thus, total coronary occlusion is frequent during the early hours of transmural infarction and decreases in frequency during the initial 24 hours, suggesting that coronary spasm or thrombus formation with subsequent recanalization or both may be important in the evolution of infarction. (N Engl J Med. 1980; 303:897–902.)

Figure 3.

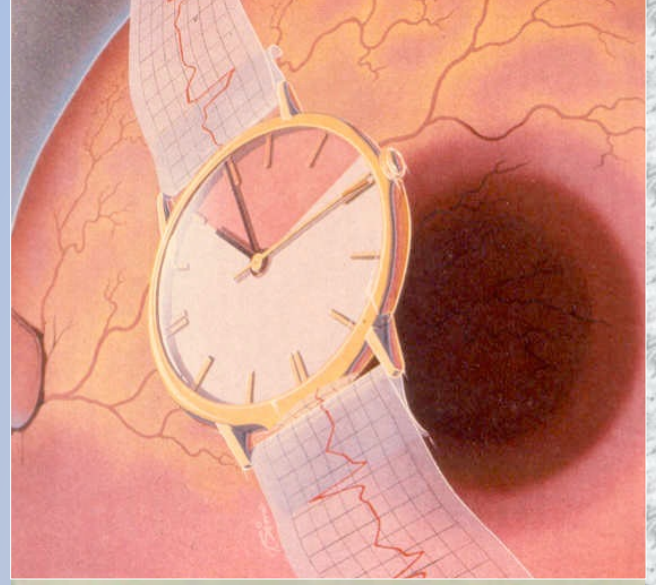


The Evolution of STEMI Care



Angina

STEMI



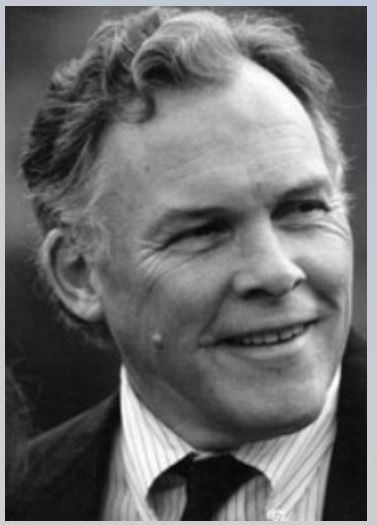
Heart Muscle
Dies Quickly
When Deprived
of a Blood Supply

Time is Muscle

1983

J. Ward Kennedy

Intacoronary Streptokinase



The Evolution of STEMI Care

The NEW ENGLAND JOURNAL of MEDICINE

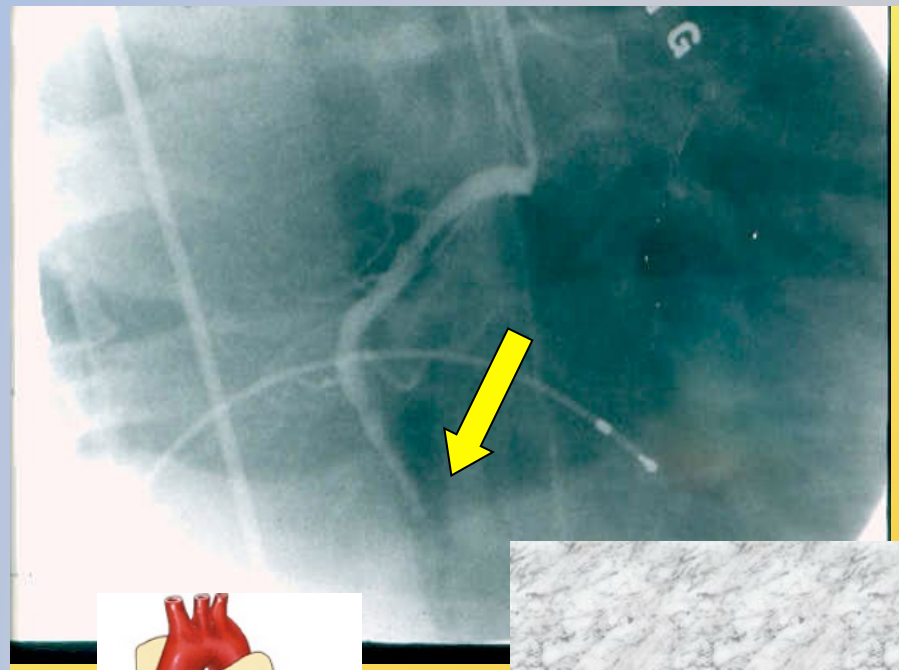
WESTERN WASHINGTON RANDOMIZED TRIAL OF INTRACORONARY STREPTOKINASE IN ACUTE MYOCARDIAL INFARCTION

J. WARD KENNEDY, M.D., JAMES L. RITCHIE, M.D., KATHRYN B. DAVIS, PH.D., AND JAMES K. FRITZ, M.D.

Abstract Two hundred fifty patients were enrolled in a multicenter, community-based study of the efficacy of intracoronary streptokinase thrombolysis in acute myocardial infarction; 134 were randomly assigned to streptokinase therapy and 116 were controls. All patients underwent left ventricular angiography and coronary arteriography before the random assignment.

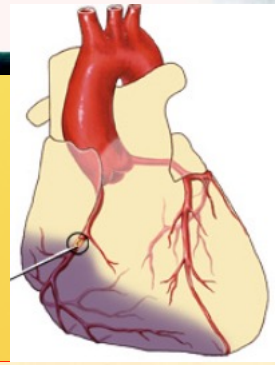
The mean time from the onset of symptoms to hospitalization was 134±144 minutes (S.D), and the mean time to random assignment was 276±185 minutes. Coronary reperfusion was achieved in 68 per cent of the streptokinase-treated group. The overall 30-day mortality was 18 (7.2 per cent); there were five deaths in the streptokinase-treated group (3.7 per cent) and 13 in the control group (11.2 per cent, $P<0.02$). Fifteen of the 18 deaths occurred in patients with anterior infarction.

Intracoronary streptokinase therapy resulted in a nearly threefold reduction in the 30-day mortality after hospitalization for acute myocardial infarction. (N Engl J Med 1983; 309:1477-82.)



Intracoronary Streptokinase

1982 - the first catheter based revascularization in Medford…and perhaps Oregon



The NEW ENGLAND JOURNAL of MEDICINE

The Evolution of STEMI Care

September 2, 1993
N Engl J Med 1993; 329:673-682

1993

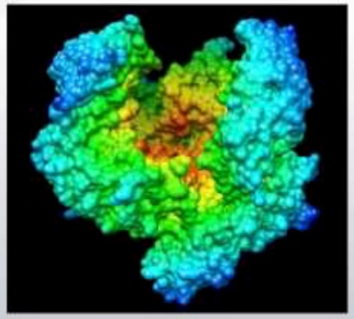
An International Randomized Trial Comparing Four Thrombolytic Strategies for Acute Myocardial Infarction

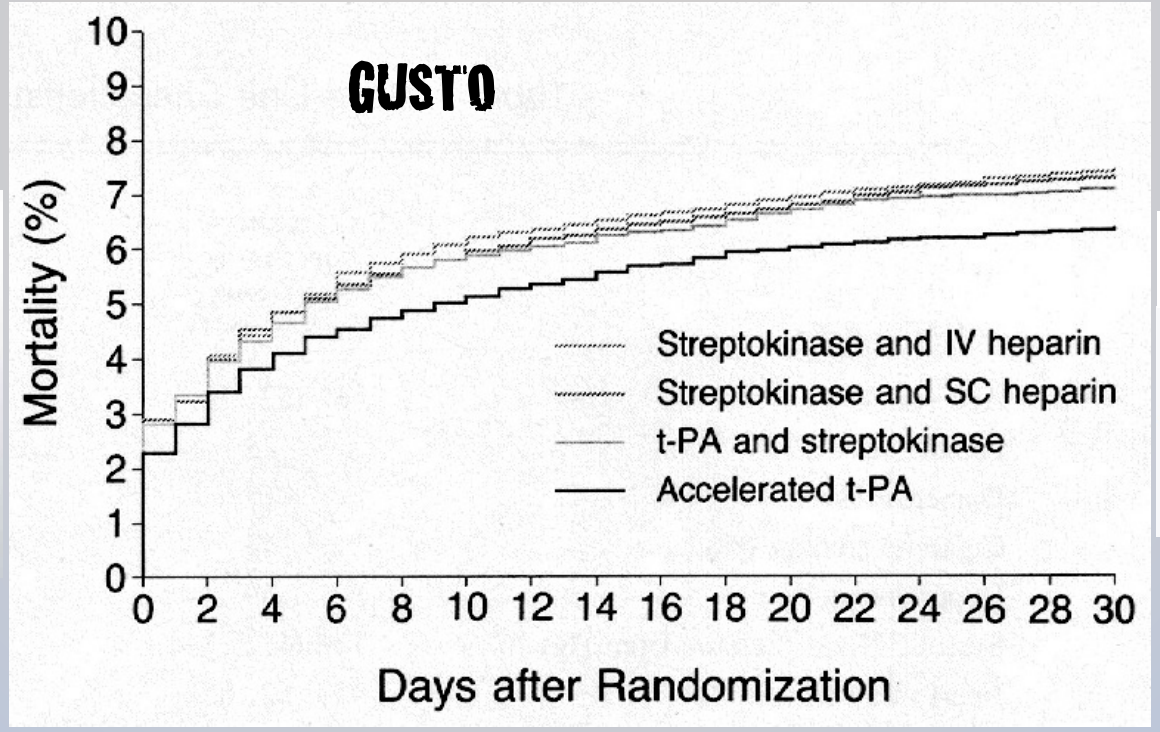
The GUSTO Investigators*

The 1993 Global Utilization of Streptokinase and Tissue Plasminogen Activator for Occluded Coronary Arteries (GUSTO) trial randomized 41,021 patients with ACS at 1,081 hospitals to SK+heparin sub-q, SK+heparin IV, rapid administration of "accelerated" tPA+heparin IV, or a combination of SK+tPA+heparin IV (with a slower administration of the tPA). The group receiving tPA+heparin had a 1% absolute risk reduction of death at 30 days over both SK+heparin groups (6.3% vs 7.2% and 7.4%; NNT 100). The tPA+heparin group had more hemorrhagic strokes and bleeding. Therapy with tPA+SK+heparin did not confer a survival benefit over SK+heparin.

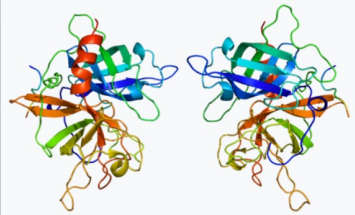
GUSTO Trial

Streptokinase





tPA



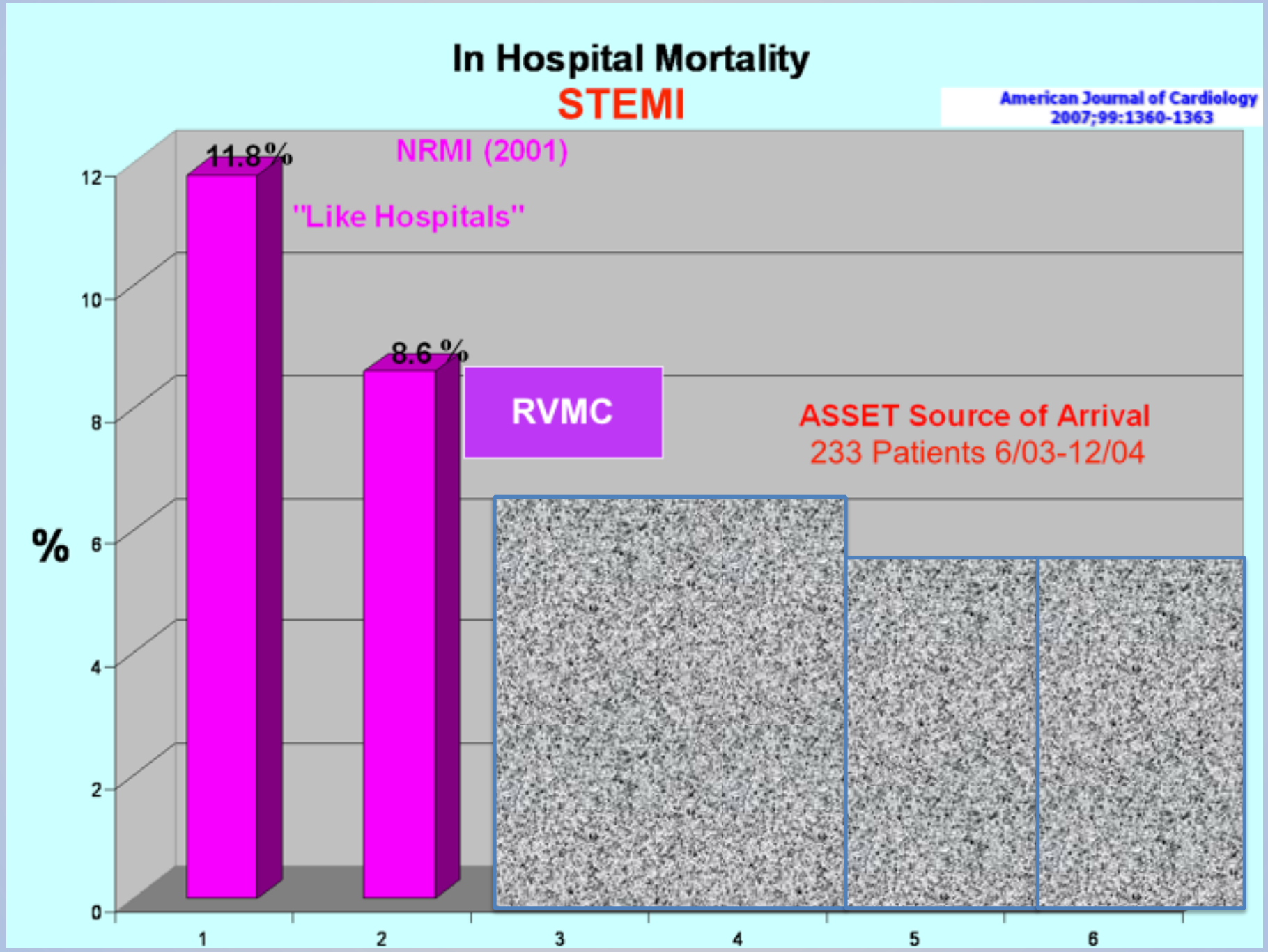
Interventions

1990-2022

BMS 1994

DES 2002

2003-2004


In Hospital Mortality
STEMI
American Journal of Cardiology
2007;99:1360-1363
NRMI (2001)
"Like Hospitals"
11.8%
8.6 %
RVMC
ASSET Source of Arrival
233 Patients 6/03-12/04
%
0
2
4
6
8
10
12
1
2
3
4
5
6

2007

The American Journal of Cardiology

Acknowledgment: We thank Karen A. Bales, RN, BSN, Dr. Douglas Burwell, Dr. Nicholas Dienel, Dr. John Forsyth, Dr. Gary Foster, Dr. Michael Fugit, Dr. Mark Huth, Dr. Ken Lightheart, Dr. David Martin, Dr. Minor Mathews, Dr. Brian Morrison, Dr. Bruce Patterson, Dr. Eric Pena, Dr. Brad Personious, Dr. Richard Schaefer, Mercy Flights, American Medical Response, Ashland Fire & Rescue, Rogue River Fire District, Northern Siskiyou Ambulance, Medford Fire Department, Jackson County Fire District #3, Rogue Valley Medical Center and PCI team, Providence Medford Medical Center, Ashland Community Hospital, Three Rivers Community Hospital, Fairchild Medical Center, Jane Sawall, RN, CNS, Heather Freiheit, RN, BSN, and Jo Jacavone, RN, MS.

An Approach to Shorten Time to Infarct Artery Patency in Patients With ST-Segment Elevation Myocardial Infarction

Brian W. Gross, MD[a,*], Kent W. Dauterman, MD[a], Mark G. Moran, MD[b], Todd S. Kotler, MD[b], Stephen J. Schnugg, MD[a], Paul S. Rostykus, MD, MPH[c], Amy M. Ross, PhD, RN, CNS[d], and W. Douglas Weaver, MD[e]

We developed a regional strategy to decrease the time to percutaneous coronary intervention (PCI) for patients with acute ST-segment elevation myocardial infarction (STEMI). Protocols were created for paramedics and referring hospitals to identify and directly triage all patients with STEMI to a single PCI center. Time to PCI reperfusion an
mortality were assessed in 233 consecutive patients with STEMI. Ninety-
hospital door-to-patent infarct artery was achieved in 58.3% of paramedic-d
directly triaged patients compared with 37.5% of "walk-ins" to the PCI hosp
only 5.2% of those transferred from another hospital emergency depa
$p < 0.001$). Overall in-hospital mortality was 2.1%, 0% in paramedic identified
0% in those walk-ins to the PCI hospital ED compared with 4.3% for thos
from a referring hospital ED ($p = 0.007$). Paramedic diagnosis of STEMI and
to a prealerted interventional hospital for primary PCI was associated wit
centage of patients achieving <90-minute infarct artery patency. Substanti
mained for those who presented initially to a non-PCI hospital ED despite
protocol. In conclusion, this observational study suggests that wider use
electrocardiographic STEMI diagnosis and direct triage to a prealerted
catheterization team may help improve outcomes of patients with STE
 (Am J Cardiol 2007;99:1360–1363)

May 2007

In 2003 we proposed a heretical approach to STEMI...
Paramedics would diagnose STEMI in the "field" and bypass the closest ER and go directly to the pre-alerted cath lab

2007

ACCF EDUCATIONAL PROGRAMS 2007

EMERGENCY CV CARE 2007: Strategies for Building Regional Integrated STEMI Systems for Reperfusion

June 1–2

Park Hyatt Washington
& Heart House
Washington, D.C.

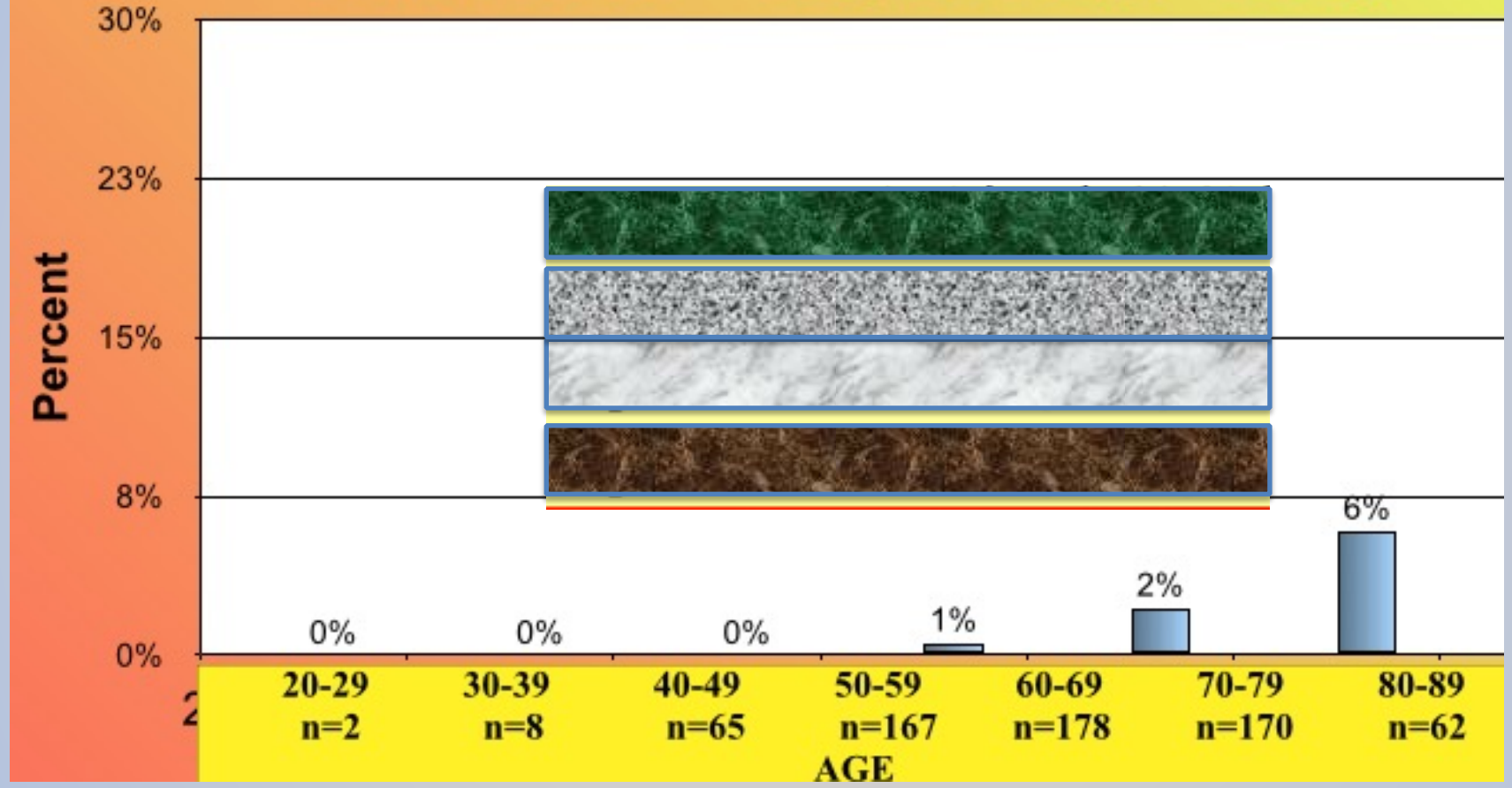
Co-sponsored by
The Duke University School of M
Office of Continuing Medical
DUKE SCHOOL OF MEDICINE

In cooperation with SAEM

Program Co-Directors
Christopher B. Granger, M.D., F.A.C.C.
James Jollis, M.D., F.A.C.C.

2008

ASSET In-Hospital Mortality by Age June 2003 – July 2008 (n=652)



Circ Cardiovasc Qual Outcomes 2009;2;e1-e66
DOI: 10.1161/CIRCOUTCOMES.109.191960

Abstract # 148

2010

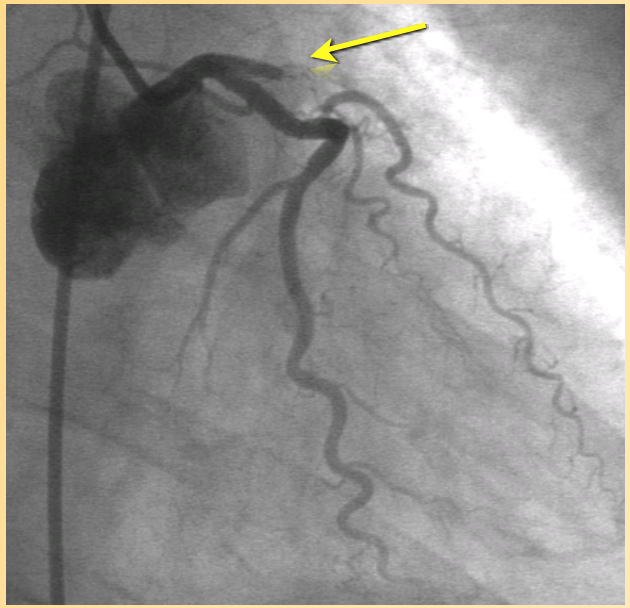
Integration of Pre-Hospital Electrocardiograms and ST-Elevation Myocardial Infarction Receiving Center (SRC) Networks

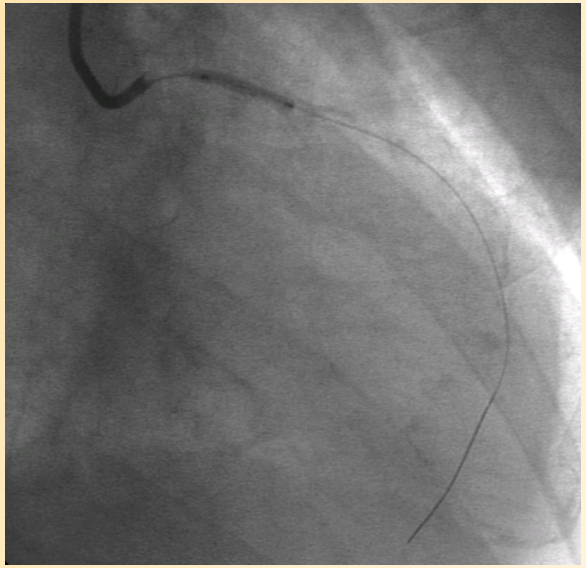
Impact on Door-to-Balloon Times Across 10 Independent Regions

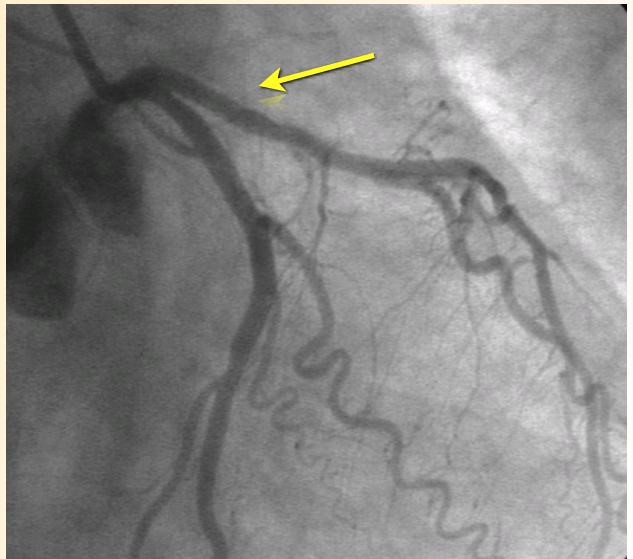
Ivan C. Rokos, MD,* William J. French, MD,† William J. Koenig, MD,‡
Samuel J. Stratton, MD, MPH,§ Beverly Nighswonger, RN,§ Brian Strunk, MD,‖
Jackie Jewell, RN,‖ Ehtisham Mahmud, MD,¶ James V. Dunford, MD,¶
Jon Hokanson, MD,# Stephen W. Smith, MD,** Kenneth W. Baran, MD,††
Robert Swor, DO,‡‡ Aaron Berman, MD,‡‡ B. Hadley Wilson, MD,§§
Akinyele O. Aluko, MD,‖‖ Brian W. Gross, MD,¶¶ Paul S. Rostykus, MD, MPH,##
Angelo Salvucci, MD,*** Vishva Dev, MD,††† Bryan McNally, MD, MPH,‡‡‡
Steven V. Manoukian, MD,§§§ Spencer B. King III, MD‖‖‖

Sylmar, Torrance, Los Angeles, Santa Ana, Greenbrae, San Diego, Ventura, and Thousand Oaks, California; Minneapolis and St. Paul, Minnesota; Royal Oak, Michigan; Charlotte, North Carolina; Medford and Ashland, Oregon; Atlanta, Georgia; and Nashville, Tennessee

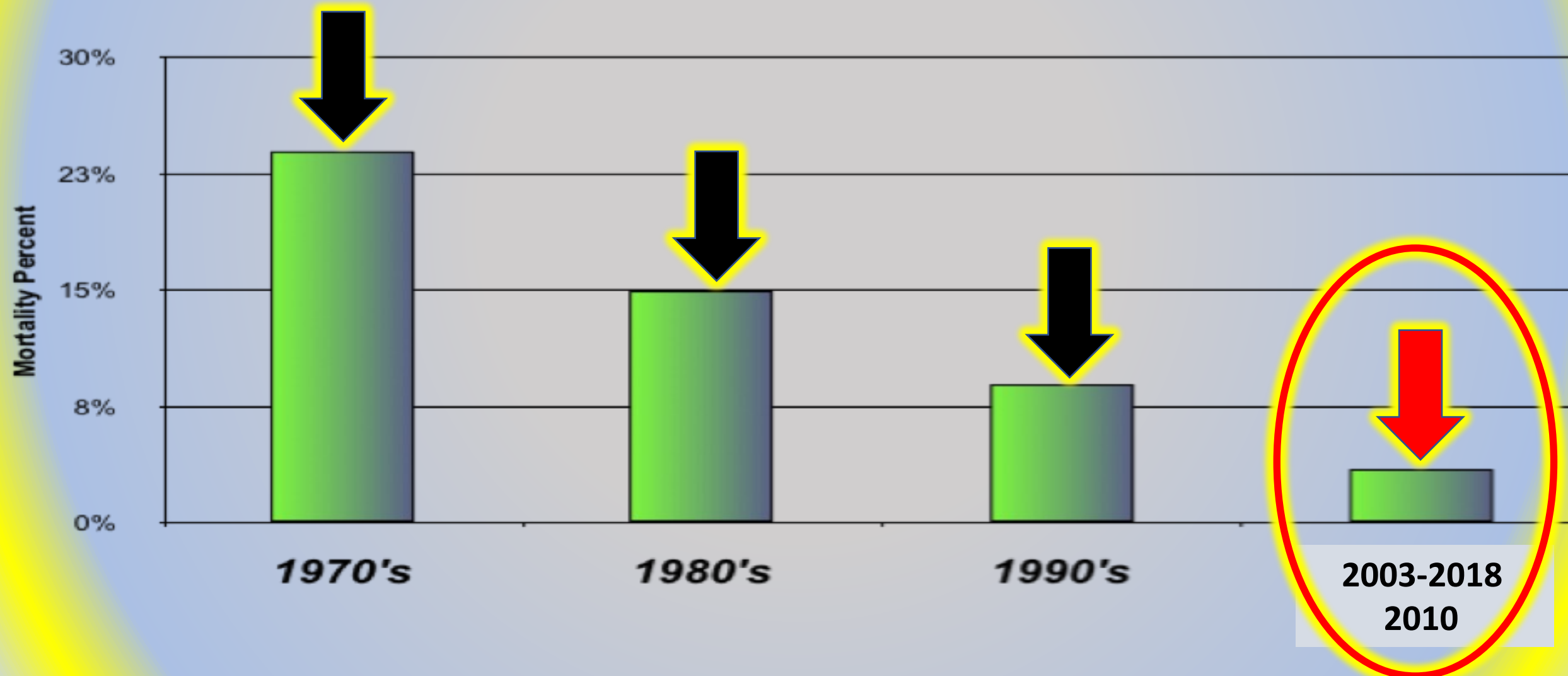
J. Am. Coll. Cardiol. Intv., April 2009; 2: 339 - 346







The History of STEMI Mortality



The Evolution of STEMI Care

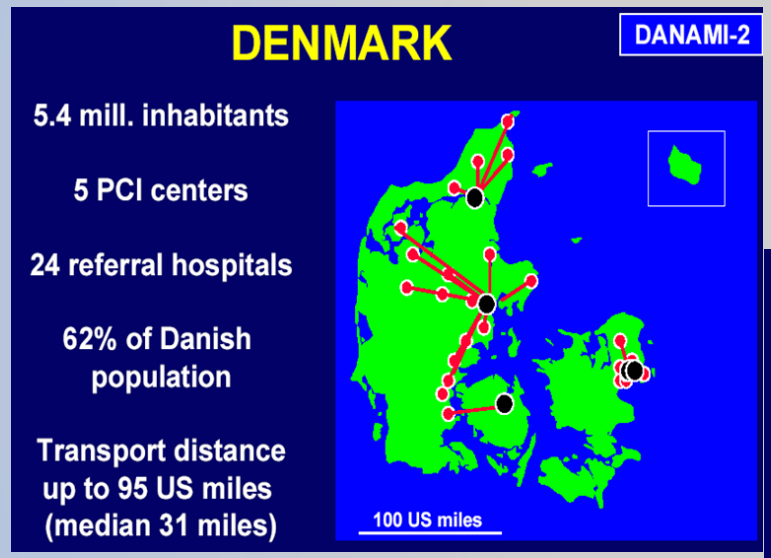
The NEW ENGLAND JOURNAL of MEDICINE

August 21, 2003
N Engl J Med 2003; 349:733-742

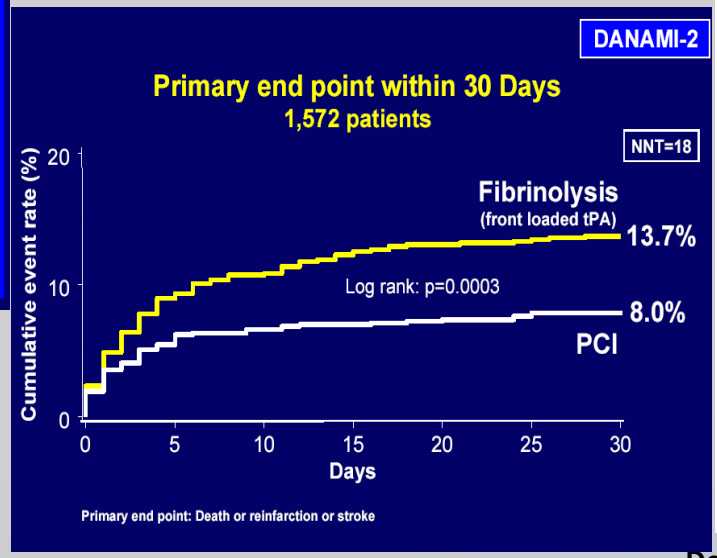
ORIGINAL ARTICLE

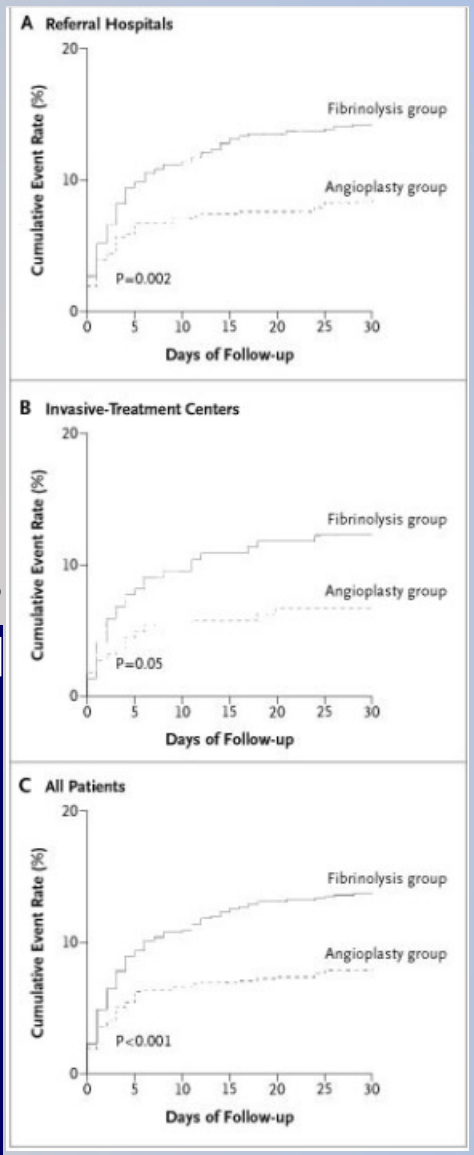
A Comparison of Coronary Angioplasty with Fibrinolytic Therapy in Acute Myocardial Infarction

Henning R. Andersen, M.D., Torsten T. Nielsen, M.D., Klaus Rasmussen, M.D., Leif Thuesen, M.D., Henning Kelbaek, M.D., Per Thayssen, M.D., Ulrik Abildgaard, M.D., Flemming Pedersen, M.D., Jan K. Madsen, M.D., Peer Grande, M.D., Anton B. Villadsen, M.D., Lars R. Krusell, M.D., et al., for the DANAMI-2 Investigators*



Primary Endpoint:
Death, Reinfarction, CVA by 30 days





Death, Re-Infarction , Disabling CVA

CONCLUSIONS

A strategy for reperfusion involving the transfer of patients to an invasive-treatment center for primary angioplasty is superior to on-site fibrinolysis, provided that the transfer takes two hours or less.

All Angioplasty patients had stents attempted

AHA GWTG STEMI Metrics

2010-2022

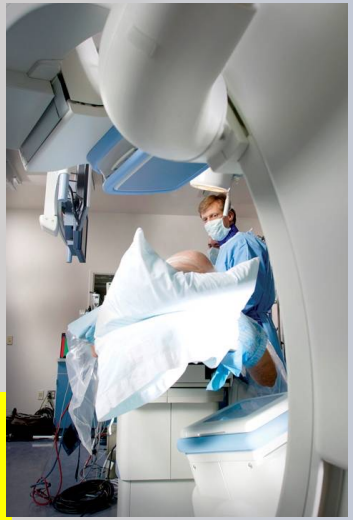
ARRMC Walk-ins or Paramedic Field STEMIs

Remote Referral Hospital STEMIs

30 min

90 min

D2Needle



Additional 30 minutes if transport > 45 minutes & Cath Lab D2B is < 30 minutes

Referring Hospital Transfers

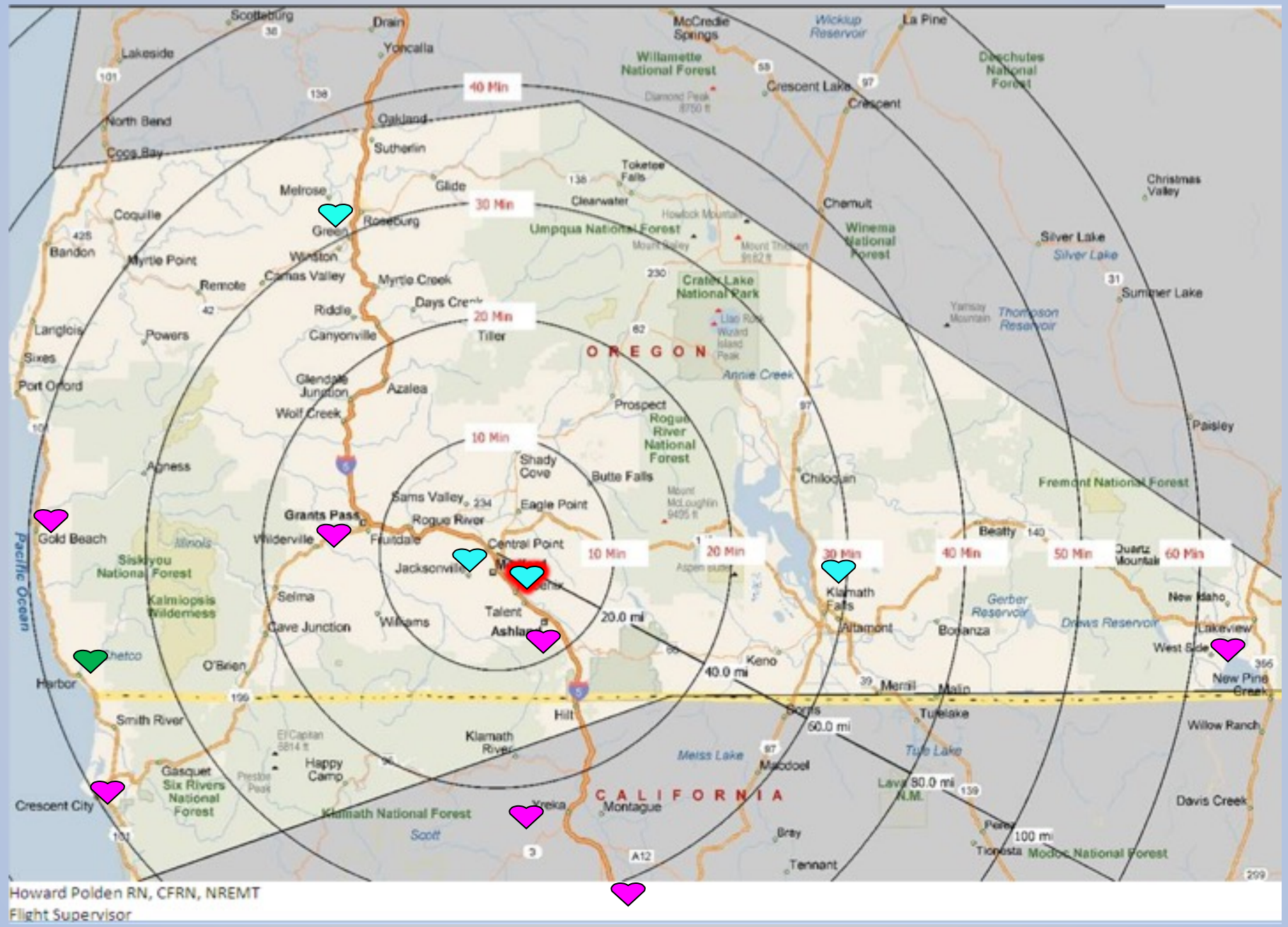
120 min

State of Jefferson
STEMI (ASSET) Program
(Acute ST Segment Elevation Taskforce)

REACH

The Heart Clinic
&
CCPC

To facilitate the accurate, rapid diagnosis, treatment, & transport of patients with Acute ST Segment Elevation Myocardial Infarction (STEMI) from throughout the region to the Asante Rogue Regional Medical Center Cath Lab for Emergent Percutaneous Coronary Intervention (PCI).



PCI/CABG Hosp

PCI Hosp

Referring Hosp

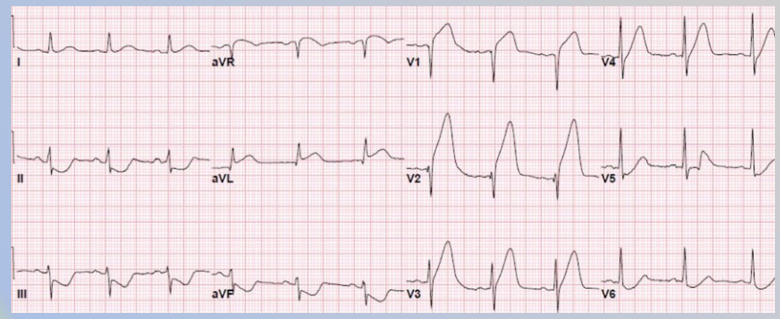
Free Standing Emergency Rm

State of Jefferson STEMI Program

Josephine County 1640 sq miles
Jackson County 2802 sq miles
Siskiyou County 6347 sq miles

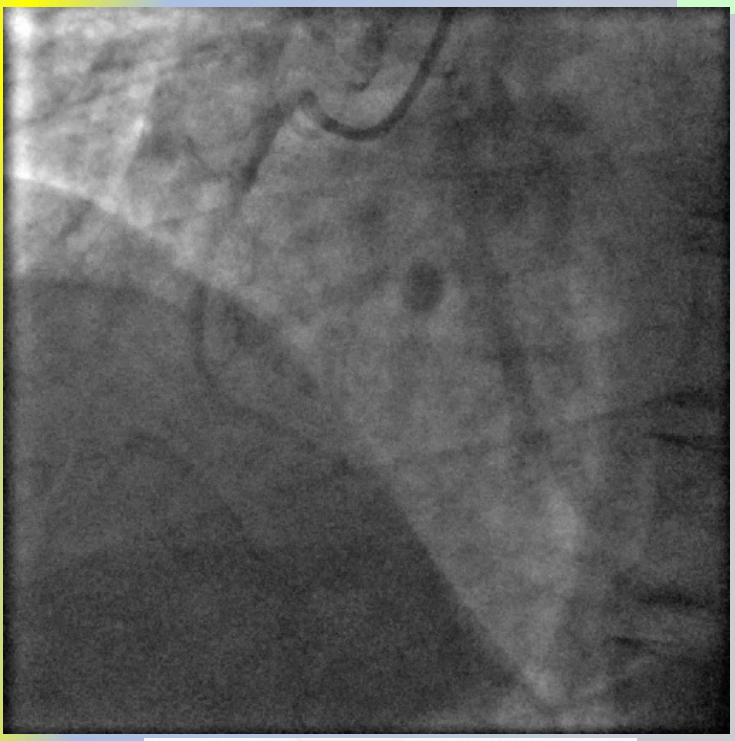
Acute STEMI PPCI Coverage

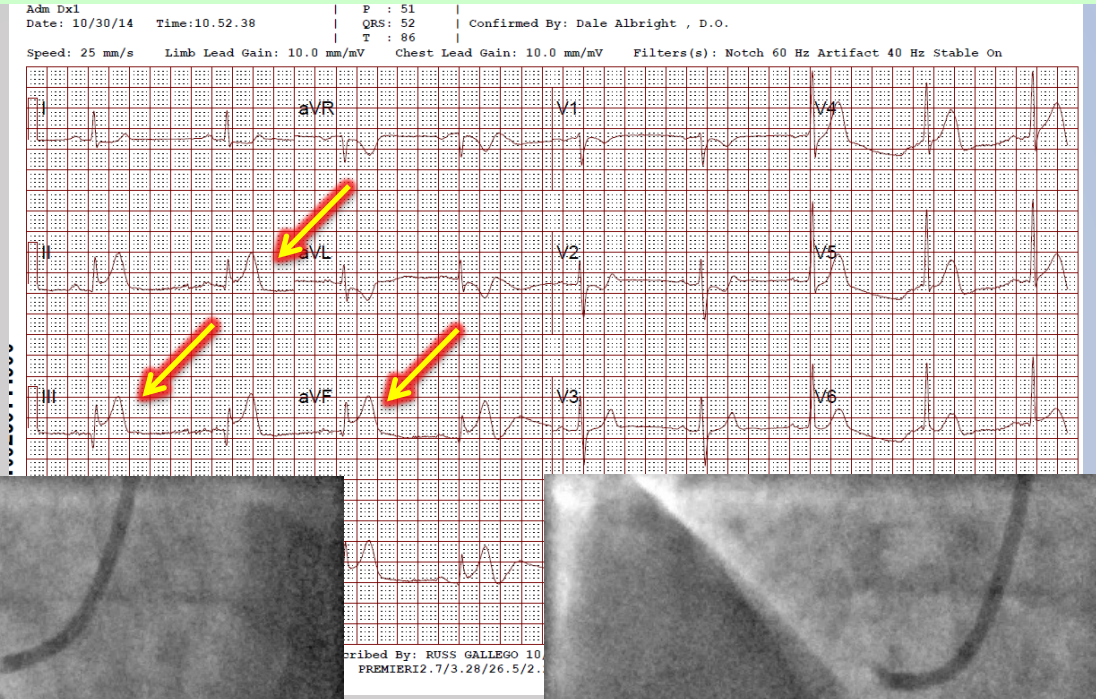
Approximately= 5000 sq miles

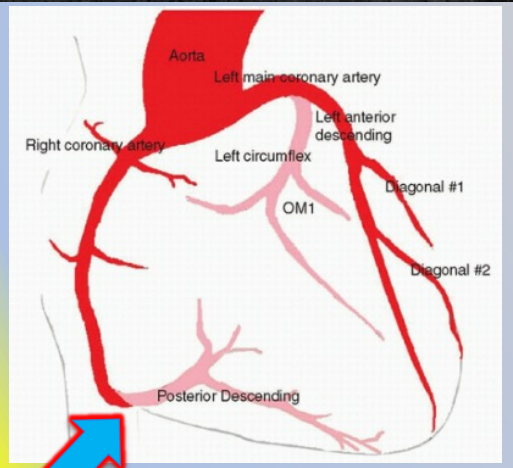


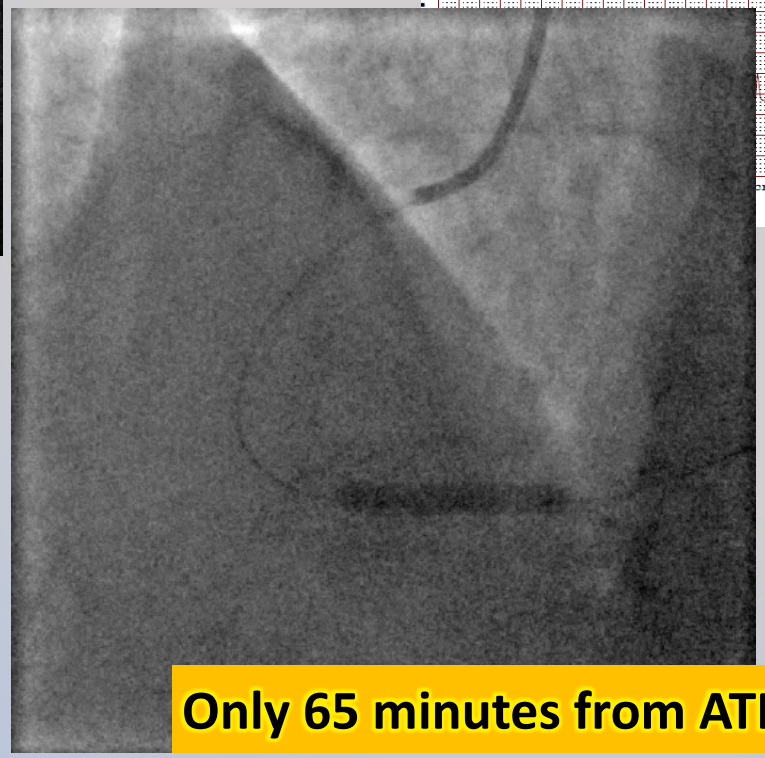
34 STEMI Programs
Each covering 5-25 square miles

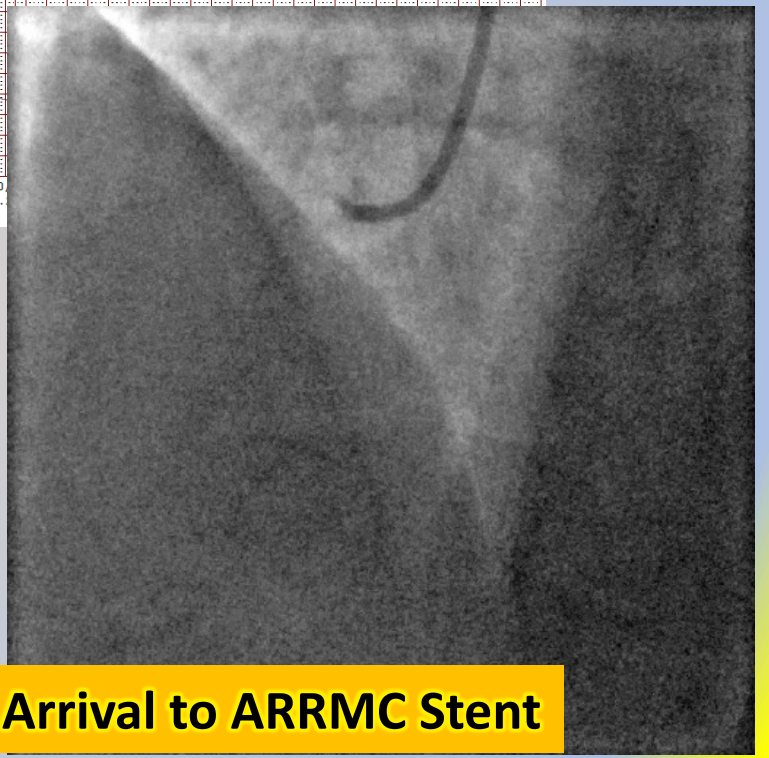
51 y.o. healthy man with sudden, unheralded, severe chest discomfort
23 min In the door-out the door at ATRCH ER by Dr Dale Albright
10 minute cath lab door to Pronto + Bare Metal Stent by KLM and BWG



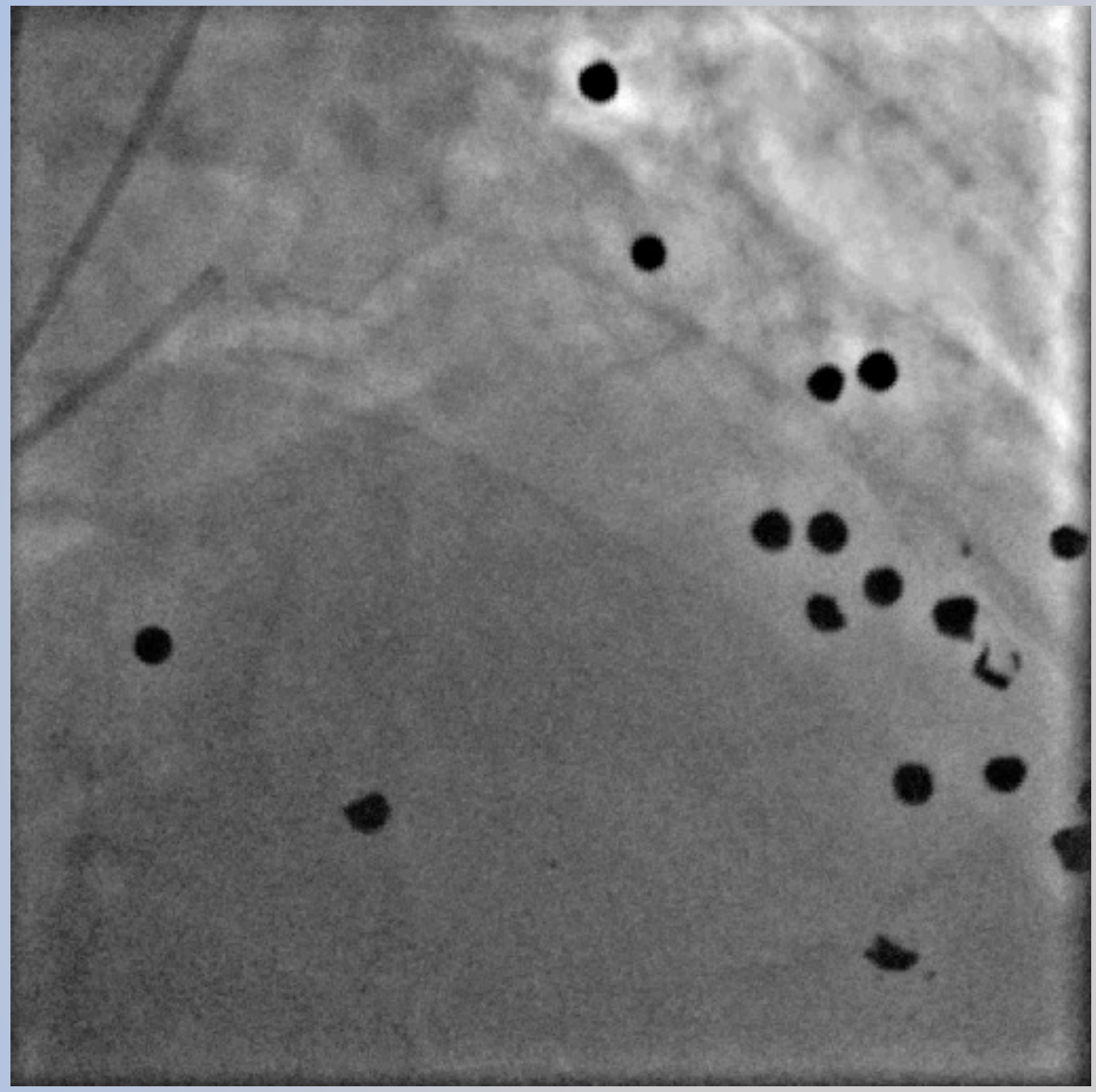


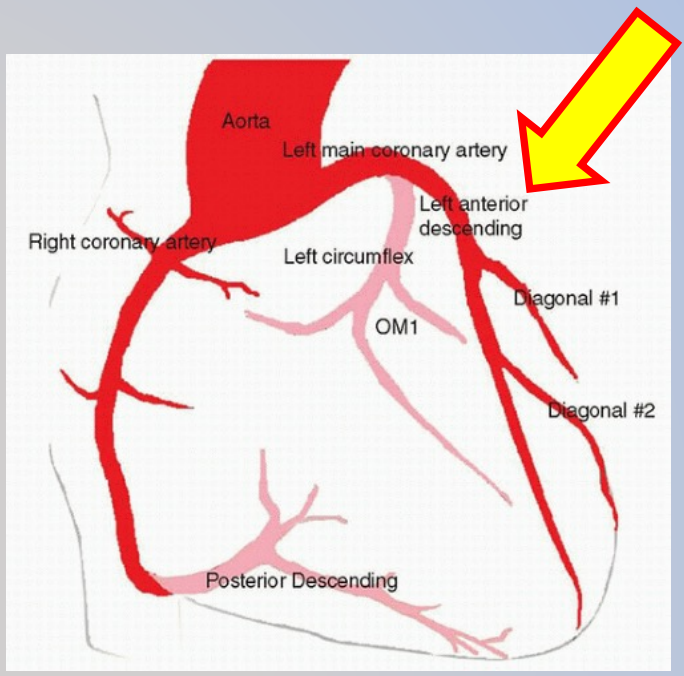






Only 65 minutes from ATRMC ER Arrival to ARRMC Stent



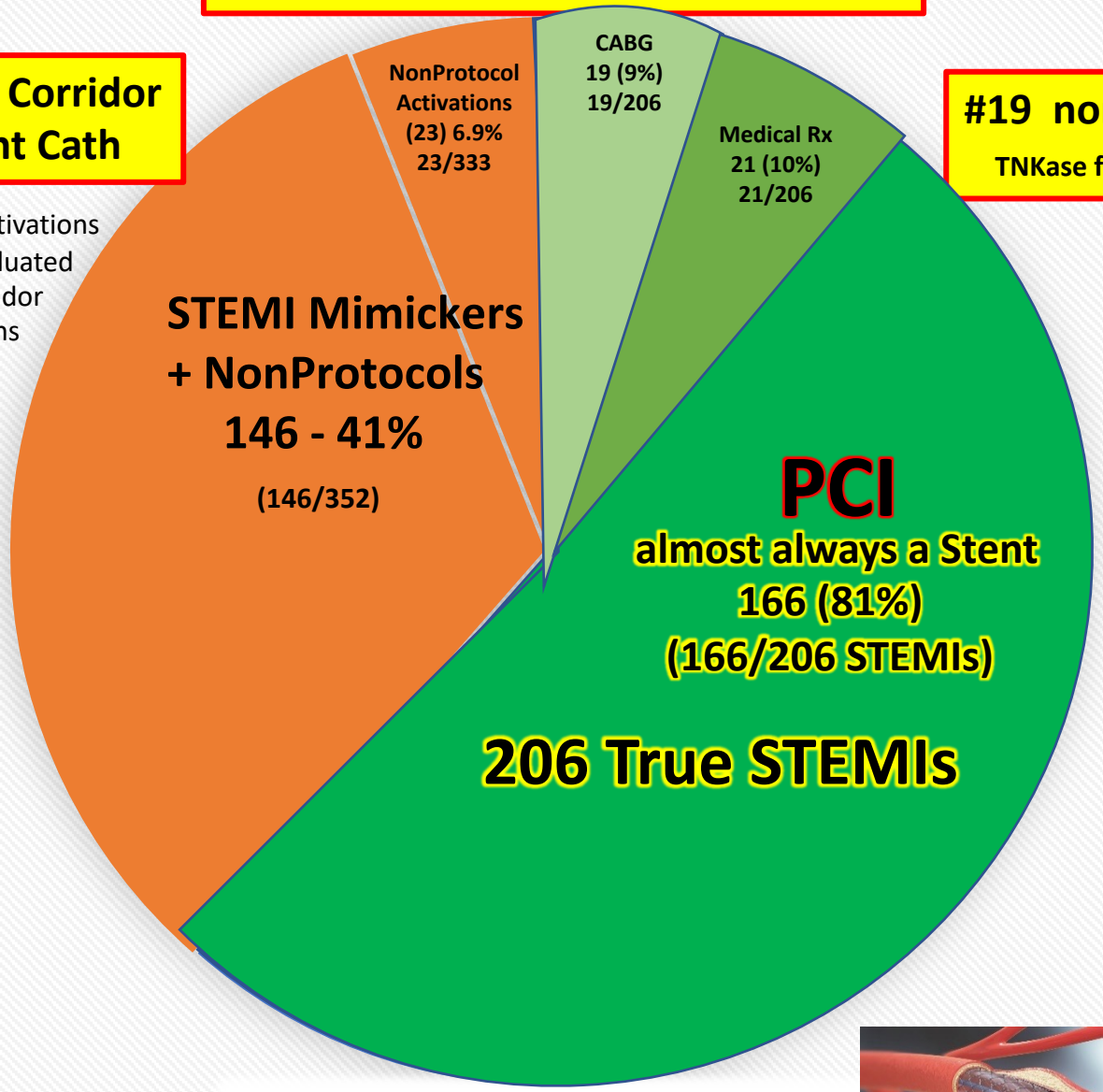


STEMI – Get the Lead Out !!!

352 Total STEMI Activations for 2021

#333 I-5 Corridor Emergent Cath

NonProtocol activations were only evaluated on I-5 Corridor activations

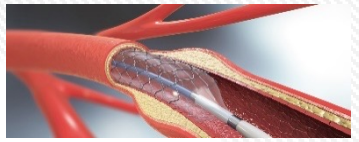


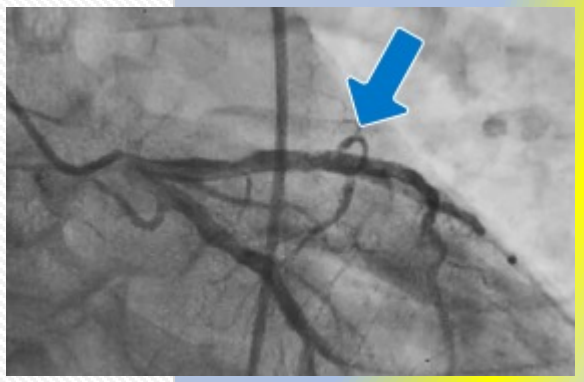
#19 non-I-5 Corridor

TNKase followed by cath

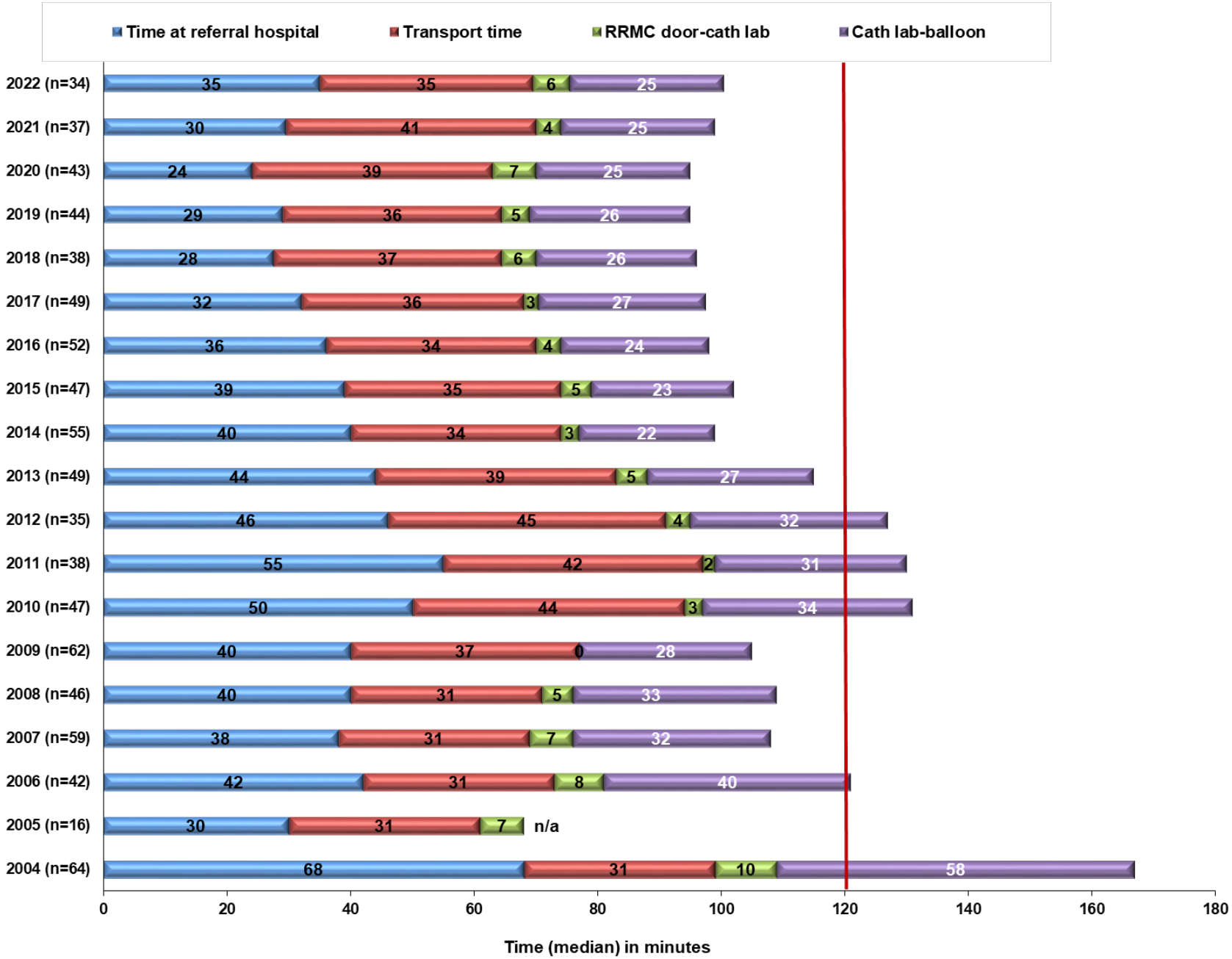
Medical Rx

-Medicine favored
-Unable to cross
-Should not cross
-DNR

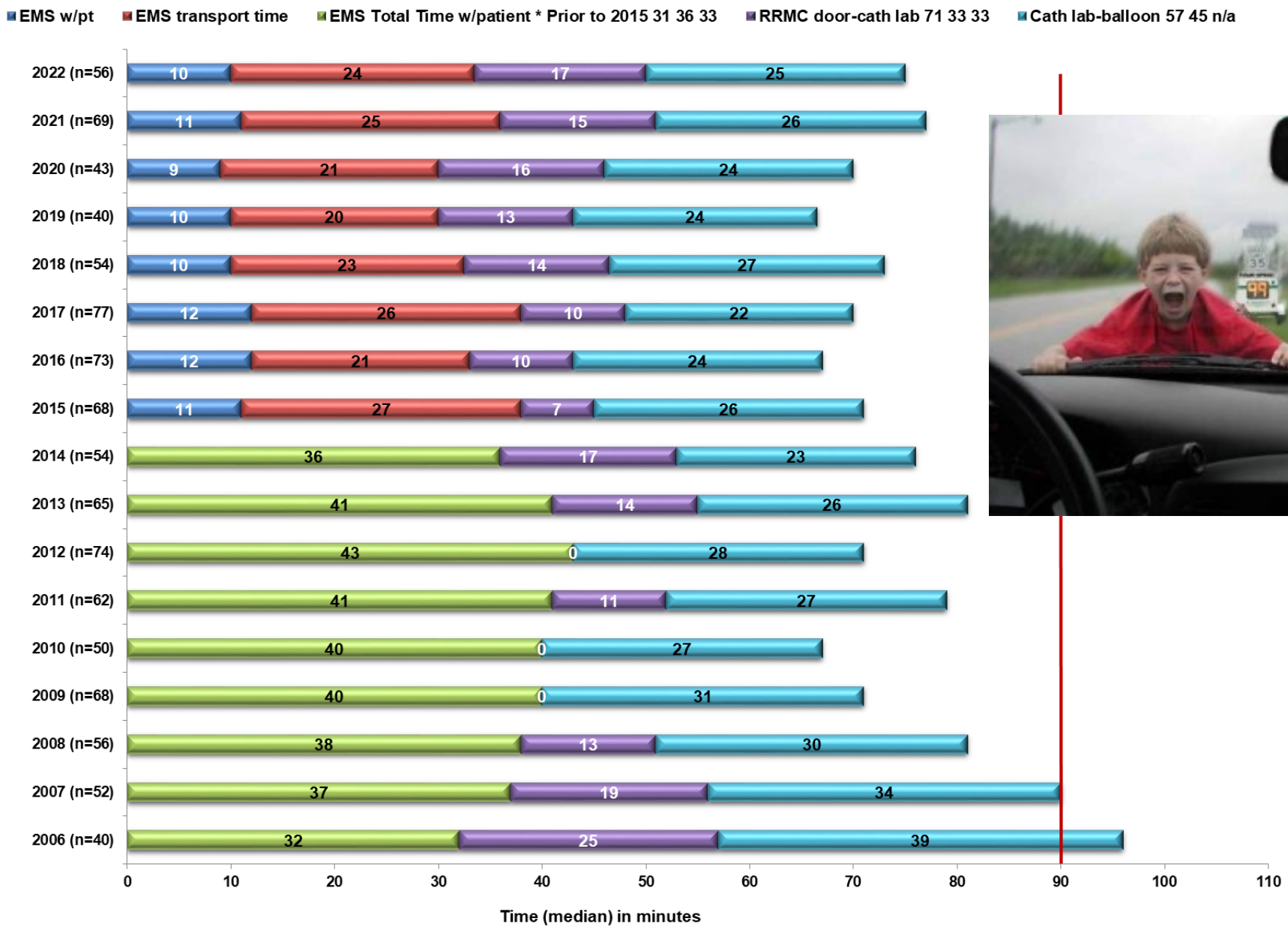




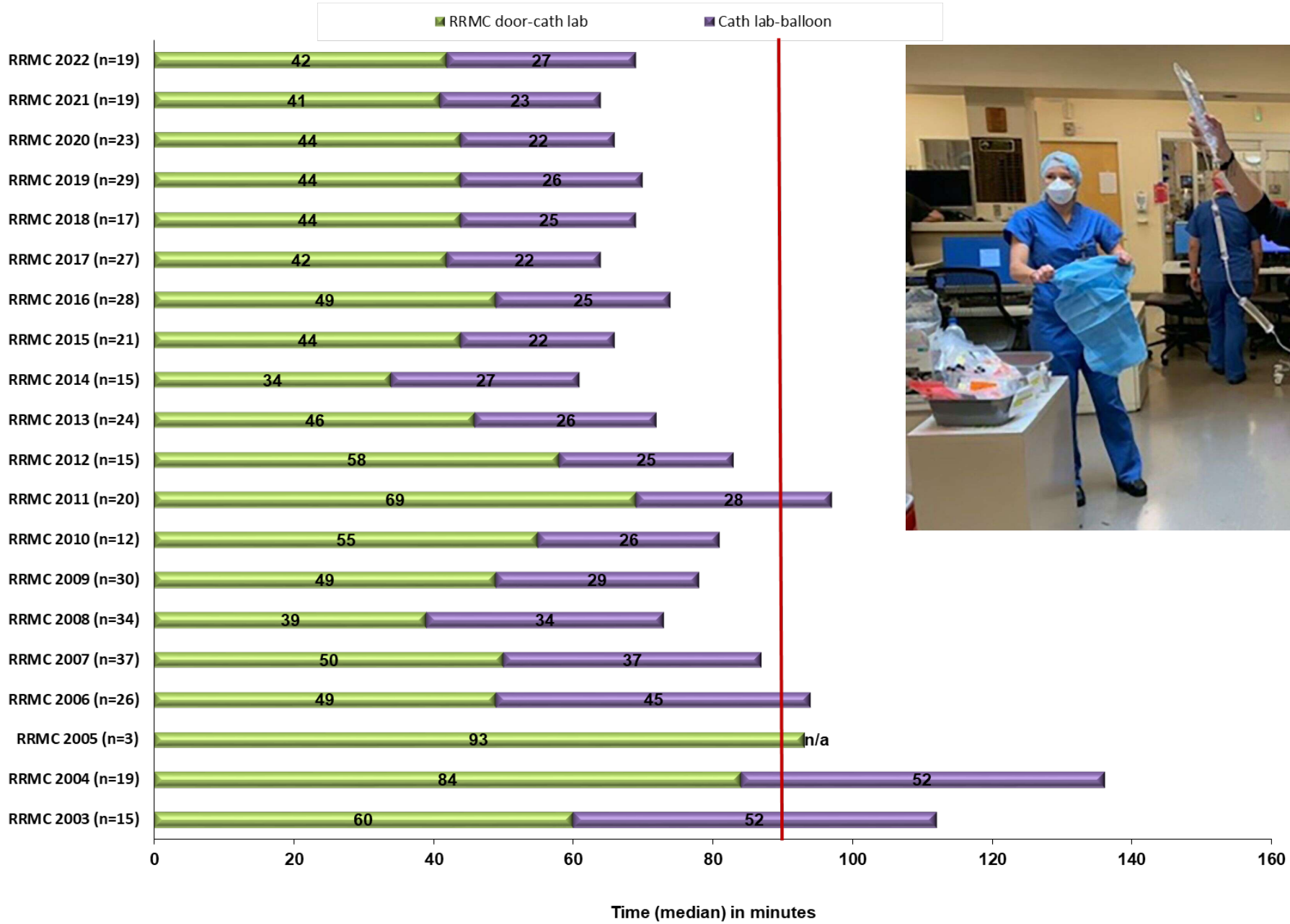
All Transferring Hospitals (excluding RRMC) STEMI Program Patients 2004-2022



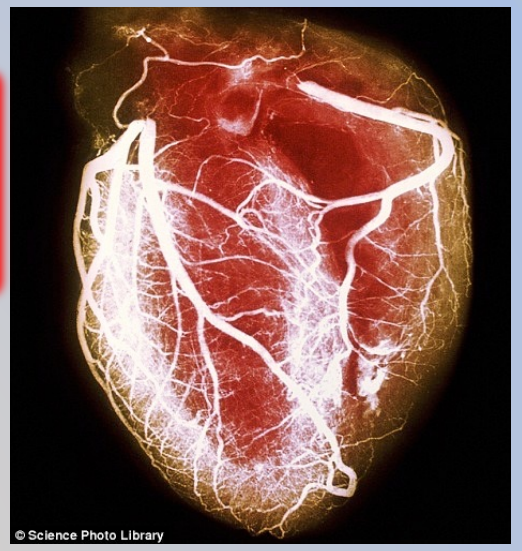
All EMS STEMI Patient Timelines June 2003-2022



RRMC STEMI Program Patients



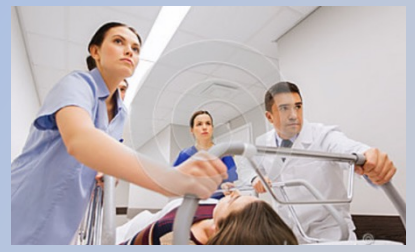
Emergency Stenting (PPCI) for ST Elevation Myocardial Infarction



"Primary Percutaneous Coronary Intervention (PPCI) is the most complex, multi-disciplinary, and time-sensitive therapeutic intervention in the world of medicine today!"

- The **Process** is measured in **Minutes**
- The **Outcomes** are measured in **Mortality**
- **Teamwork** and smooth **Transitions** are essential

Dr. Ivan Rokos,STEMI Systems, May 2007



NTG

Creatinine

Dopamine

Impella RP

ASA

Epinephrine

Nipride

Clopidogrel

Drug Coated Stent

Impella 2.5 / CP /5.0

Amiodarone

Blood Pressure

Hgb

Norepinehrine

Heart rate

IABP

Reopro

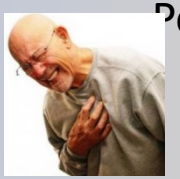
Bare Metal

COVID

ACT

Potassium

Lidocaine



Dyspnea

Heparin

TTM vs Therapeutic Hypothermia

Balloon

Groin vs Wrist Access

Oxygen saturation

Ticagrelor

ECMO

Pacer

Pain Control

Culprit vs Complete

Cangrelor

HCO3

Praugrel

Allergies

TNKase

GFR

Emergent CABG

Catheter Choice

Contrast Load

History

PMH

Aggrastat

Tandem Heart

Wire Choice

GPFD
Rural Metro
AMR

ASANTE®

American Heart Association ACCREDITATION
Heart Attack Receiving Center

MISSION: LIFELINE

STEMI Feedback Report

Indicator FMC = First Medical Contact PCI = Device/balloon	Actual time	Goal	Goal met
FMC to ECG time	2	≤10 minutes	👍
FMC to cleared scene time	10	≤15 minutes	Track Only
ECG to One-Call (ER Blast Pages) time	5	≤7 minutes	👍
FMC to Cath Lab time	50		
Cath Lab to PCI time (D2B)	21	≤30 minutes	👍
FMC to PCI time	71	≤90 minutes	👍

Pt C/C: This 79 yo male had a LAD stent placed in May 2020, with a planned end to Plavix in June 2022. Today, while working on his car in 103 F degree heat, he developed an abrupt onset of 9/10 chest pressure radiating down his inner left arm, with weakness & excessive diaphoresis. He told EMS "it feels like my heart attack 2 years ago." Pt hx HTN & continued half-pack per day cigarette smoking.

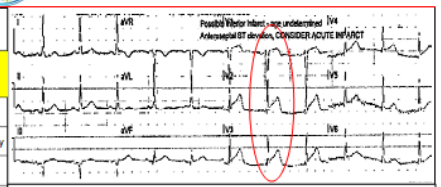
ECG: He has 2 mm ST elevation septal leads V1-3 (red oval) with peaked T-waves & slight reciprocal ST depression lateral leads I & aVL.

Cath Lab findings: Dr. Dauterman & team found a thrombotic occlusion in the proximal end of his May 2020 LAD stent (notice the hazy outline beyond the red arrow).

Treatment: Dr. Dauterman & team first used the Pronto aspiration catheter removing a large amount of red and white clot followed by deployment of a 3.5 x 28 mm stent, post-dilated to 4 mm, with excellent results (right picture). His troponin peaked at 54.6 & echo showed LVEF 40%, with akinesis in the distal half of the anteroseptal wall and apex. His CP never returned after PCI, he had an uneventful hospital course, was counseled on smoking cessation, & discharged home in good condition in 3 days.

Excellence: Green across the board is very impressive STEMI team, especially given that half the total (35 minutes) was transport time!

Recommendations: Textbook Case!



Angiogram showing blockage | Post-stent blood flow

STEMI team: EMS: GPFD. AMR: Donald Cooper, Toby Wallace

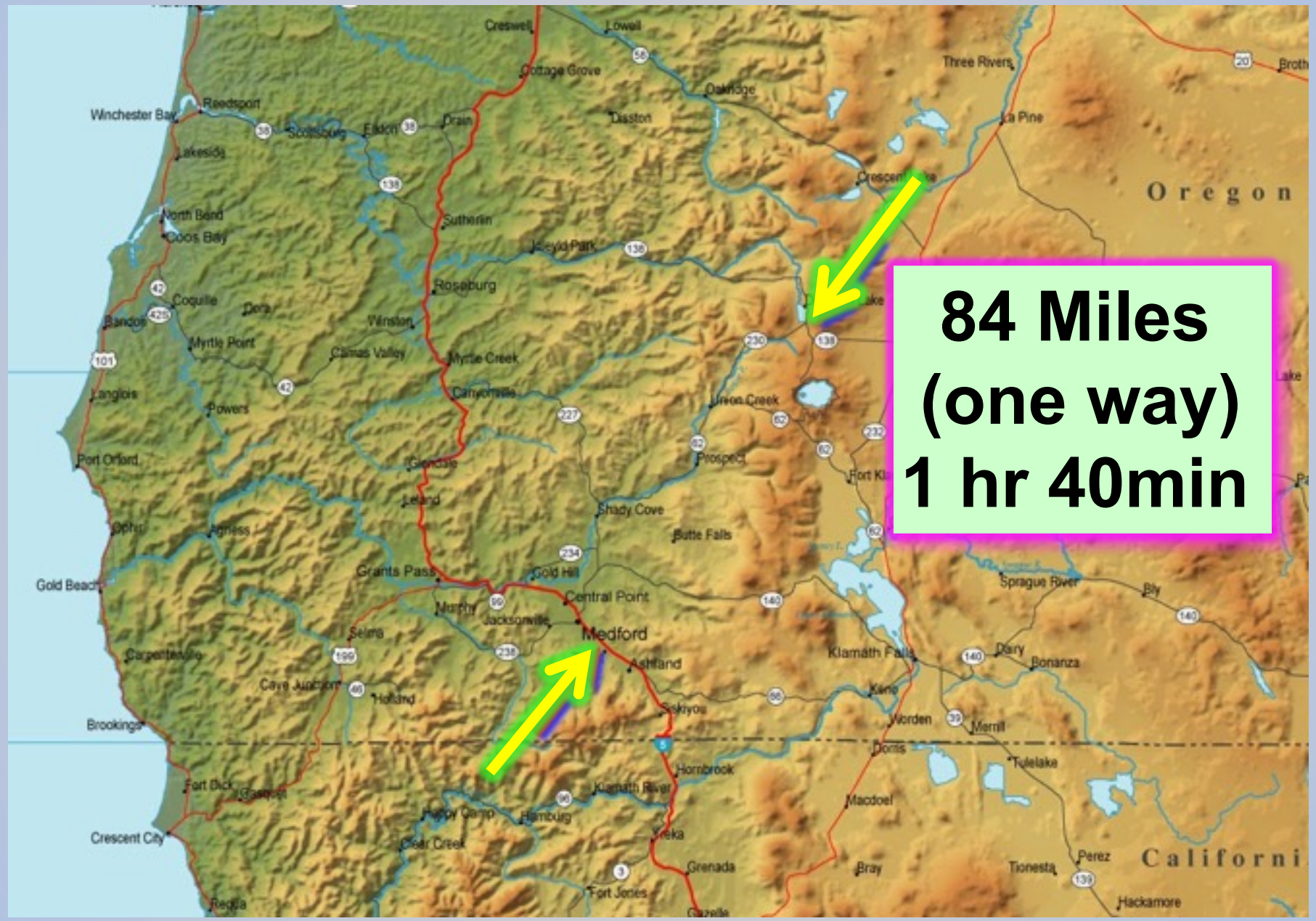
ED: Lindsey Maher, Shelby Hughes

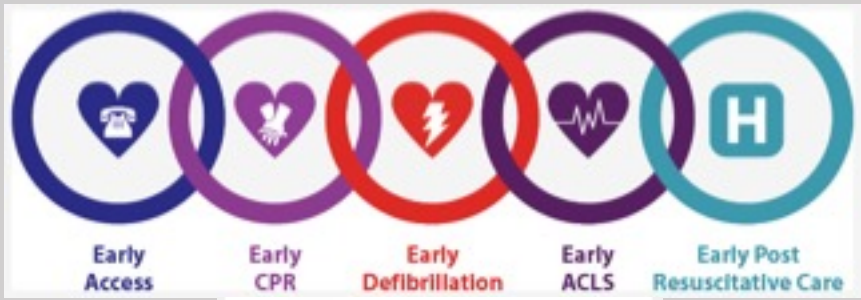
Cardiology: Dr. Dauterman

Cath Lab: Lindsy Gollihar, Kris Blake, Olivia Rhein, Marcia Anderson

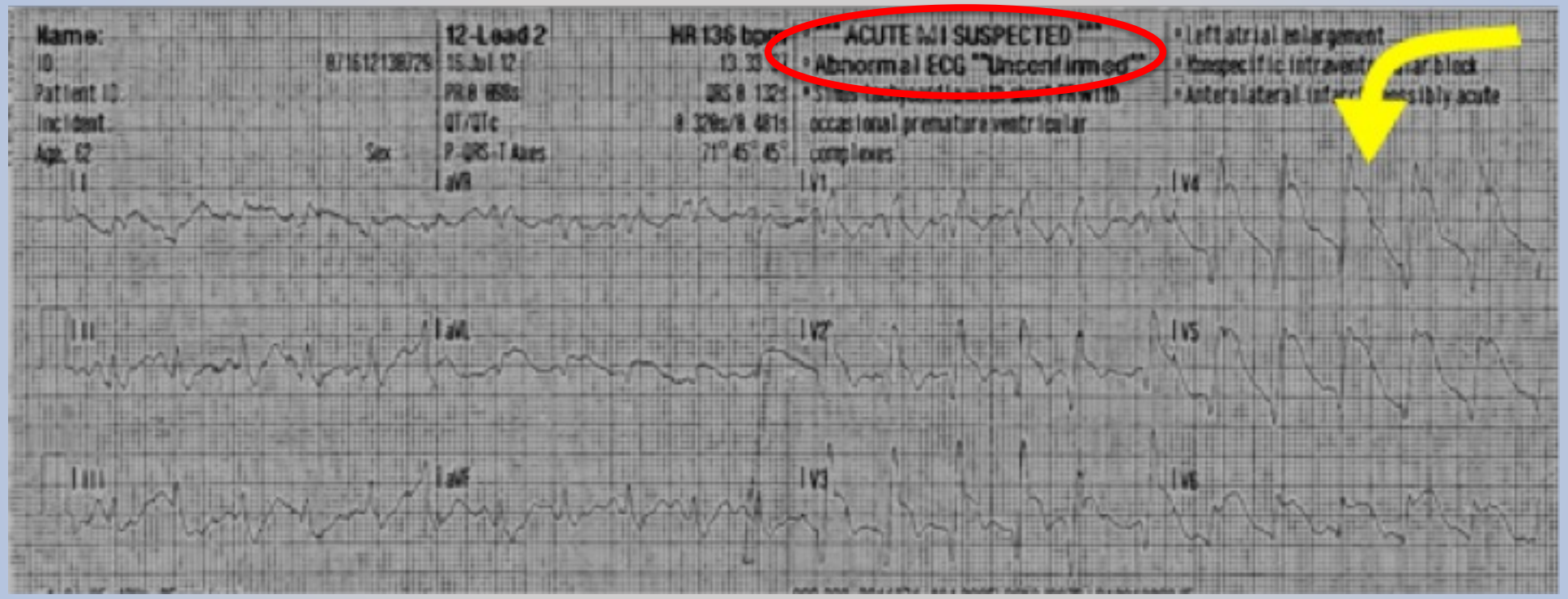
We're supplying this feedback to optimize our coordinated team response for every STEMI patient. Thank you for your ongoing effort to provide quick and excellent care to our STEMI patients. *Sincerely, Dr. Brian Gross, Dr. Kent Dauterman and Daniel Moore, RN, – our STEMI Program medical directors & nurse coordinator. DWM 01/22*

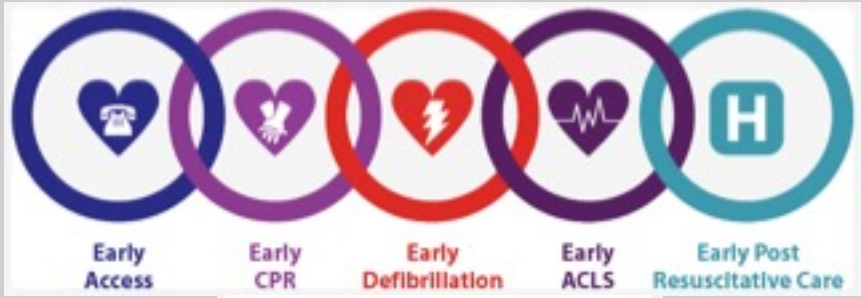

2003 © M. GIULI


84 Miles
(one way)
1 hr 40min
Oregon
Medford
Grants Pass
Roseburg
Coos Bay
Crescent City
Klamath Falls
Ashland
Gold Beach
Brookings
Port Orford
Bandon
Coquille
Myrtle Point
Powers
Langlois
Reedsport
Winchester Bay
Lakeside
North Bend
Sutherlin
Oakland
Cottage Grove
Creswell
Lowell
Three Rivers
La Pine
Sprague River
Bonanza
Merrill
Tulelake
Macdoel
Bray
Tionesta
Hackamore
Perez
Californi
Grenada
Fort Jones
Yreka
Hornbrook
Klamath River
Happy Camp
Hamburg
Orleans
Willow Creek
Cave Junction
Selma
Jacksonville
Central Point
Gold Hill
Shady Cove
Butte Falls
Prospect
Union Creek
Camas Valley
Myrtle Creek
Canyonville
Glendale
Leland
Agness
Gardiner
Reedsport
Scottsburg
Elkton
Drain
Yoncalla
Drain
Dorena
Winston
Dillard
Days Creek
Riddle
Tri City
Wilbur
Sutherlin
Oakland
Diamond Lake
Crescent
Chemult
Beatty
Dairy
Worden
Keno
Malin
Tulelake
Dorris
Merrill
Bonanza
Lakeview
Silver Lake
Fort Klamath
Crater Lake
Lake



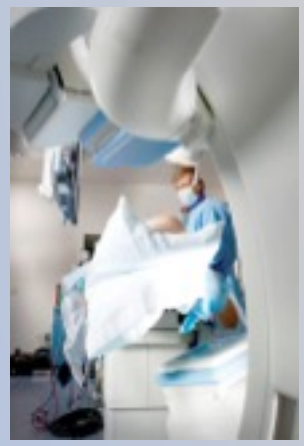
American Heart Association®

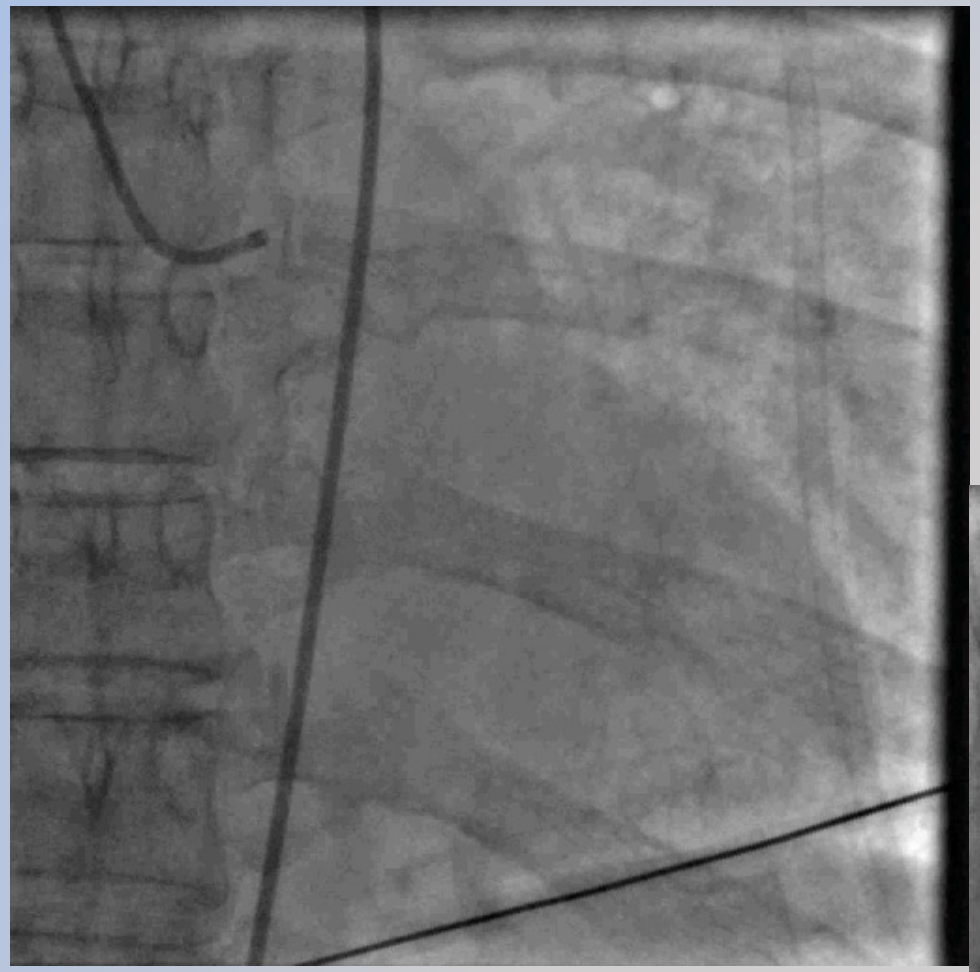

Name:
ID
Patient ID
Incident
Age 62
Sex
12-Lead 2
15 Jul 12
PR/R
QT/QTc
P-QRS-T Axes
HR 136 bpm
*** ACUTE MI SUSPECTED ***
* Abnormal ECG "Unconfirmed"
occasional premature ventricular complexes
* Left atrial enlargement
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6

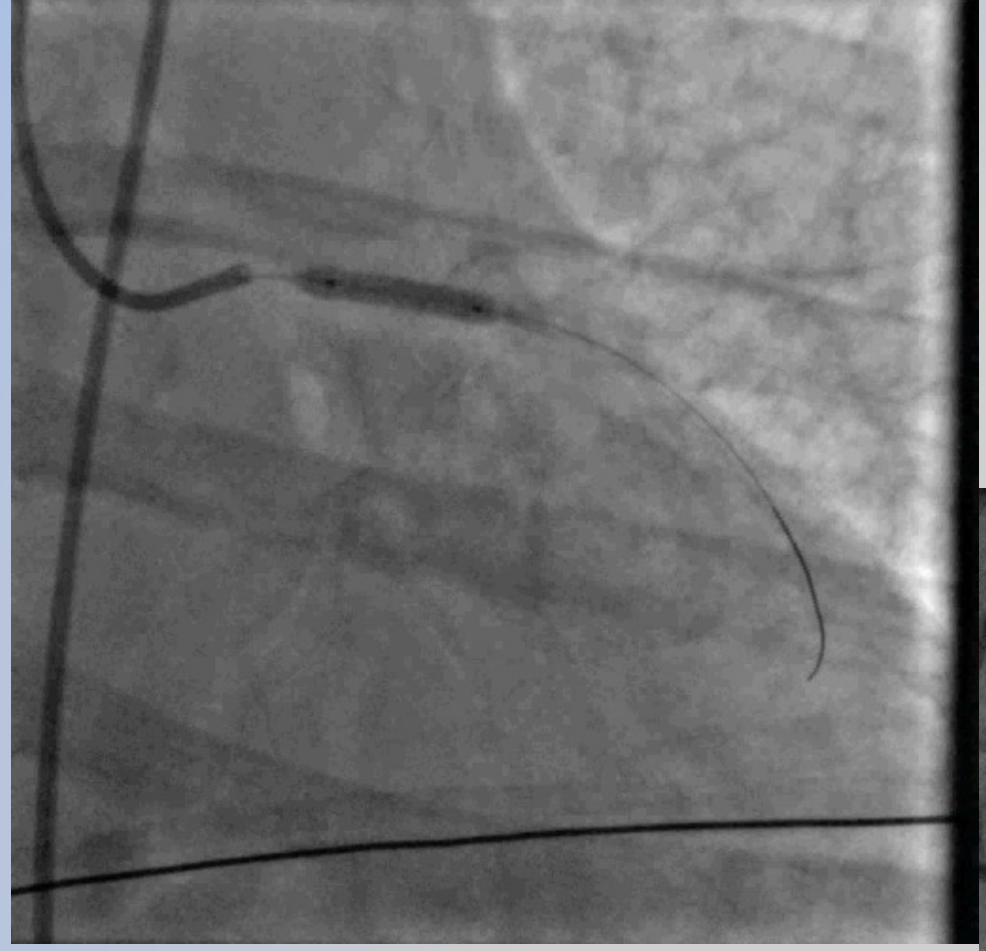

Early Access
Early CPR
Early Defibrillation
Early ACLS
Early Post Resuscitative Care

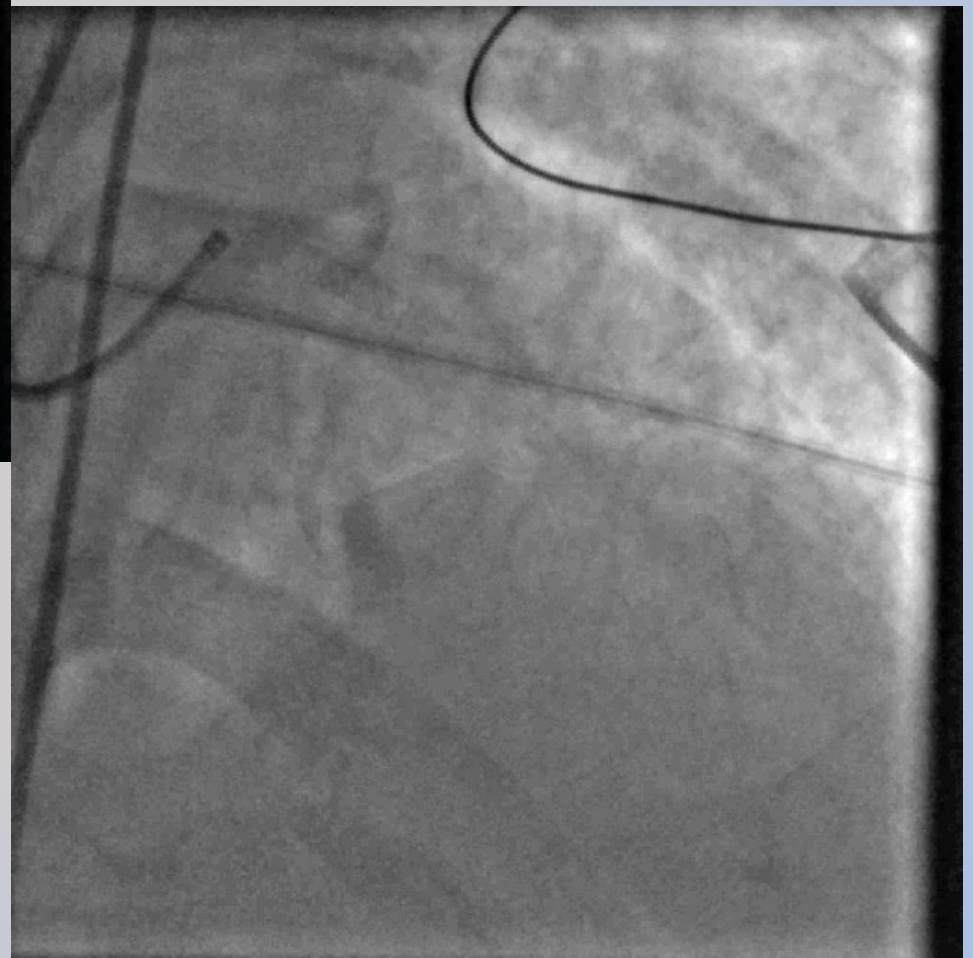

American Heart Association


AED

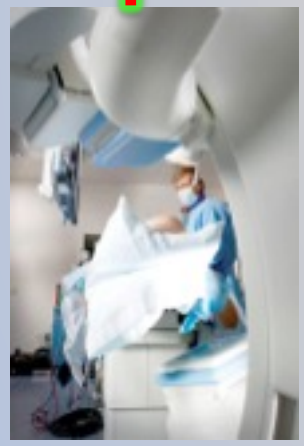


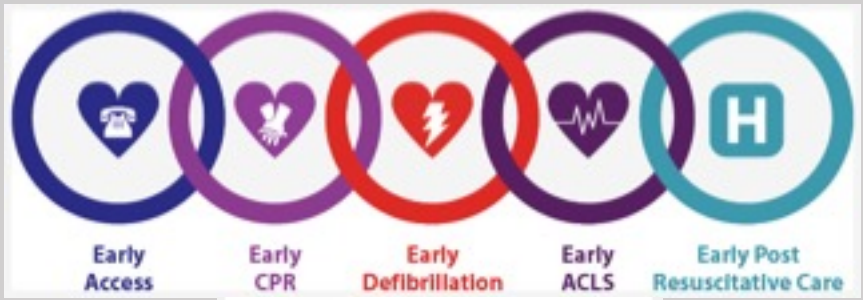




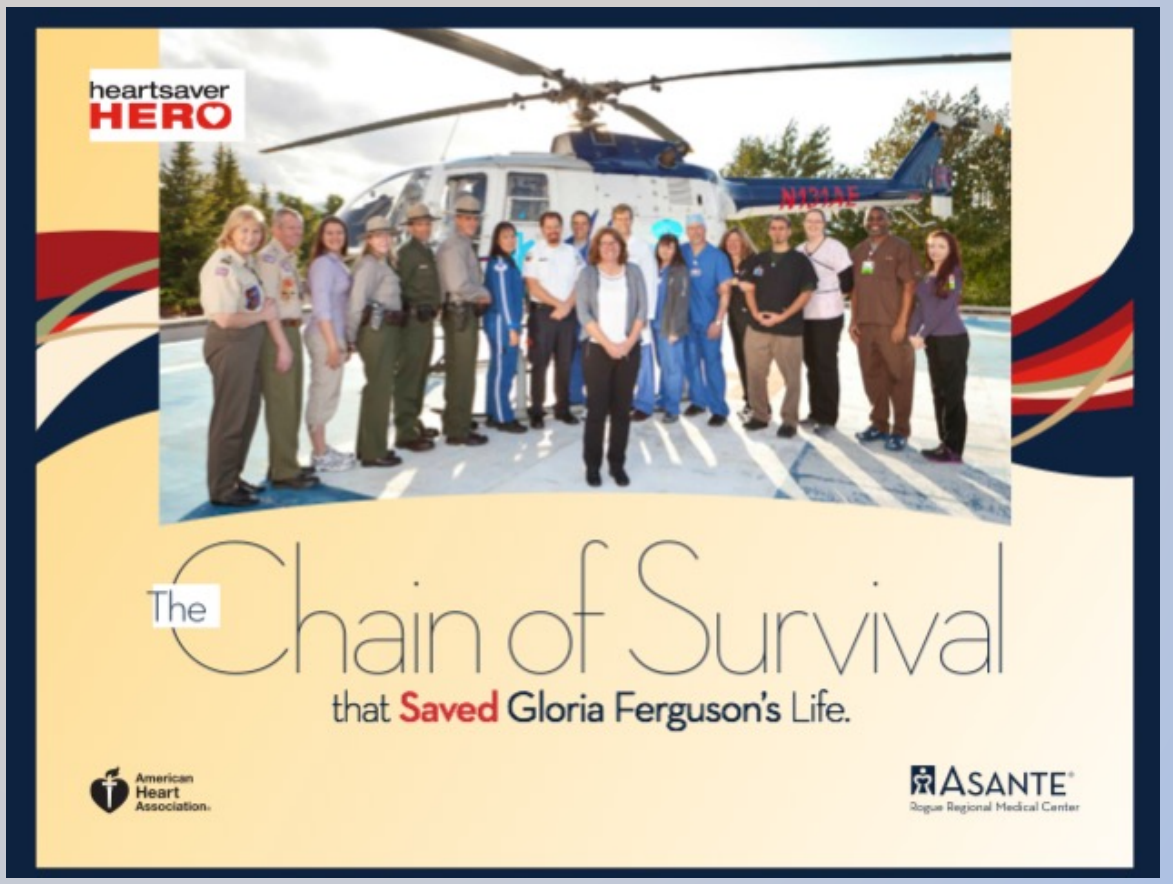



AED




Early
Access
Early
CPR
Early
Defibrillation
Early
ACLS
Early Post
Resuscitative Care
H


American
Heart
Association

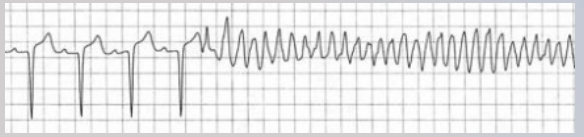

heartsaver
HERO
The Chain of Survival
that Saved Gloria Ferguson's Life.
American Heart Association.
ASANTE
Rogue Regional Medical Center

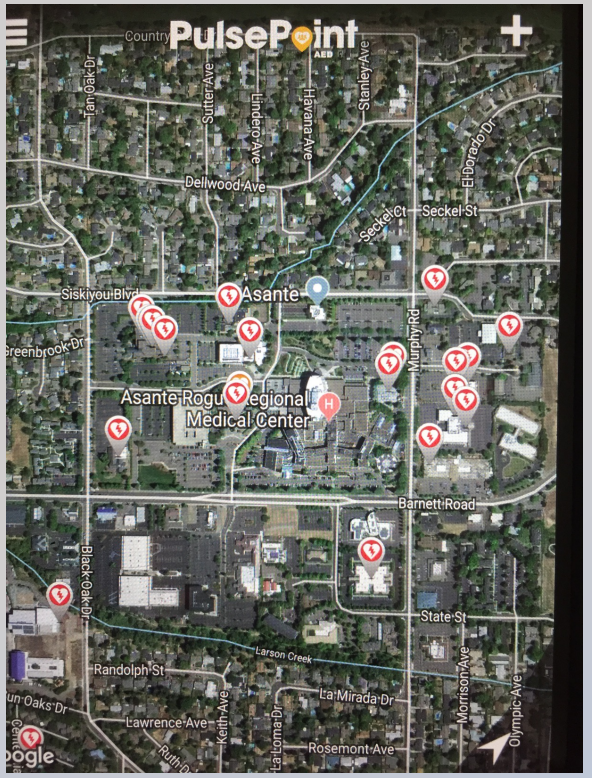
Out of Hospital Cardiac Arrest

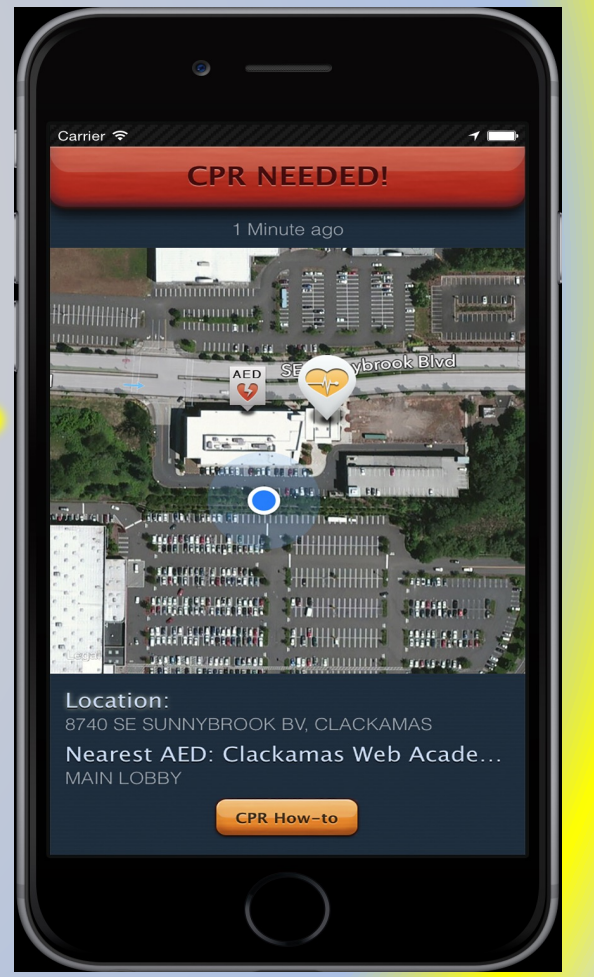
Pulse Point - Community Based Response for Out of Hospital Cardiac Arrest

911

EMS



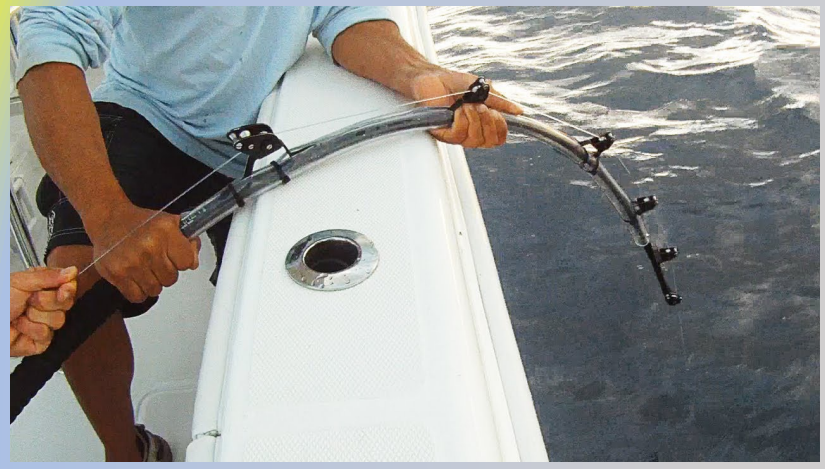




Conclusions:

STEMI & OHCA Patients are like Bottom Fishing…

You really don't know what you have until you bring it to the surface…



FDA Clears Smart Toilet Seat for Heart Health Monitoring

Diana Ernst, RPh | May 1, 2023

The toilet seat-based monitoring system measures heart rate and blood oxygenation.