ECCU 2017 CONFERENCE & EXHIBITION • A CALL TO ACTION...AND ALL THAT JAZZ!

Door to Balloon Time: The CA in CAth Lab Stands for Cardiac Arrest

Karl B. Kern, MD

Professor of Medicine

The Gordon A. Ewy, MD Distinguished Endowed Chair of Cardiovascular Medicine

Co-Director, Sarver Heart Center,

Division of Cardiology

University of Arizona

Tucson, Arizona

ECCU2017 Emergency Cardiovascular Care Update

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Presenter Disclosure Information

Karl B. Kern, MD
"CA in Cath Lab Stands for Cardiac Arrest"

FINANCIAL DISCLOSURE:

- Science Advisory Boards:
  - Zoll Medical
  - Physio-Control, Inc

- Grant Support:
  - Physio-Control, Inc.
  - Arizona Biomedical Research Commission (ABRC)
  - Gootter Foundation

UNLABELED/UNAPPROVED USES DISCLOSURE:

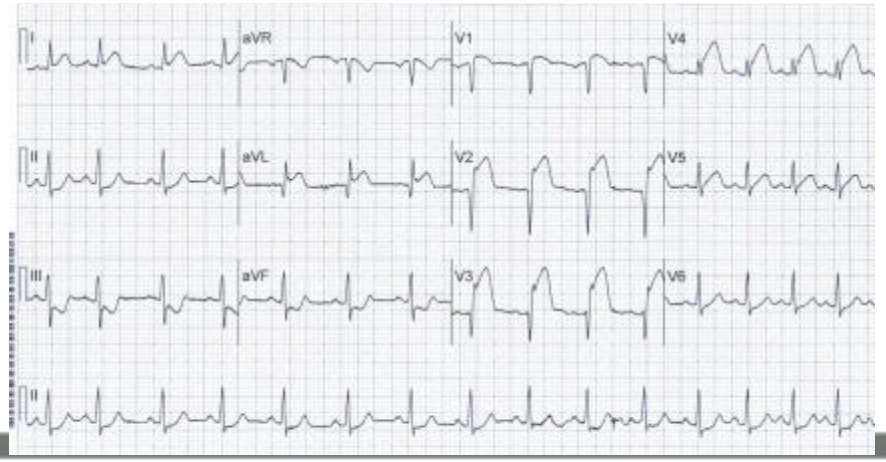
- None

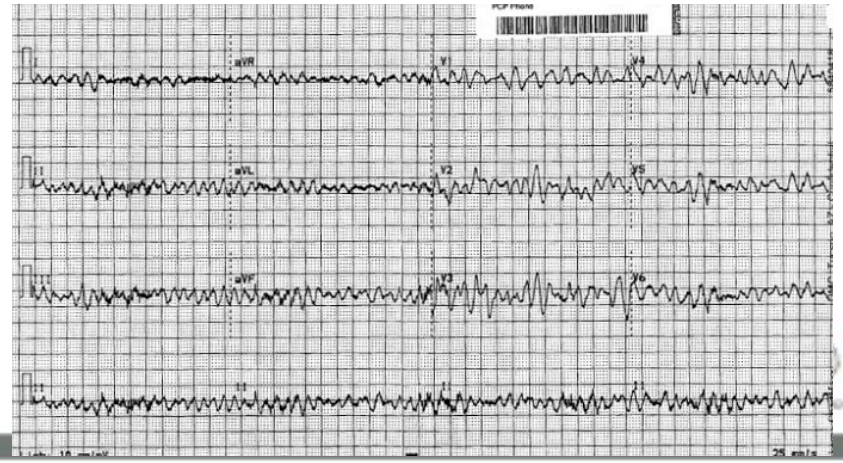
Cardiology Issues:

- Early Coronary Angiography & PCI
- Mechanical CPR & Rescue PCI for CA in the CCL
- LVADs for CA in the CCL
- Hyper-invasive Approach for Refractory CA
- More than just Atherosclerosis

The worst presentation of ACS is not STEMI …

but rather Cardiac Arrest !





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Potential Value of Coronary Angiography Post Arrest

- Identify ‘culprit’ coronary lesion
- Restore coronary flow
  - Salvage myocardium
- ? Reduce risk of Re-arrest
- ? Improve hemodynamics of CNS perfusion
- ? Improve Survival

Early Cardiac Catheterization and PCI After Resuscitation from Cardiac Arrest

- ❑ Who should go to the Cath Lab?
- ❑ When should they go?
- ❑ Does it Really Improve Outcome?

Survival Post Cardiac Arrest After Early PCI

Author/Date (19 studies)	Surv to DC	Good Neuro among Surv
Kahn 1995	6/11	4/6
Spaulding 1997	32/84	30/32
Lin 1998	9/10	NA
Bulut 2000	4/10	NA
McCollough 2002	22/54	14/22
Borger van der Berg 2003	39/42	NA
Keelan 2003	11/15	9/11
Bendz 2004	29/40	NA
Quintero-Moran 2006	18/27	NA
Gorjup 2007	90/135	72/90
Garot 2007	102/186	88/102
Richling 2007	24/46	22/24
Markusohn 2007	19/25	17/19
Werling 2007	9/13	NA
Pleskot 2008	14/20	11/14
Hosmane 2009	63/98	58/63
Anyfantakis 2009	35/72	33/35
Reynolds 2009	52/96	NA
Lettieri 2009	77/99	67/77
Totals: n= 1,083 pts	655/1083 (60%)	425/495 (86%)*

Non-randomized
Case Series

Summary
(Not Meta-analysis)

No MTH

*Includes both conscious and comatose pts

What If Emergent PCI is Combined with Therapeutic Hypothermia Post Cardiac Arrest?

TABLE 1 28 Clinical Reports of Combining TTM and Early Coronary Angiography in Resuscitated, But Comatose Patients With STEMI on the ECG

First Author, Date (Ref. #)	Survivors to DC (n = 2,687/4,510 [60%])	Good Neuro Among Survivors (n = 2,090/2,426 [86%])
Hovdenes et al., 2007 (17)	41/50	34/41
Richling et al., 2007 (33)	24/46	22/24
Knafelj et al., 2007 (18)	30/40	22/30
Wolfrum et al., 2008 (22)	12/16	11/12
Peels et al., 2008 (104)	22/44	NA
Schefold et al., 2009 (34)	NA	19/31
Reynolds et al., 2009 (14)	52/96	NA
Nielsen et al., 2009 (35)	303/479	278/303
Batista et al., 2010 (27)	8/20	6/8
Dumas et al., 2010 (3)	171/435	160/171
Koeth et al., 2010 (105)	114/143	NA
Stub et al., 2011 (28)	52/81	46/52
Laish-Farkash et al., 2011 (36)	69/110	59/69
Tømte et al., 2011 (37)	140/252	132/140
Radsel et al., 2011 (31)	154/212	128/154
Mooney et al., 2011 (12)	78/140	72/78
Cronier et al., 2011 (11)	60/111	54/60
Gräsner et al., 2011 (90)	143/183	118/143
Bro-Jeppesen et al., 2012 (30)	211/360	207/219
Zanuttini et al., 2012 (10)	29/48	NA
Liu et al., 2012 (106)	36/81	NA
Nanjayya et al., 2012 (59)	18/35	14/18
Strote et al., 2012 (58)	44/61	34/44
Waldo et al., 2013 (107)	57/84	NA
Velders et al., 2013 (32)	187/222	168/183
Callaway et al., 2014 (43)	495/765	413/495
Thomas et al., 2014 (108)	168/348	115/168
Sideris et al., 2014 (88)	97/300	80/97

Recent 2015 Studies

	Surv to DC	Good Neuro in Surv
Kern et al	205/364 (56%)	186/205 (91%)
Geri et al	470/1094 (43%)	NA
Vylas et al	1484/1953 (76%)	1393/1484 (94%)
Total	**2169/3411 (64%)**	**1579/1689 (93%)**

Total of 43 Clinical Cohort Studies

8,134 patients with overall:

- 62% survival to Hosp DC (5,050/8,134)
- 89% of survivors have good neurological function (4,085/4,570)

Nearly “60/90” Club

~ 62% survival rate !

~ 89% of survivors with good neurological function !

Historically no better then ’30/66’ range!

Who Should Go to the Cath Lab Post Resuscitation?

Patients resuscitated from OHCA Associated with a STEMI

Patients resuscitated from OHCA Without ST Elevation

2013 ACCF/AHA Guideline for the Management of ST-Elevation Myocardial Infarction

Developed in Collaboration with American College of Emergency Physicians and Society for Cardiovascular Angiography and Interventions

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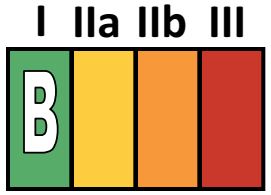
Evaluation and Management of Patients With STEMI and Out-of-Hospital Cardiac Arrest

Therapeutic hypothermia should be started as soon as possible in comatose patients with STEMI and out-of-hospital cardiac arrest caused by VF or pulseless VT, including patients who undergo primary PCI.



Immediate angiography and PCI when indicated should be performed in resuscitated out-of-hospital cardiac arrest patients whose initial ECG shows STEMI.

2015 ILCOR CPR Evaluations

- Hospital Reperfusion Decisions After ROSC
  - We recommend emergency cardiac catheterization laboratory evaluation in comparison with cardiac catheterization later in the hospital stay or no catheterization in select adult patients with ROSC after out-of-hospital cardiac arrest (OHCA) of suspected cardiac origin with ST elevation on ECG.

Welsford M, et al; on behalf of the Acute Coronary Syndrome Chapter Collaborators. Part 5: acute coronary syndromes: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. *Circulation*. 2015;132(suppl 1):S146–S176.

2015 AHA CPR Guidelines

2015 Recommendations—Updated

- Coronary angiography should be performed emergently (rather than later in the hospital stay or not at all) for OHCA patients with suspected cardiac etiology of arrest and ST elevation on ECG

(Class I, LOE B-NR).

O'Connor RE, et al. Part 9: acute coronary syndromes: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2015;132(suppl 2):S483–S500.

2015 AHA CPR Guidelines

2015 Recommendations—Updated

- Coronary angiography is reasonable in post–cardiac arrest patients where coronary angiography is indicated regardless of whether the patient is comatose or awake

(Class IIa, LOE C-LD).

O'Connor RE, et al. Part 9: acute coronary syndromes: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2015;132(suppl 2):S483–S500.

What Do You Find at Cath in the Post Resuscitated STEMI Patient?

Outcomes of Comatose Cardiac Arrest Survivors With and Without ST-Segment Elevation Myocardial Infarction

Importance of Coronary Angiography

Karl B. Kern, MD,* Kapildeo Lotun, MD,* Nainesh Patel, MD,† Michael R. Mooney, MD,‡ Ryan D. Hollenbeck, MD,§ John A. McPherson, MD,§ Paul W. McMullan, MD,‖ Barbara Unger, RN,‡ Chiu-Hsieh Hsu, PhD,* David B. Seder, MD,¶ for the INTCAR-Cardiology Registry

OBJECTIVES The aim of this study was to compare outcomes and coronary angiographic findings in post-cardiac arrest patients with and without ST-segment elevation myocardial infarction (STEMI).

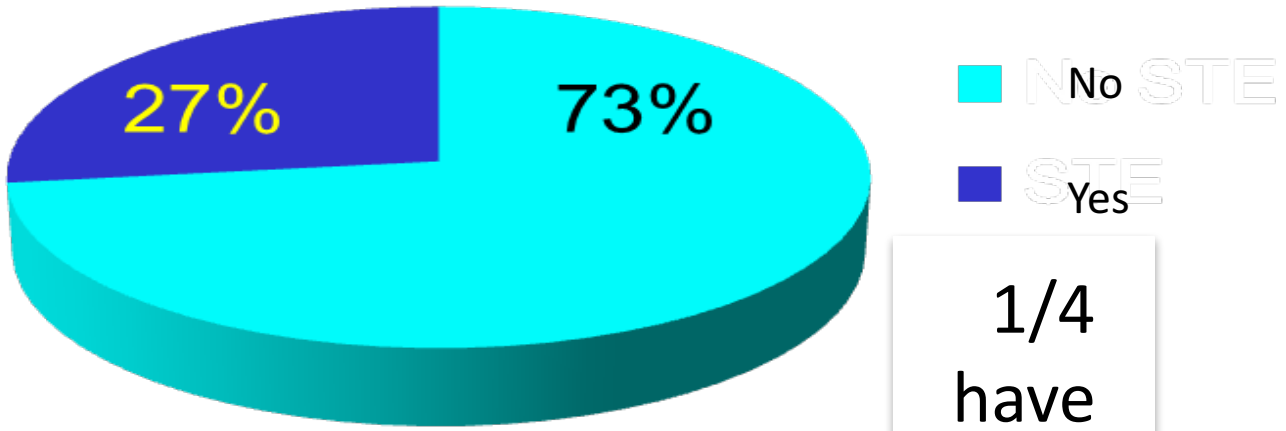
CONCLUSIONS Early coronary angiography is associated with improved functional outcome among resuscitated patients with and without STEMI. Resuscitated patients with a presumed cardiac etiology appear to benefit from immediate coronary angiography. (J Am Coll Cardiol Intv 2015;8:1031–40) © 2015 by the American College of Cardiology Foundation.

Kern KB et al. JACC Intv 2015;8:1031-40

INTCAR-Cardiology 1.0

n = 754

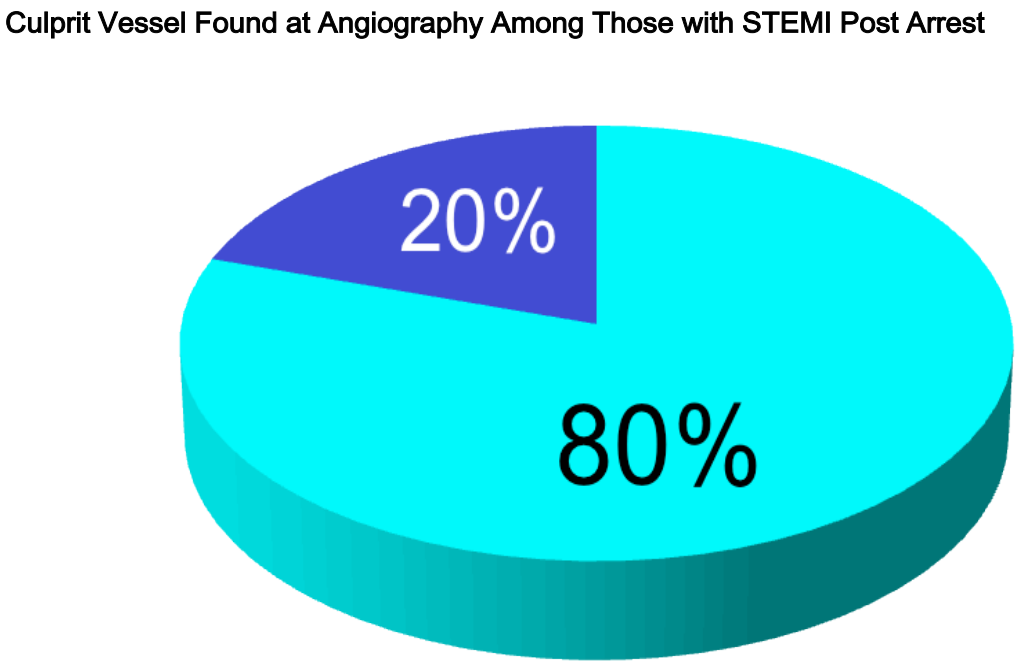
ST Elevation on initial PR ECG



1/4 have STEMI

Kern KB et al. JACC Intv 2015;8:1031-40

INTCAR-Cardiology 1.0



8 out of 10 have a culprit vessel

Kern KB et al. JACC Intv 2015;8:1031-40

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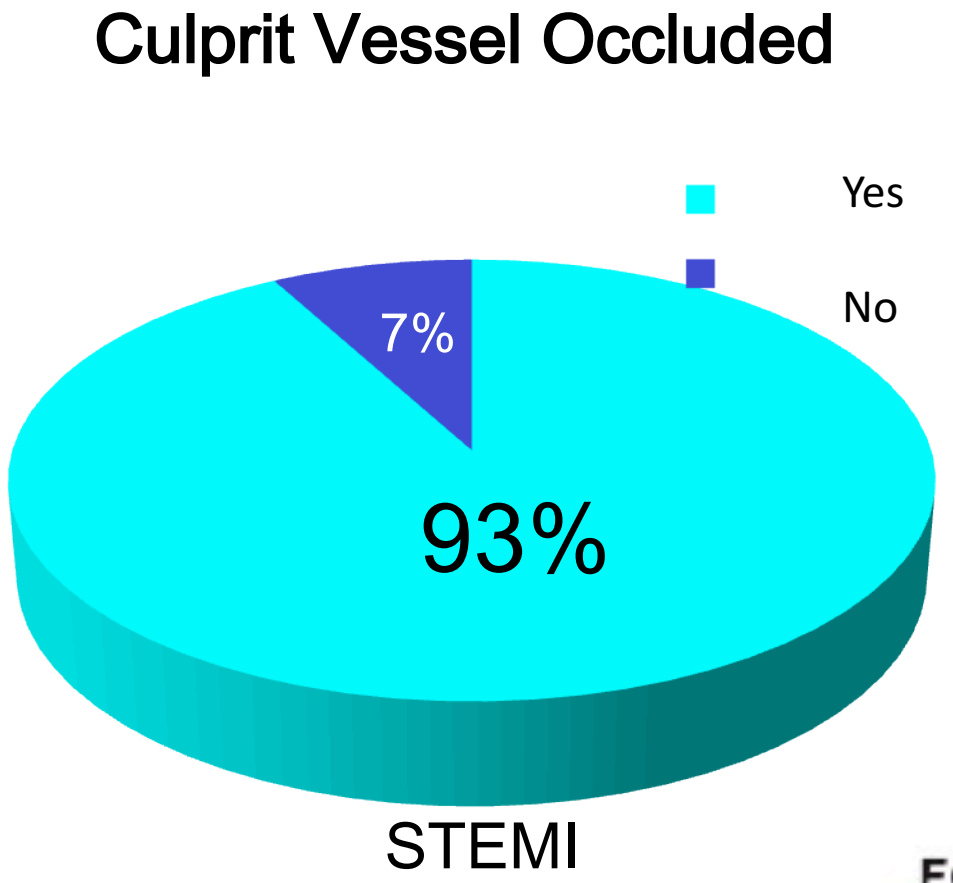
INTCAR-Cardiology 1.0



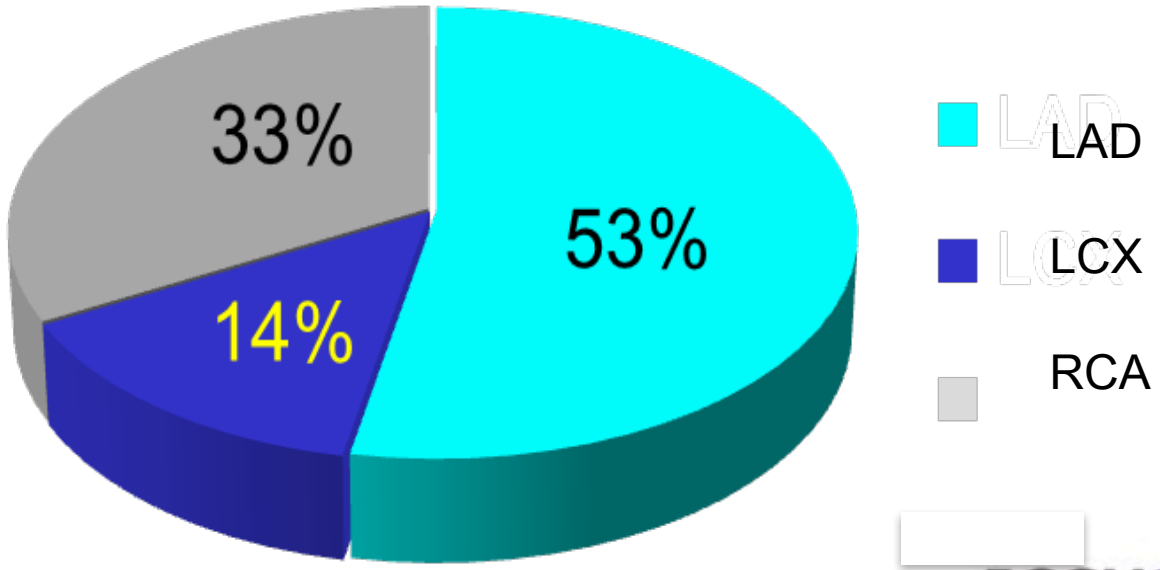
Kern KB et al. JACC Intv 2015;8:1031-40

INTCAR-Cardiology 1.0

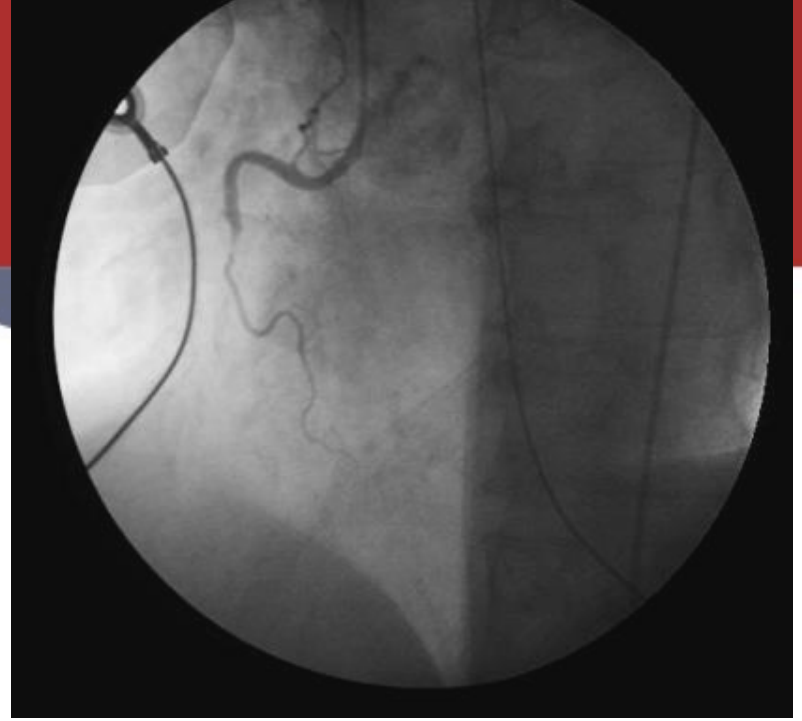
n = 141

STEMI: Culprit Vessel

p < 0.001



Kern KB et al. JACC Intv 2015;8:1031-40

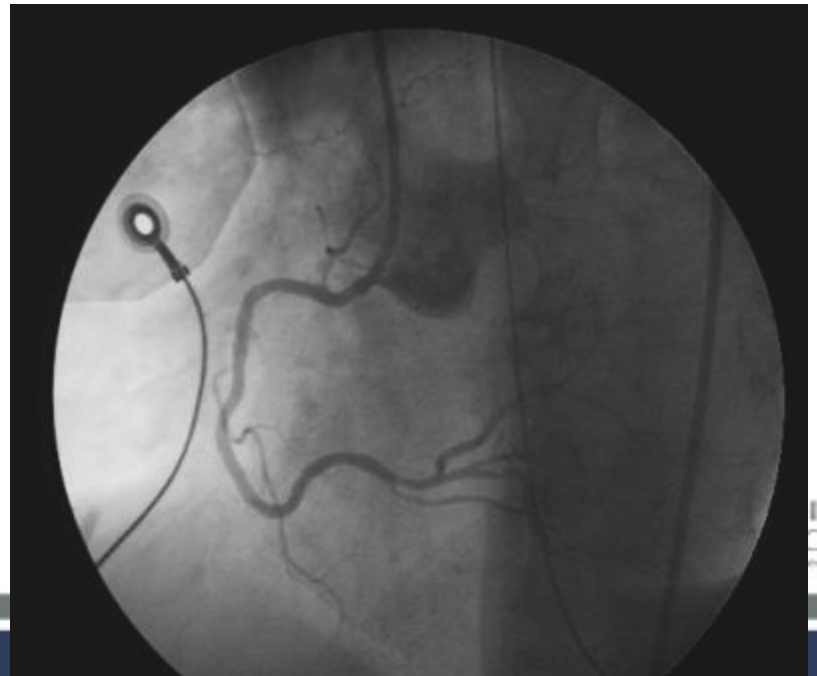


80% have identified culprit vessel

93% of such culprits are acutely occluded

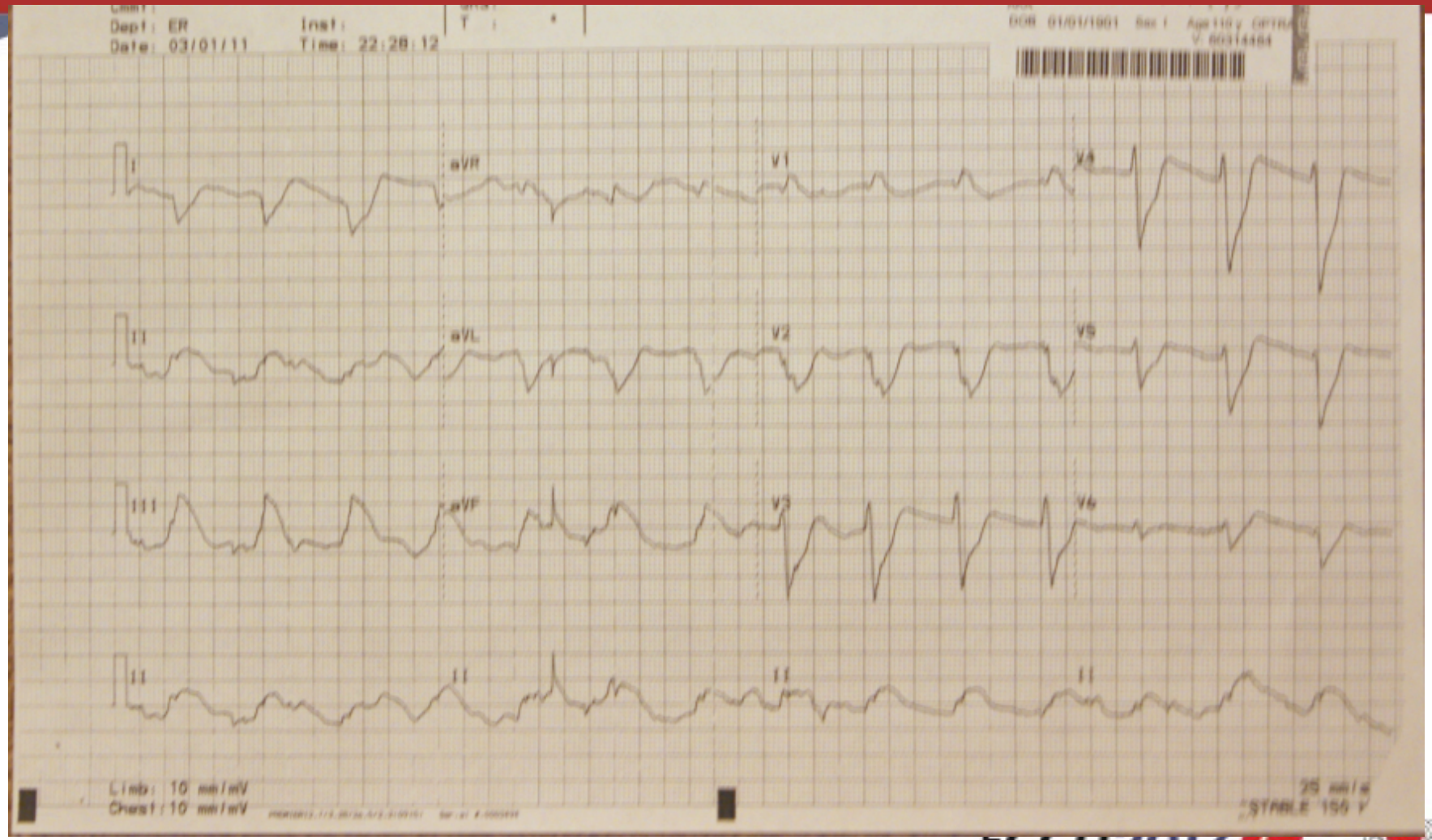
.80 X .93 = .74

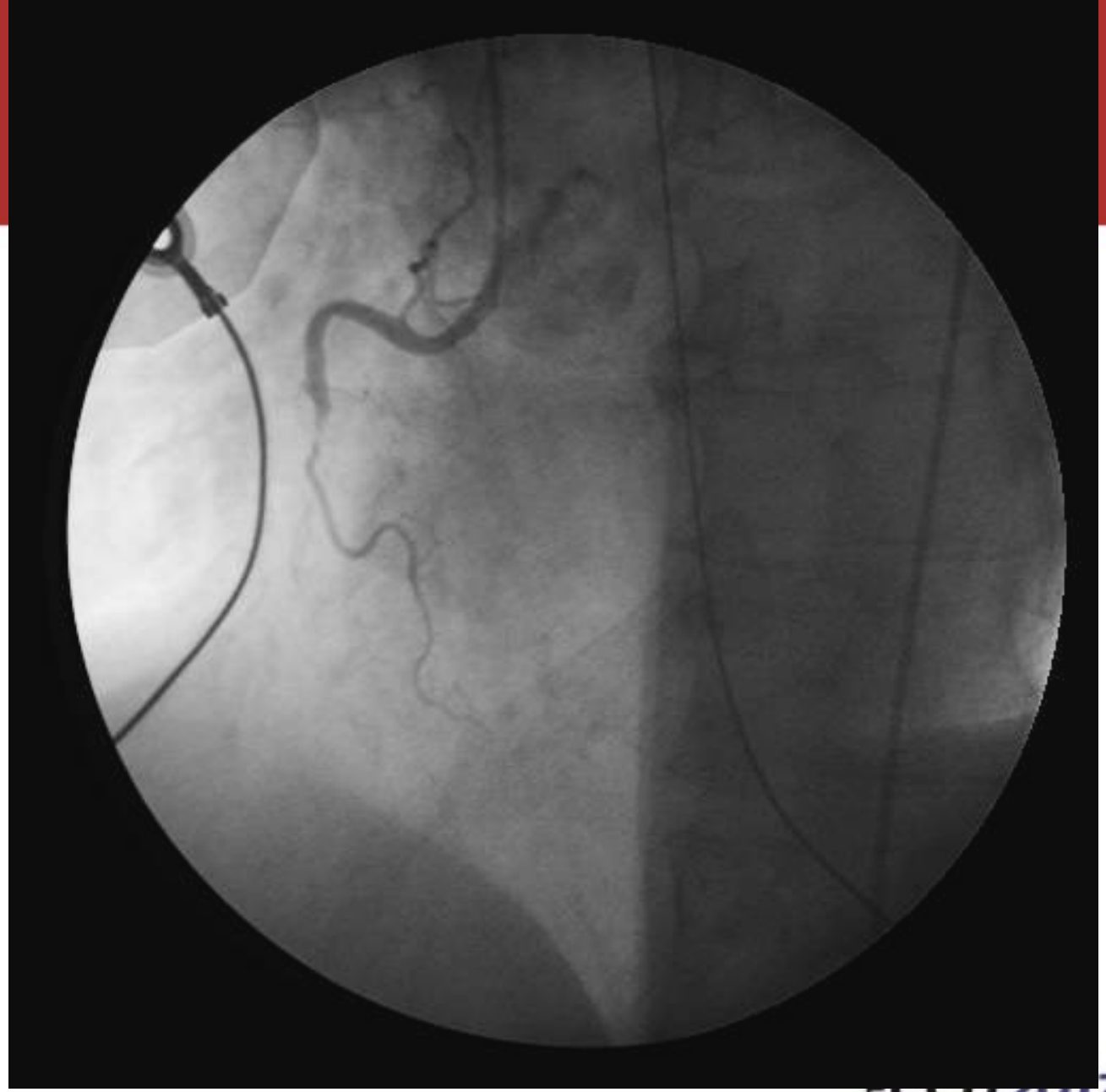
3 of every 4 such patients
have an acutely occluded culprit



- 68 yr old male with witnessed collapse
- Bystander CPR (?) started & 911 called
- EMS found pt in VF and shocked 6 times
- Defib into asystole, but developed rhythm and BP after lengthy resuscitation efforts

ECG in ED





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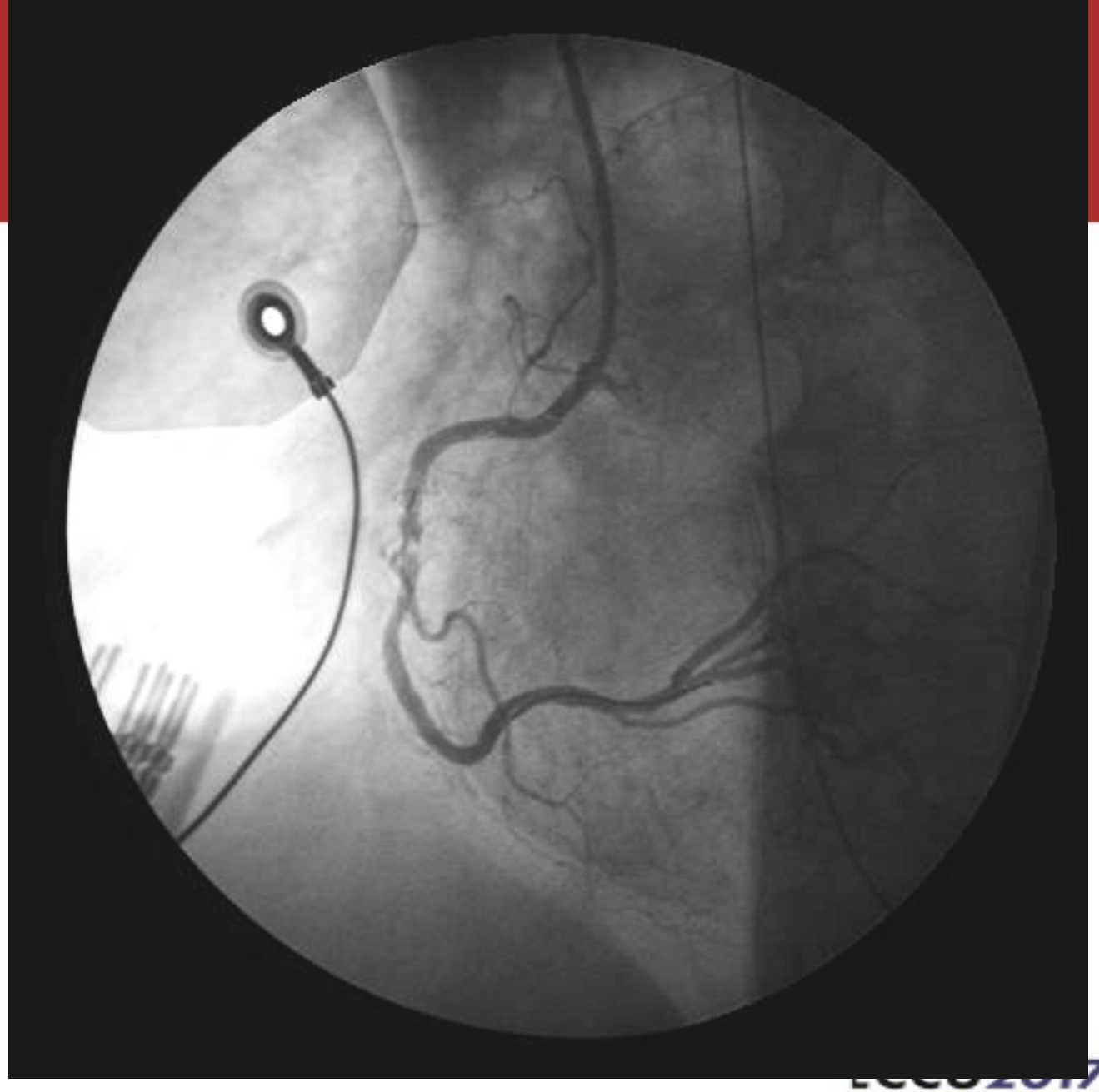

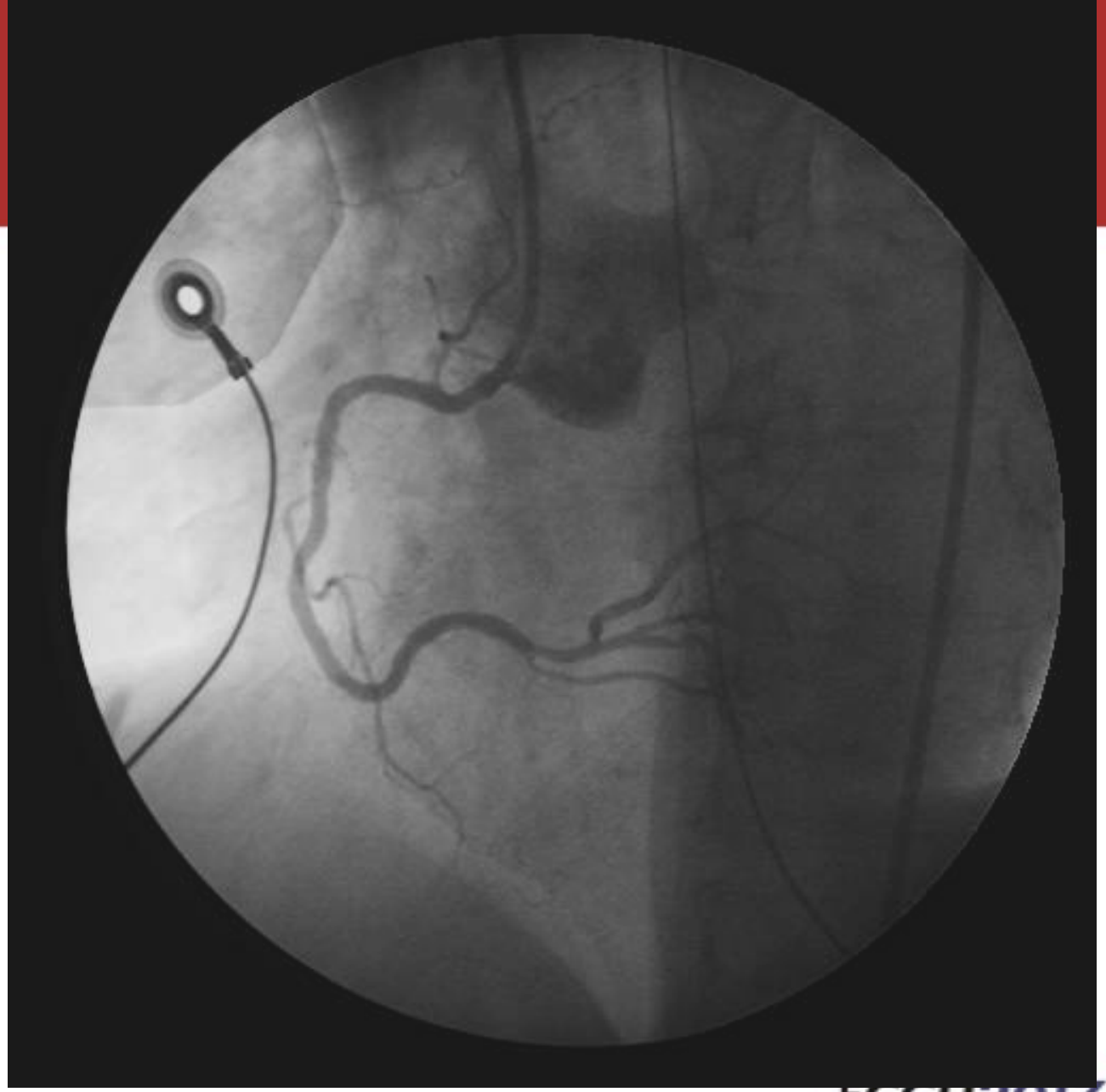

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Who Should Go to the Cath Lab Post Resuscitation?

Patients resuscitated from OHCA Associated with a STEMI

Patients resuscitated from OHCA
Without ST Elevation

| Vent rate: 132| FINAL REPORT IN MEDICAL RECORDS

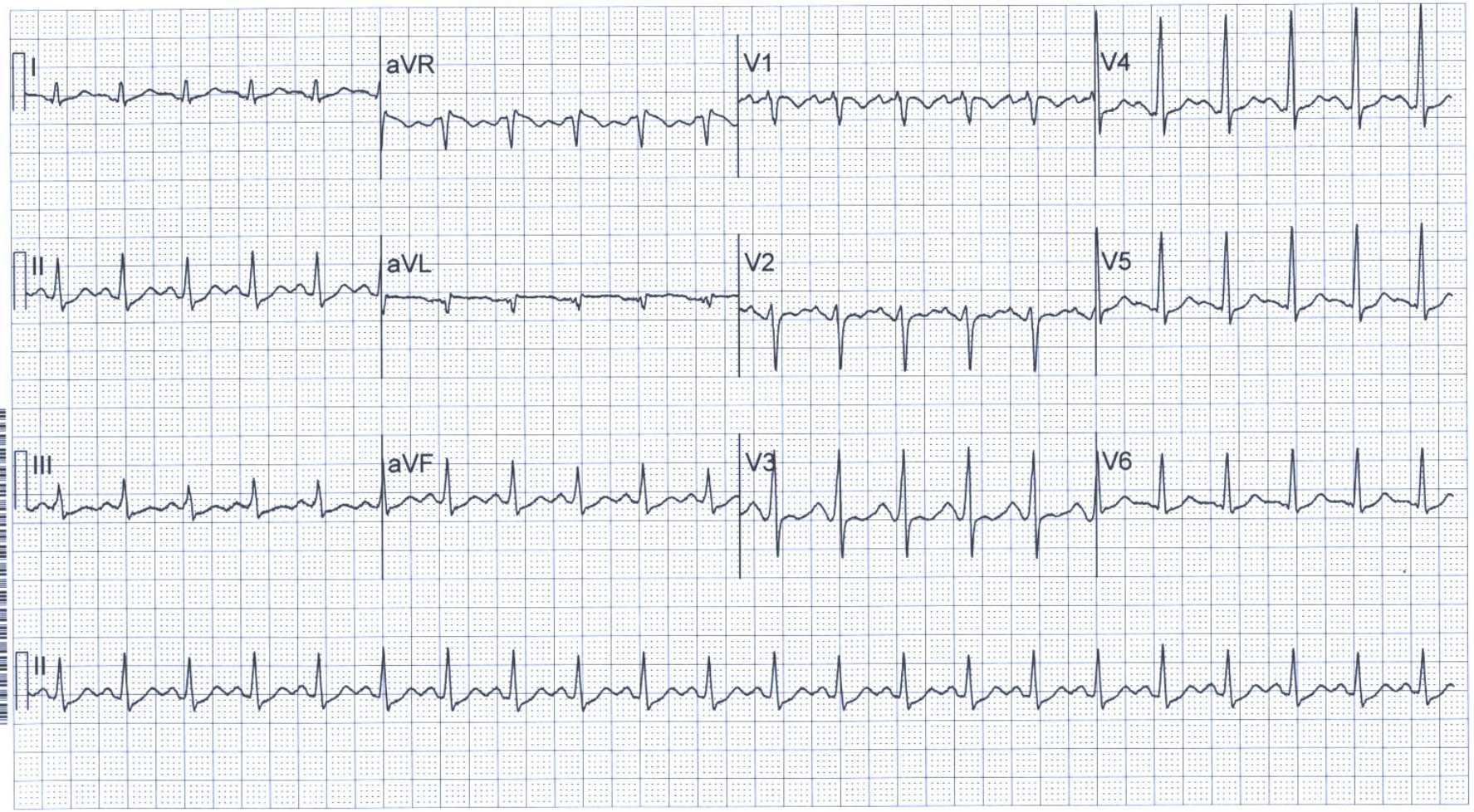
ID#: 14143580
DOB: 10/05/65 Age: 40 years
Sex: Male Race:Caucasian
Tech: RSHIRL
DX: UNC UNRS
Ord MD:BESTKIND
BEST POSS

Visit#:2902483
Dept :ER
Time: 07.26.50 05/23/06
University Medical Center

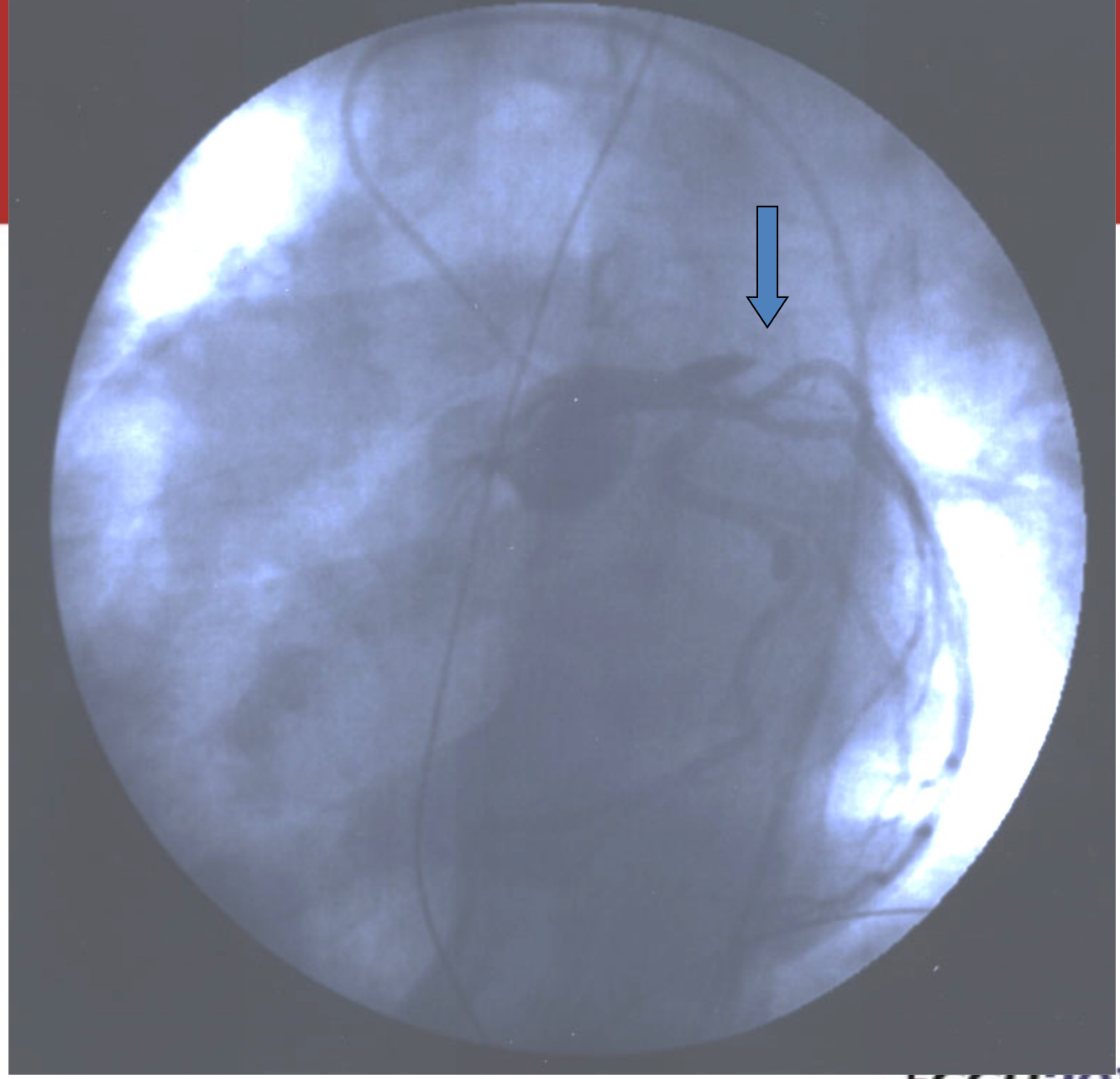
| --Durations-- |
| P : 122 |
| QRS: 100 |
| --Intervals-- |
| PR : 144 |
| QT : 314 |
| QTc: 440 |
| QTd: 34 |
| --Axes-- |
| P : 57 |
| QRS: 73 |
| T : 28 |

Reviewed by: PHYSICIAN EMERGENCY

Speed: 25 mm/s Limb Lead Gain: 10.0 mm/mV Chest Lead Gain: 10.0 mm/mV Filter(s): 60Hz Notch, 150Hz Artifact



RETRIEVE Current ECG Printed 04/06/07 09.19.55 Transcribed By: LEE PILLOW 05/29/06 12.57.26
PLUSI PLUSI1.94/3.22/25.4/1.66



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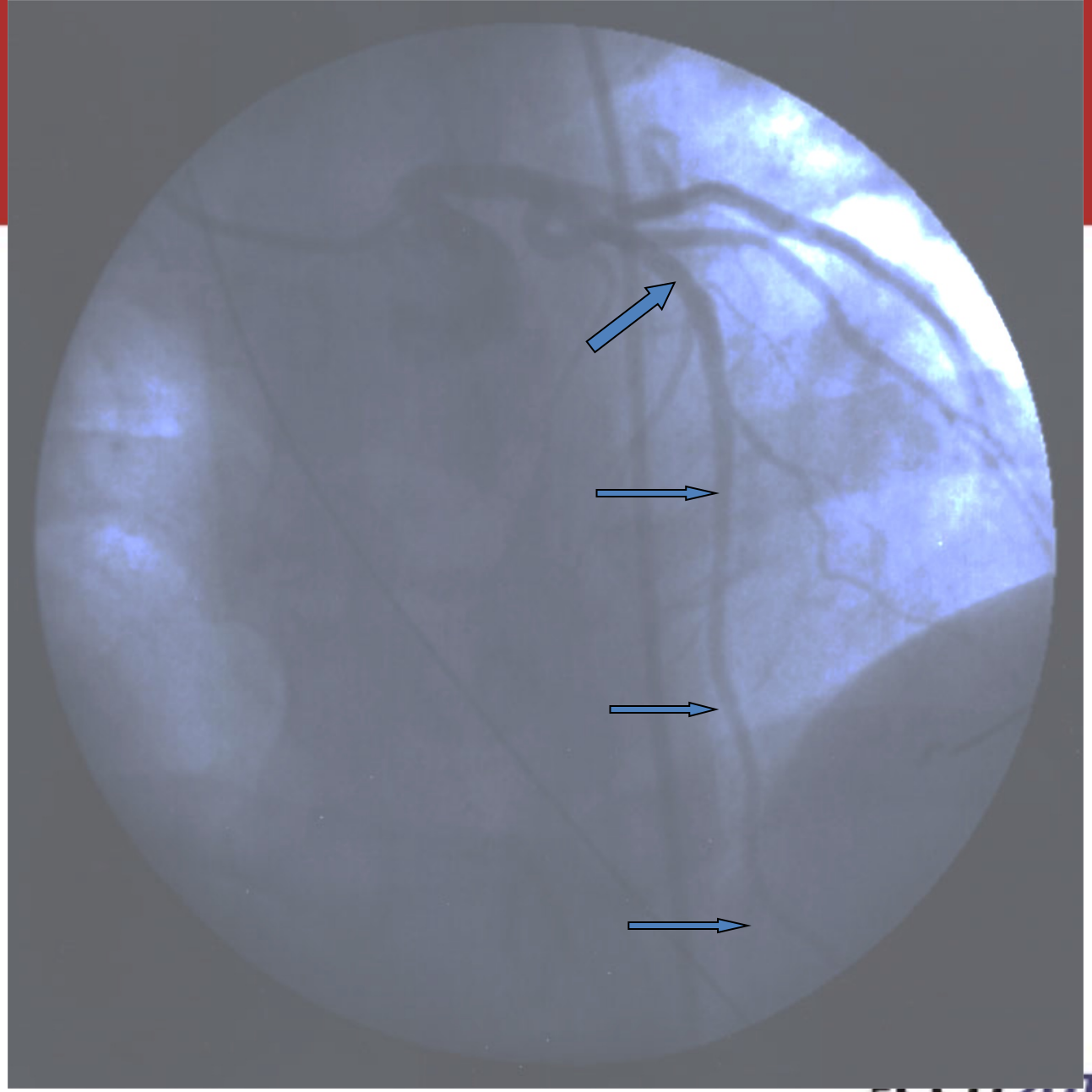
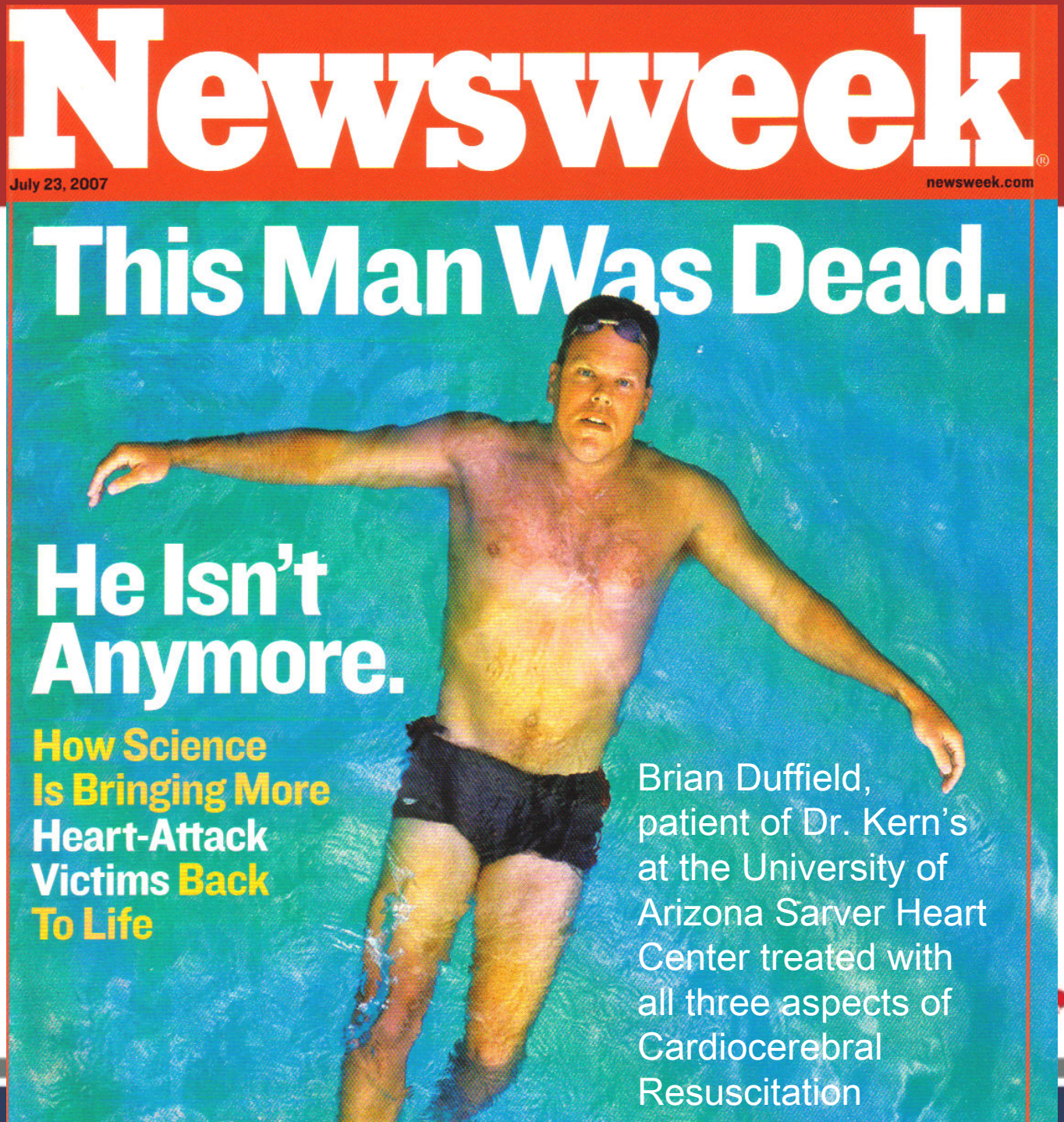


- Echo after PCI:
  - Global Hypokinesis
  - LVEF = 20%

- Warmed up after 24 hours
- COMPLETELY NORMAL CNS Function

- Discharged 5 days later
- Business trip the following week

Newsweek Cover July 23, 2007



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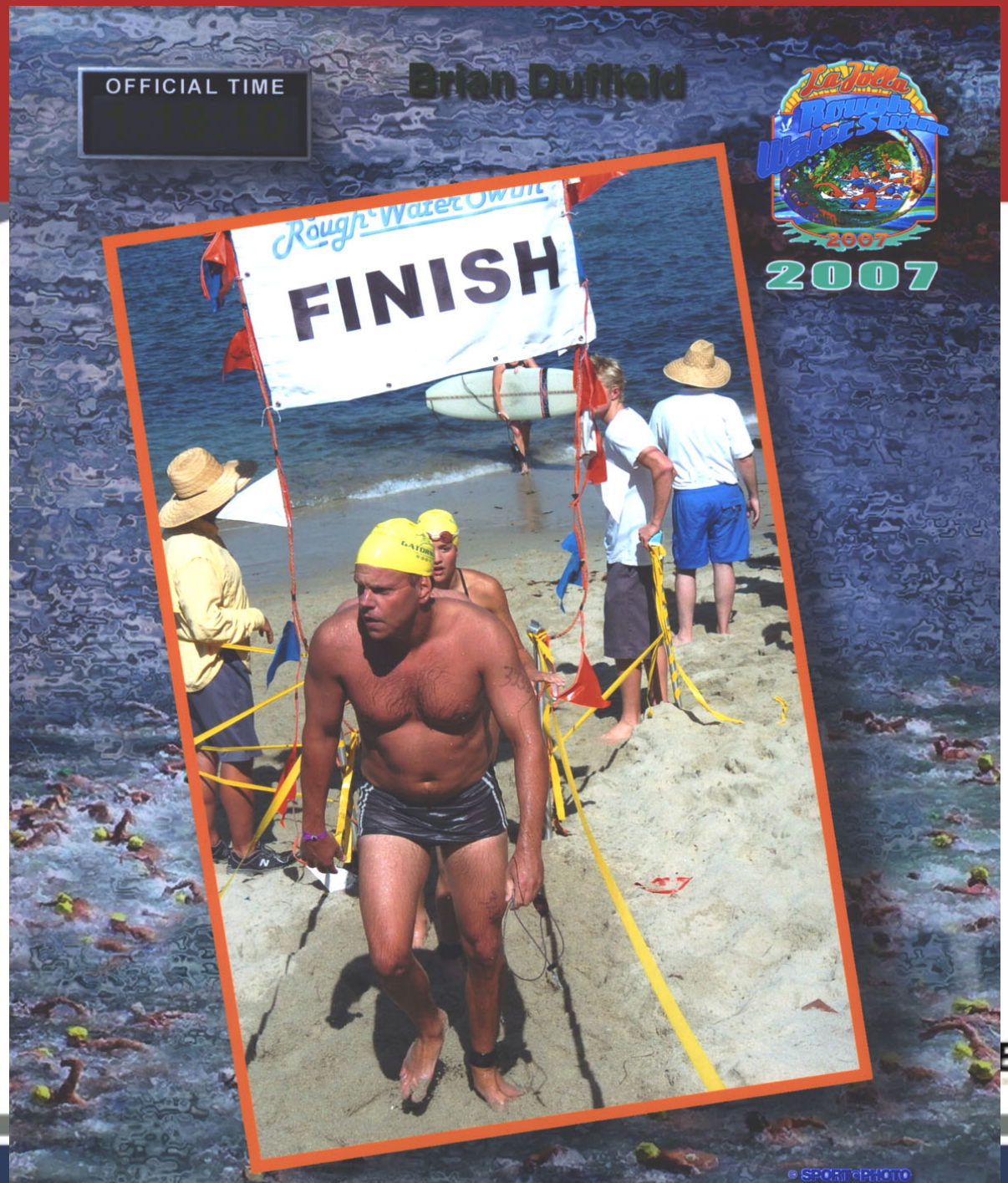

Brian Duffield,
Finishing the 3 mile
Rough Water Swim
in the Pacific Ocean
on Sept 9, 2007.

16 months after being
resuscitated from
out-of-hospital
cardiac arrest and then
receiving therapeutic
hypothermia and early
cath/PCI.

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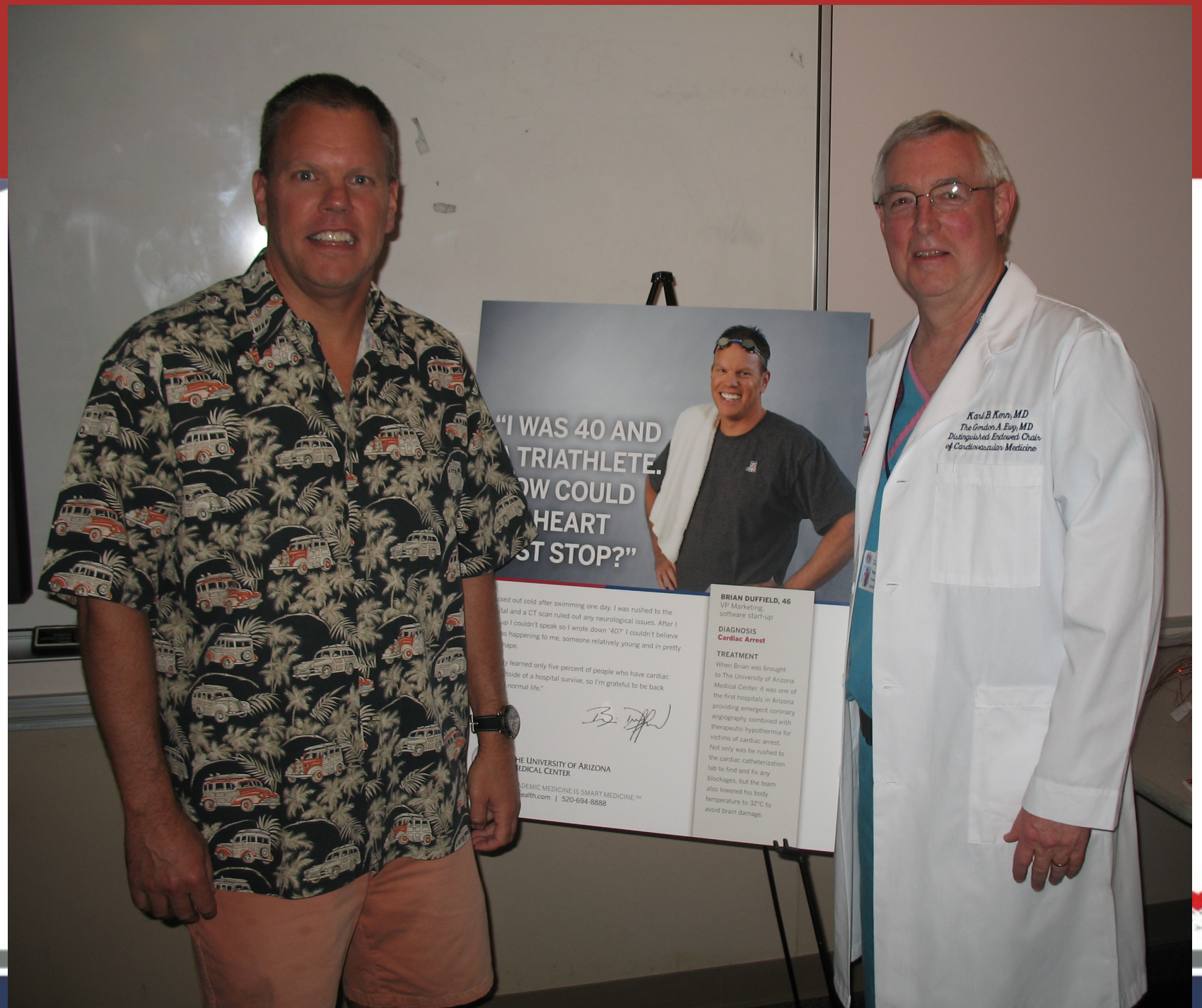

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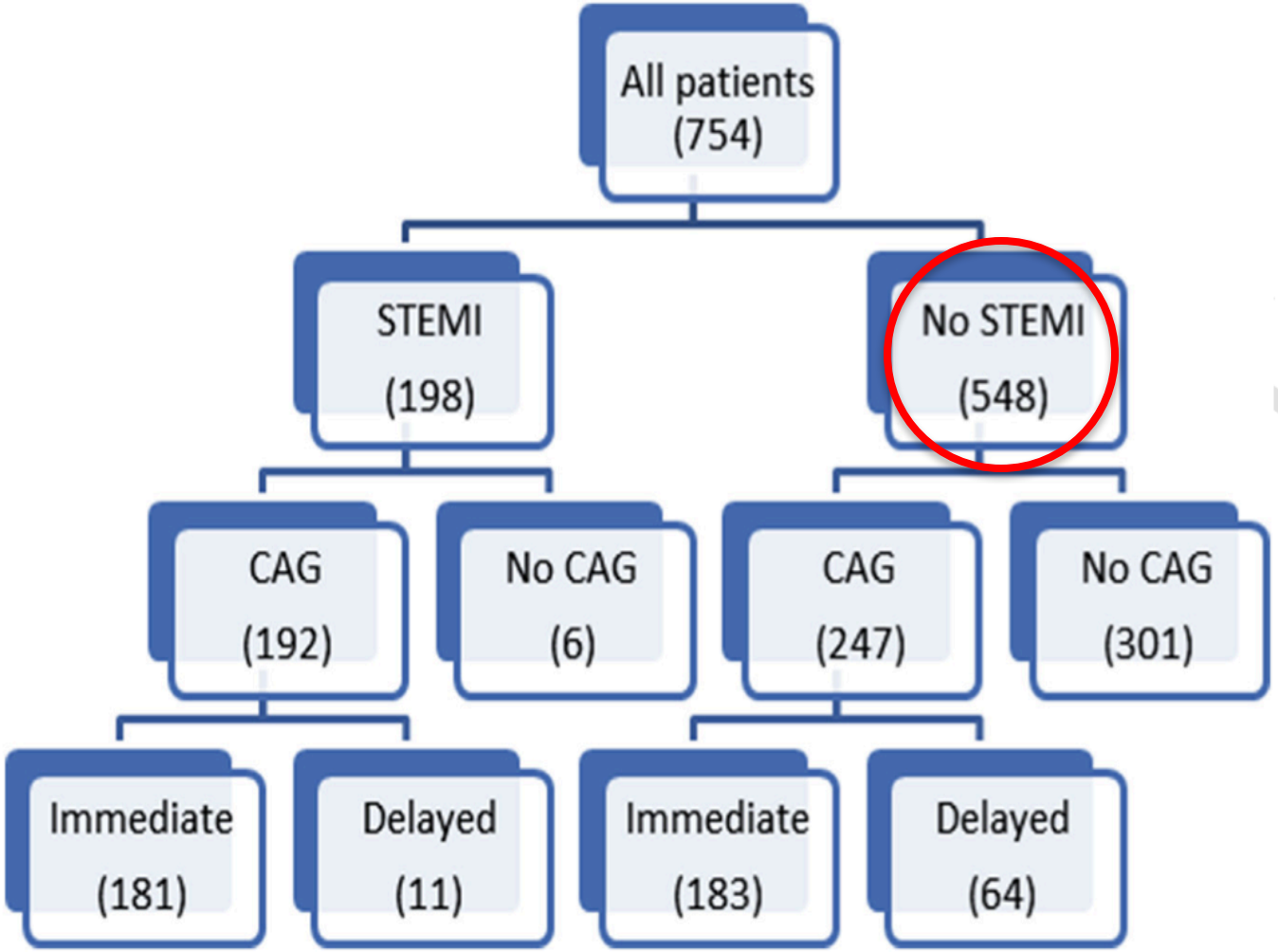
What Do You Find at Cath in the Post Resuscitated Patient Without ST Elevations?


All patients
(754)
STEMI
(198)
No STEMI
(548)
CAG
(192)
No CAG
(6)
CAG
(247)
No CAG
(301)
Immediate
(181)
Delayed
(11)
Immediate
(183)
Delayed
(64)

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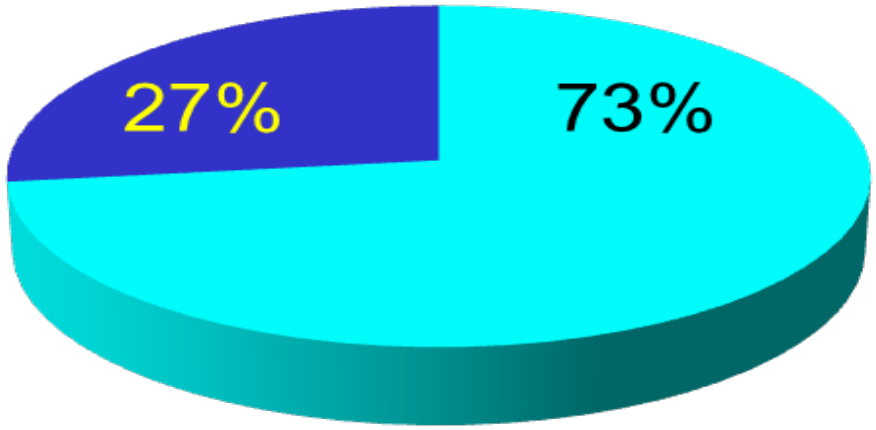
n = 754

ST Elevation on initial PR ECG

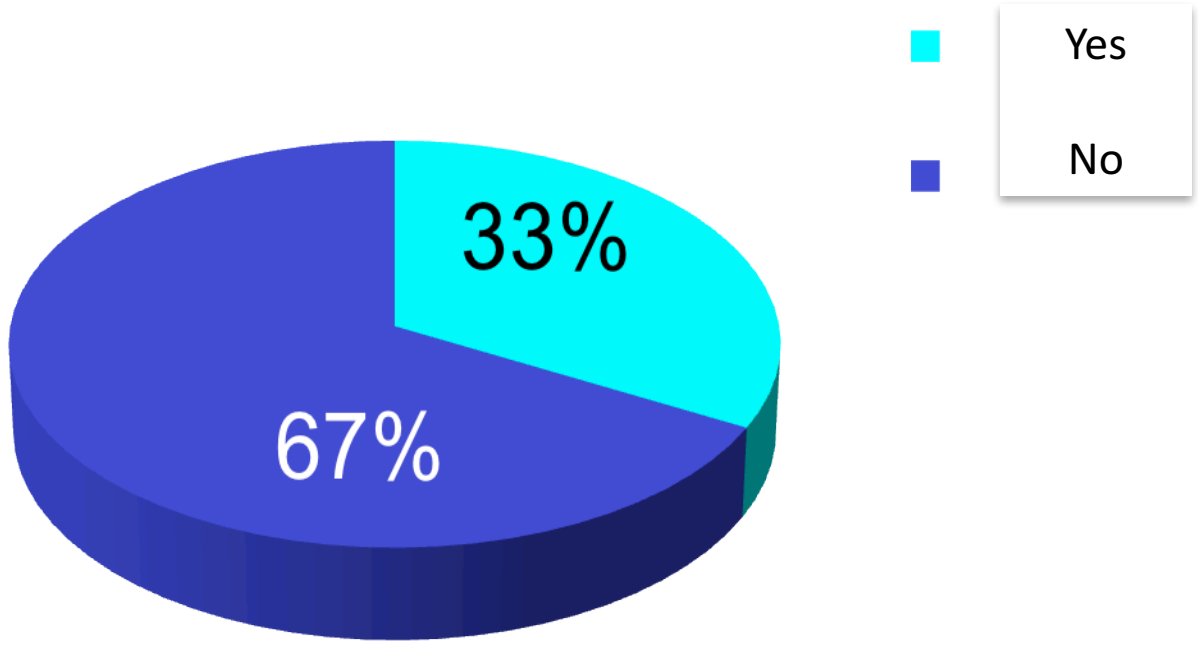


3/4 have No ST Elevation

Kern KB et al. JACC Intv 2015;8:1031-40

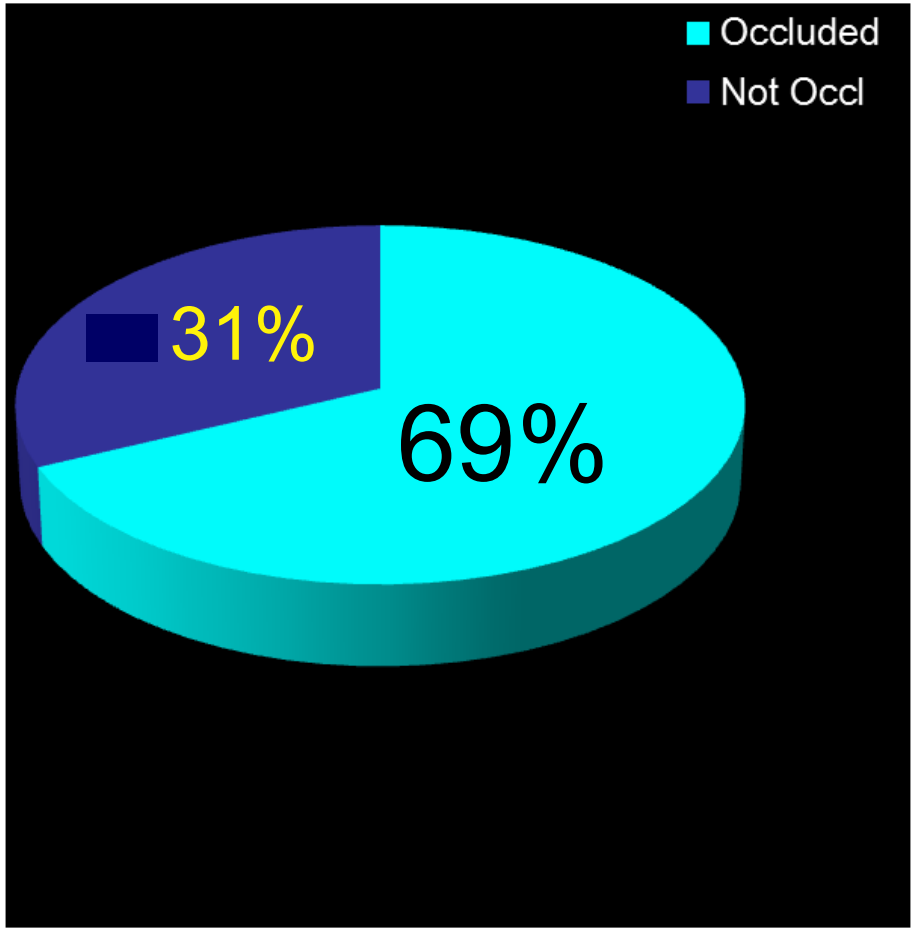
No ST Elevation

Culprit Vessel Found at Angiography



No ST Elevation

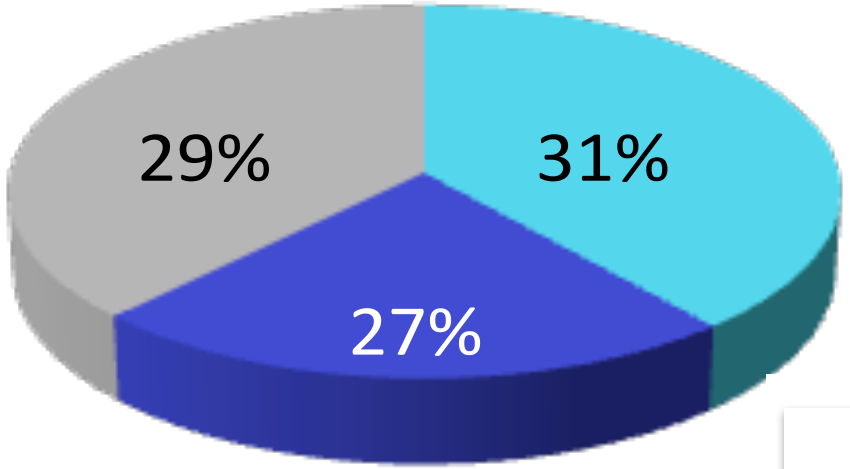
Culprit Vessel Occluded



No ST Elevation Culprit Anatomy

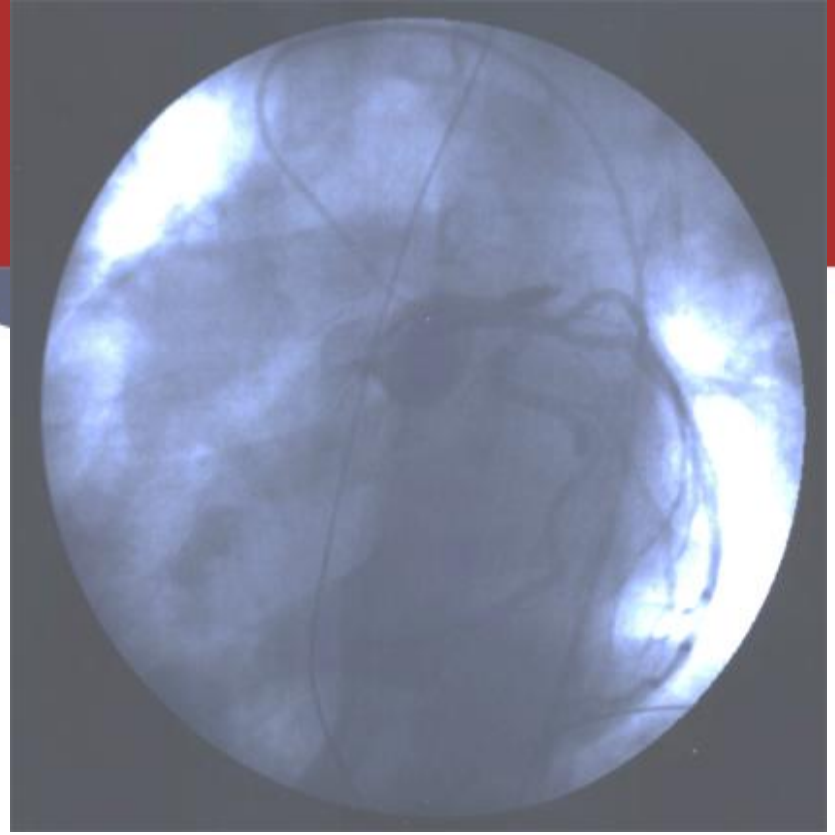
n = 222

No STEMI: Culprit Vessel



LM = 13%

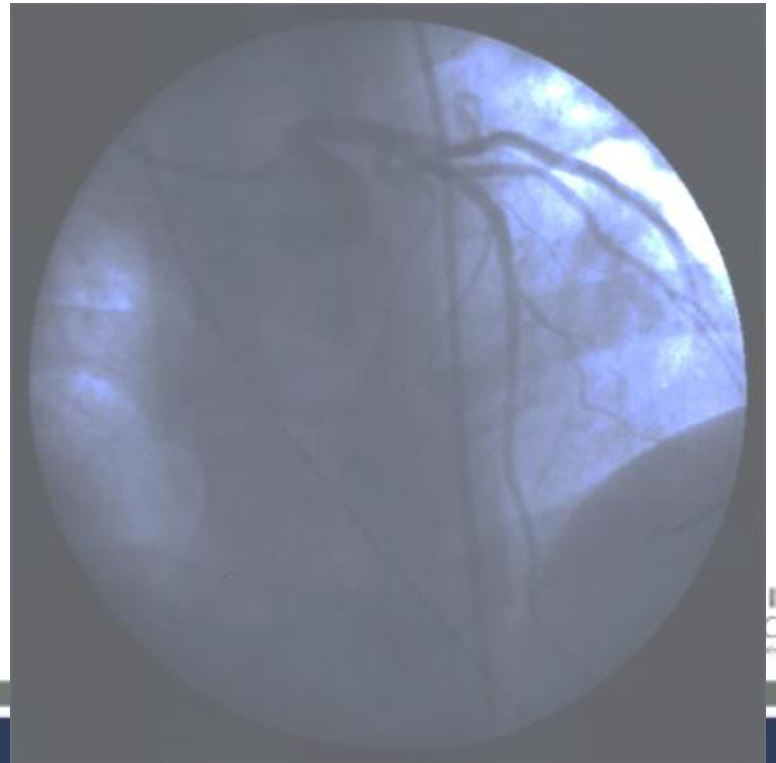
p = NS



33% have identified culprit vessel
69% of such culprits are acutely occluded

.33 X .69 = .23

1 of every 4 such No STE patients have an acutely occluded culprit



No ST Elevation but Acutely Occluded Coronary at Angiography Post Arrest

Spaulding 1997:	9/85	(11%)
Anyfantakis 2009:	8/44	(17%)
Radsel 2011:	20/54	(36%)
Gupta 2014:	891/2775	(32%)
Kern 2015:	57/247	(23%)
SUMMARY:	985/3205	(31%)

What Proportion is Enough?

1:1?

1:2?

1:3?

1:4?

1:5?

Is 1:3 or 1:4 Enough?

Because that's what it is!

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Can We More Selectively Identify the Non-STEMI CA Patients that should go to the Cath Lab ?

Spaulding et al.

"Clinical and electrocardiographic findings, such as chest pain and or ST elevation on the ECG were poor predictors of acute coronary occlusion."

9/85 (11%) of patients found to have an acutely occluded coronary without ST elevation on the post resuscitation ECG nor precedent chest pain prior to cardiac arrest

NEJM 1997;336:1629

Using Additional Post Resuscitated ECG Data

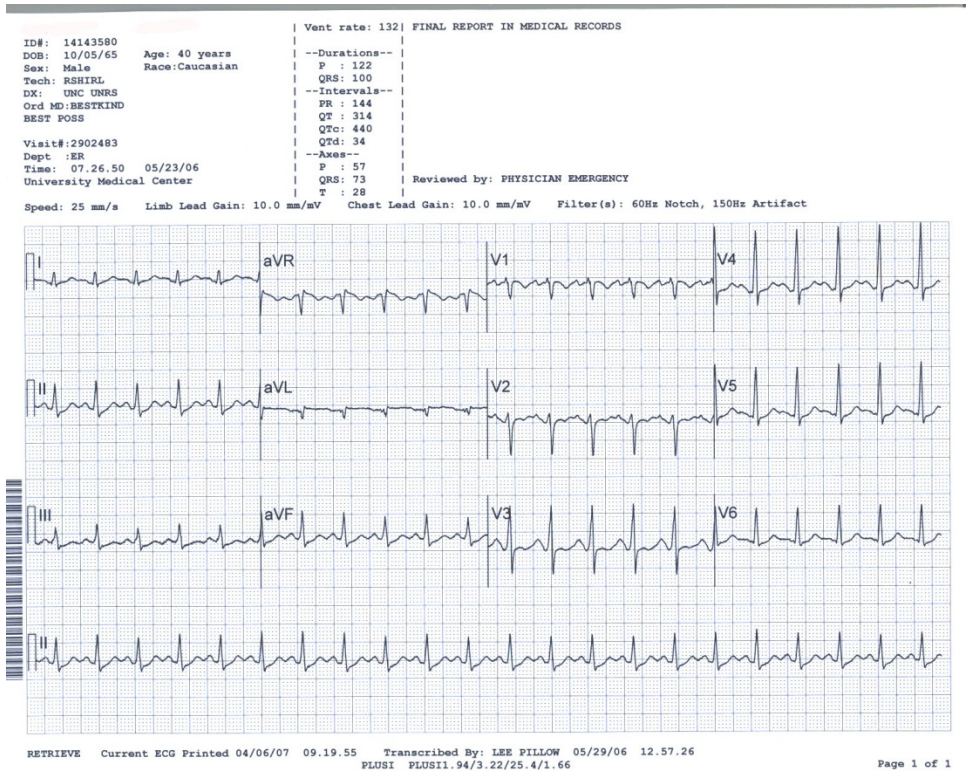
n = 169 patients; Sensitivity and specificity for AMI

ST elevation present:	88% & 84%
Plus ST depression:	95% & 62%
Plus BBB:	100% & 46%

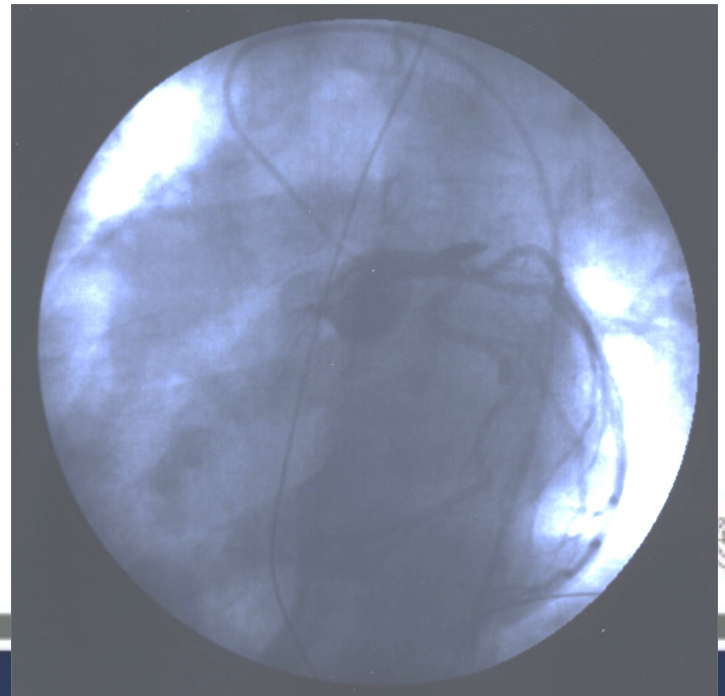
- 30% of those cathed would not have had such, with none of those pts would have CAD

Siderais et al. Resuscitation 2011;82:1148

Criteria not yet independently validated on a separate population



Can't be 100% sensitive, for it would have missed this case of an acute occluded LAD



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JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY
VOL. 66, NO. 1, 2015

ISSN 0735-1097/$36.00
PUBLISHED BY ELSEVIER INC.
http://dx.doi.org/10.1016/j.jacc.2015.05.009

THE PRESENT AND FUTURE

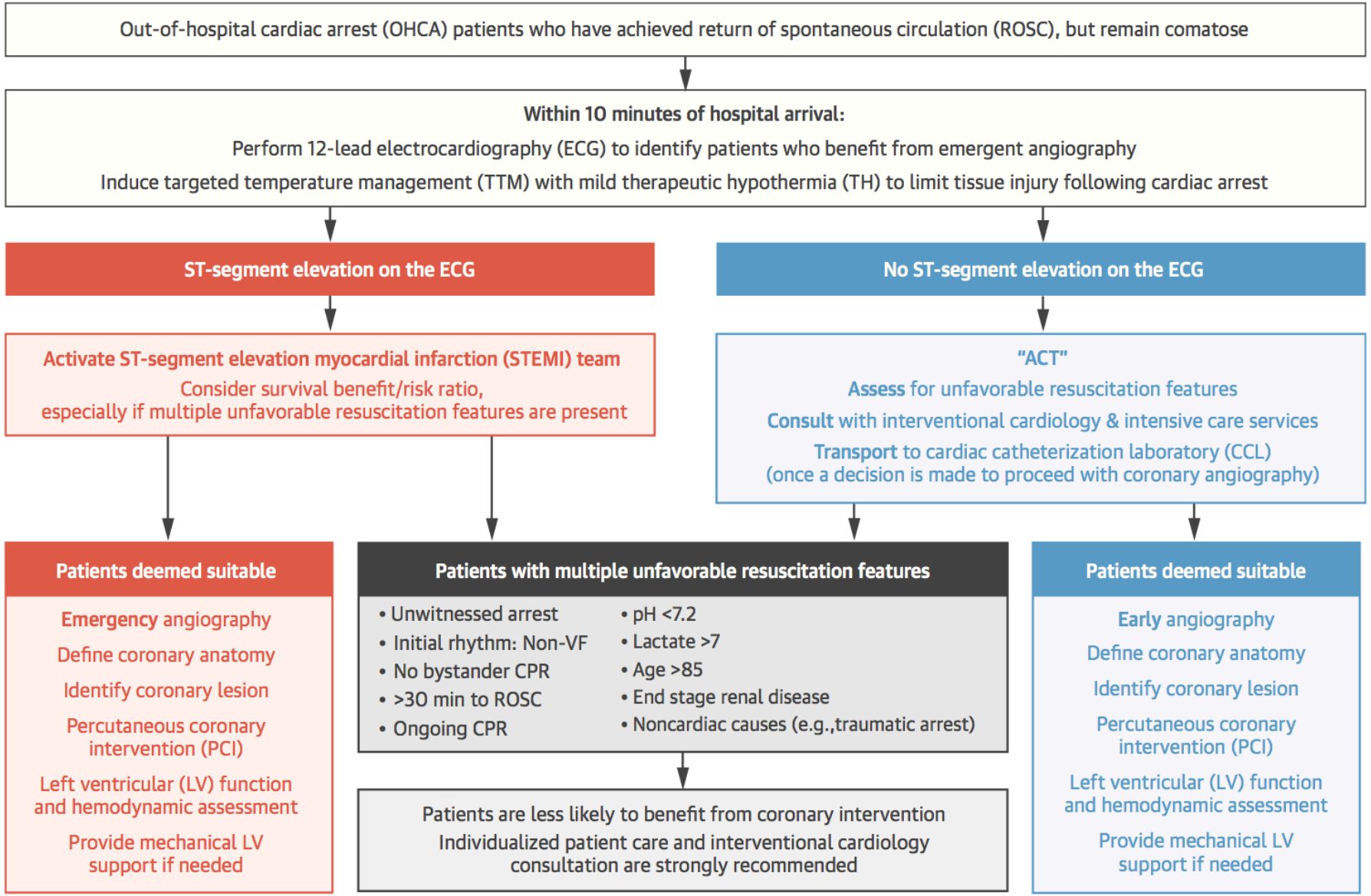
COUNCIL PERSPECTIVES

Cardiac Arrest

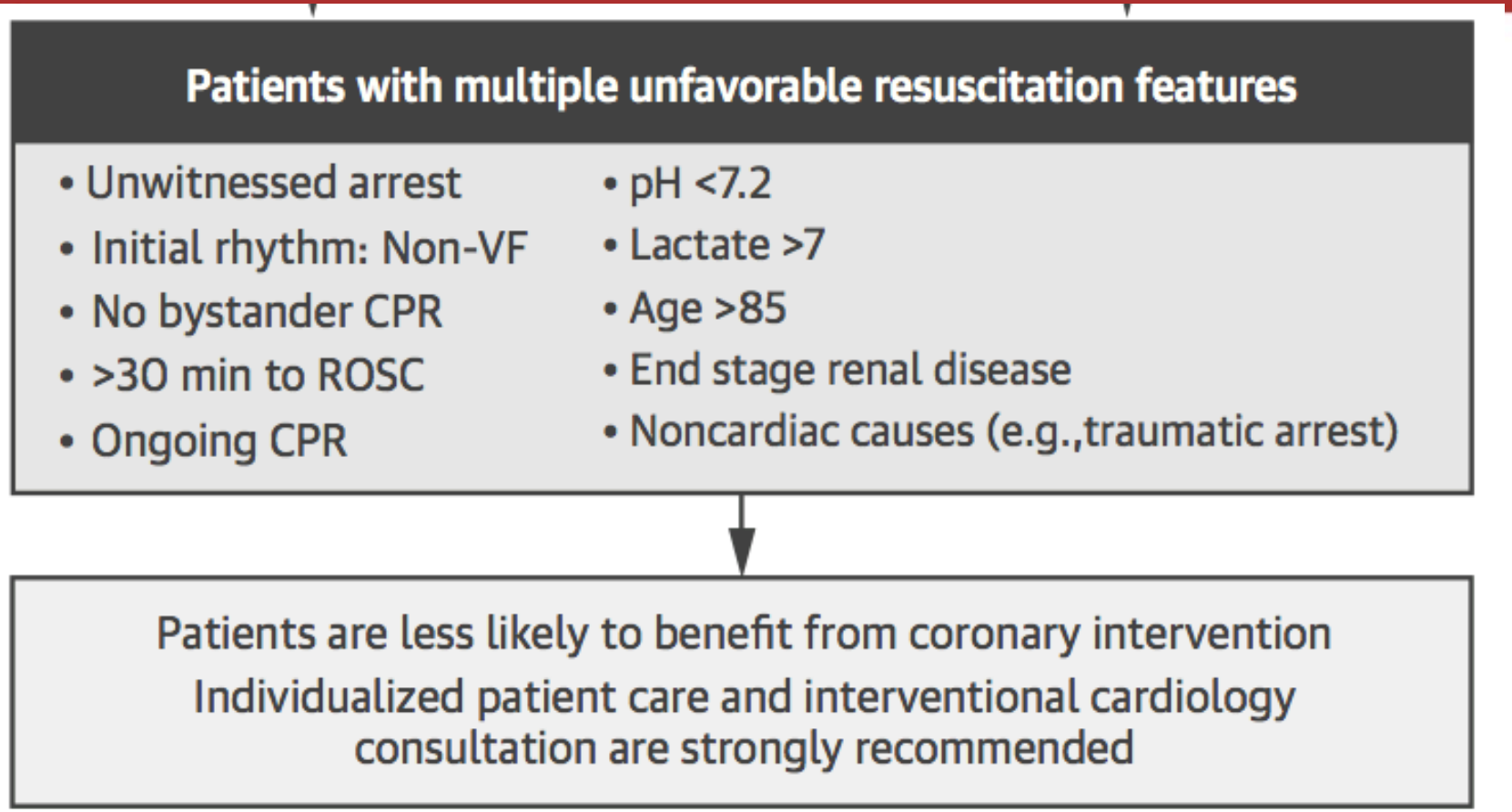
A Treatment Algorithm for Emergent Invasive Cardiac Procedures in the Resuscitated Comatose Patient

Tanveer Rab, MD,* Karl B. Kern, MD,† Jacqueline E. Tamis-Holland, MD,‡ Timothy D. Henry, MD,§ Michael McDaniel, MD,‖ Neal W. Dickert, MD, PhD,* Joaquin E. Cigarroa, MD,¶ Matthew Keadey, MD,# Stephen Ramee, MD,** on behalf of the Interventional Council, American College of Cardiology

CENTRAL ILLUSTRATION **Algorithm for Risk Stratification of Comatose Cardiac Arrest Patients**



Rab, T. et al. J Am Coll Cardiol. 2015; 66(1):62-73.



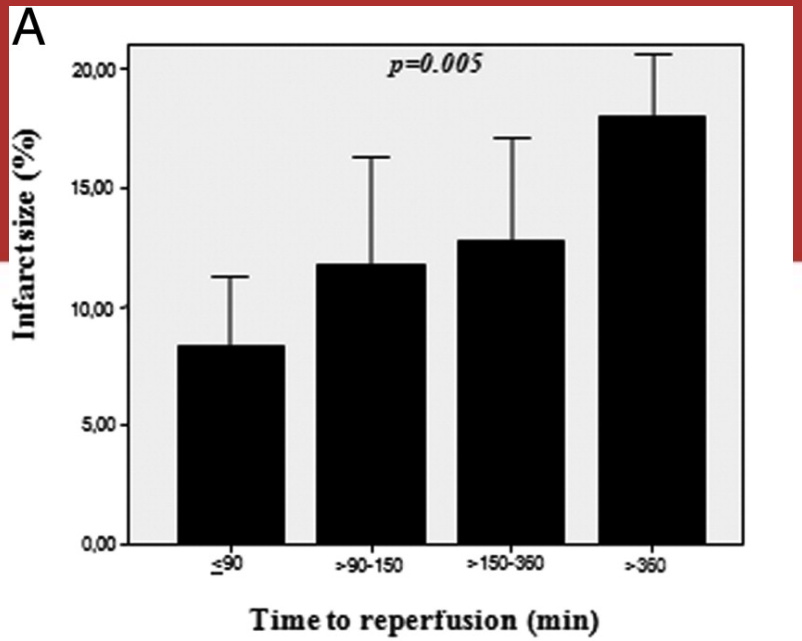
Rab & Kern et al. J Am Coll Cardiol 2015;66:62-73

Early Cardiac Catheterization and PCI After Resuscitation from Cardiac Arrest

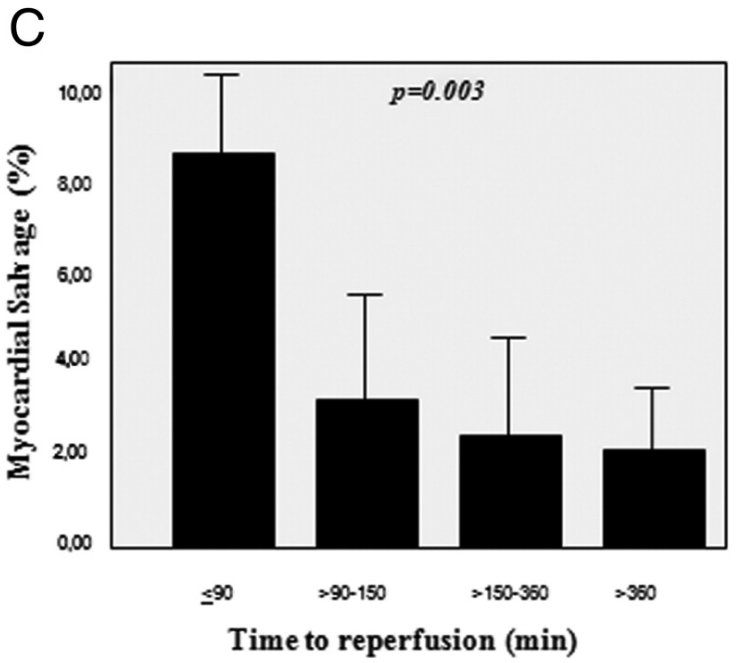
- ❑Who should go to the Cath Lab?
- ❑When should they go?
- ❑Does it Really Improve Outcome?

What's the Real Purpose of Catheterization Post Arrest?

- Salvage Myocardium
  - Preserve LV Function
  - Prevent Recurrent Cardiac Arrest
- Improve Favorable Long-Term Survival
  - Neurologically-intact survival!



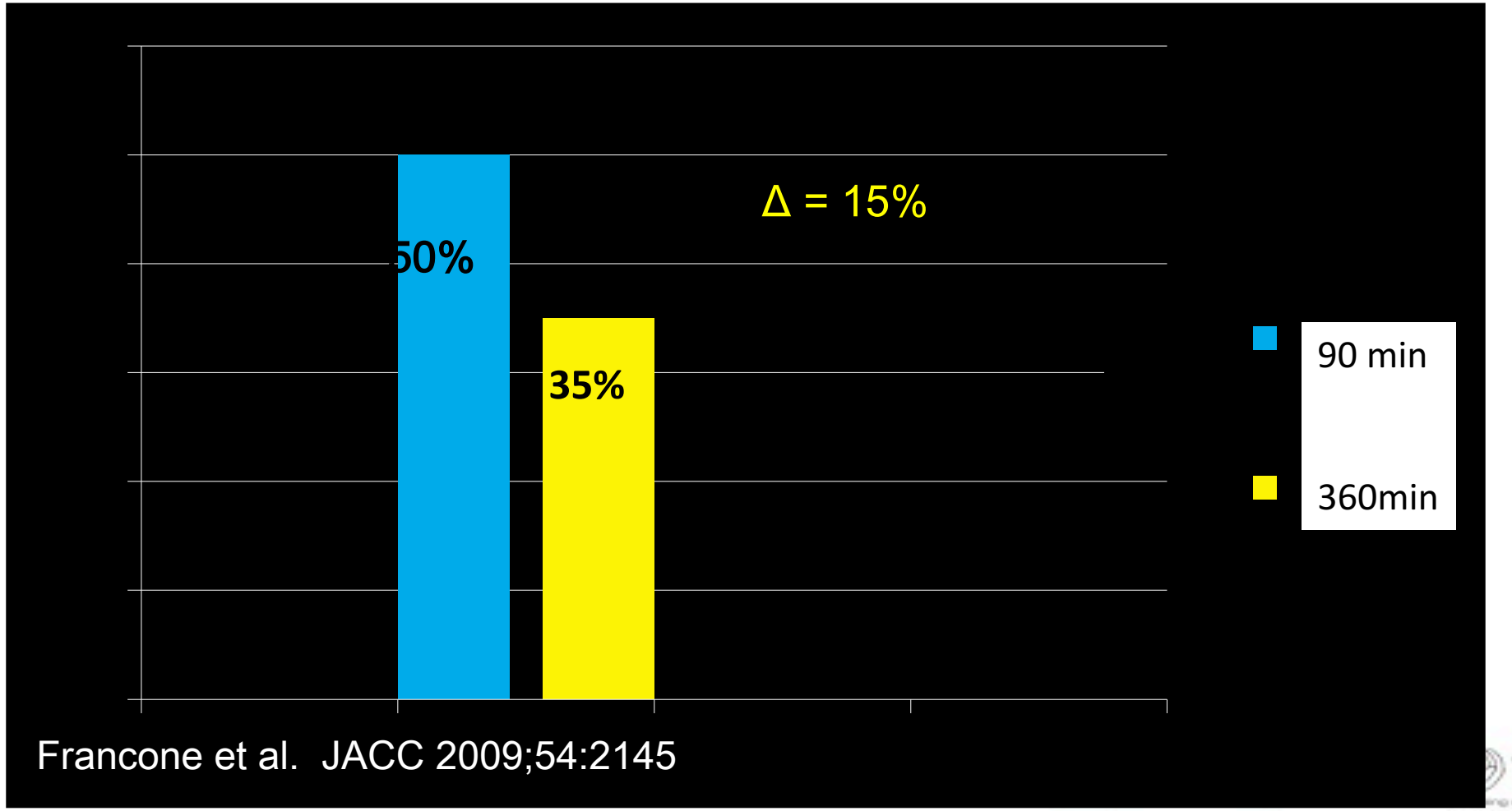
Infarct size doubles if wait to reperfuse for 6 hours



Percent of myocardium Salvaged decreases From 9% to 2%.

Francone et al. JACC 2009;54:2145

LVEF After Reperfusion
(100% Occlusion of Culprit Vessel)



Francone et al. JACC 2009;54:2145

What Accomplishes That Best?

Early Emergent Catheterization and PCI

or

Late “Elective” Catheterization and PCI
After Neurological Status is Known

2015 AHA CPR Guidelines

2015 Recommendations—Updated

- Emergency coronary angiography is reasonable for select (eg, electrically or hemodynamically unstable) adult patients who are comatose after OHCA of suspected cardiac origin but without ST elevation on ECG

  (Class IIa, LOE B-NR).

O'Connor RE, et al. Part 9: acute coronary syndromes: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2015;132(suppl 2):S483–S500.

Early Cardiac Catheterization and PCI After Resuscitation from Cardiac Arrest

- ❑Who should go to the Cath Lab?
- ❑When should they go?
- ❑Does it Really Improve Outcome?

The Data in 2015

- No randomized, controlled studies

- Lots of cohort: “Before and After” evidence
  - Nearly 9,000 patients in literature
  - Very consistent:
    - 62% survival to discharge
    - 89% of survivors have good neuro function

- But that’s still not …“Proof”

What's Next ?

- General consensus that RCTs are needed to resolve the controversy around those without ST elevation.

- Numerous calls for such RCTs.

  "…emphasizes the need for a randomized comparison"

JACC Intv 2015;8:1041-3.

Randomized Clinical Trials of Coronary Angiography for Out-of-Hospital Cardiac Arrest

Protocol Titles	**DISCO (Pilot)** **DI**rect or **S**ubacute **CO**ronary angiography in out-of-hospital cardiac arrest - a randomized Study NCT02309151	**COACT** **CO**ronary **A**ngiography after **C**ardiac arres**T**: NTR4973 www.trialregister.nl	**PEARL** A Randomized **P**ilot Clinical Trial for **E**arly Coronary **A**ngiography Versus No Early Coronary Angiography for Post-Cardiac **AR**rest Patient with No ST Segment **EL**evation on their ECG NCT02387398	**Cardiac Catheterization in Cardiac Arrest** Role of **Cardiac Catheterization in Cardiac Arrest**-A pilot Study NCT02587494	**COUPE** Coronangiography in **OU**t-of-Hos**P**ital Cardiac Arr**E**st NCT02641626
PI(s):	Prof. Sten Rubertsson/ Per Nordberg MD, PhD	Prof. Jorrit S. Lemkes	Prof. Karl B. Kern	Prof. Shahar Lavi	Prof. Ana Viana-Tejedor

Country Clinical Centers	Sweden 15	Netherlands 14	USA; Slovenia; Australia 5	Canada ?	Spain 8
Start and End Dates	Dec 2014 Mar 2017	1 Dec 2014 1 Dec 2017	Dec 2015 Nov 2018	Dec 2015 Dec 2018	Jan 2016 July 2019
Projected "N"	80	552	140	75	166

Protocol Titles	**TOMAHAWK** Immediate Unselected Coronary Angiography Versus Delayed Triage in Survivors of Out-of-hospital Cardiac Arrest Without ST-segment Elevation NCT02750462	**EMERGE** **Emerge***ncy* versus delayed coronary angiogram in survivors of out-of-hospital cardiac arrest with no obvious non cardiac cause of arrest NCT02876458	**DISCO-2 (Pivotal trial)** **DI**rect or **S**ubacute **CO**ronary angiography in out-of-hospital cardiac arrest - a randomized Study NCT02309151	**ACCESS** **ACCESS** to the cardiac catheterization laboratory in patients without ST-segment elevation myocardial infarction resuscitated from out-of-hospital cardiac arrest NCT03119571
PI (s):	Prof. Steffen Desch	Prof. Christian Spaulding	Prof. Sten Rubertsson/ Per Nordberg MD, PhD	Prof. Demetris Yannopoulos/ Prof. Tom Aufderheide

Country Clinical Sites	Germany 17 (goal 37)	France 21	Sweden plus? 15	USA 30
Start and End Dates	Aug 2016 Aug 2019	Dec 2016 June 2019	Sept 2017 Sept 2020	Jan 2018 Dec 2021
Projected "N"	558	970	1006	864

Cardiology Issues:

- Early Coronary Angiography & PCI
- Mechanical CPR & Rescue PCI
- ECMO & LVADs
- Hyper-invasive Approach for Refractory Cardiac Arrest

What if that Cardiac Arrest Location is the Cath Lab?

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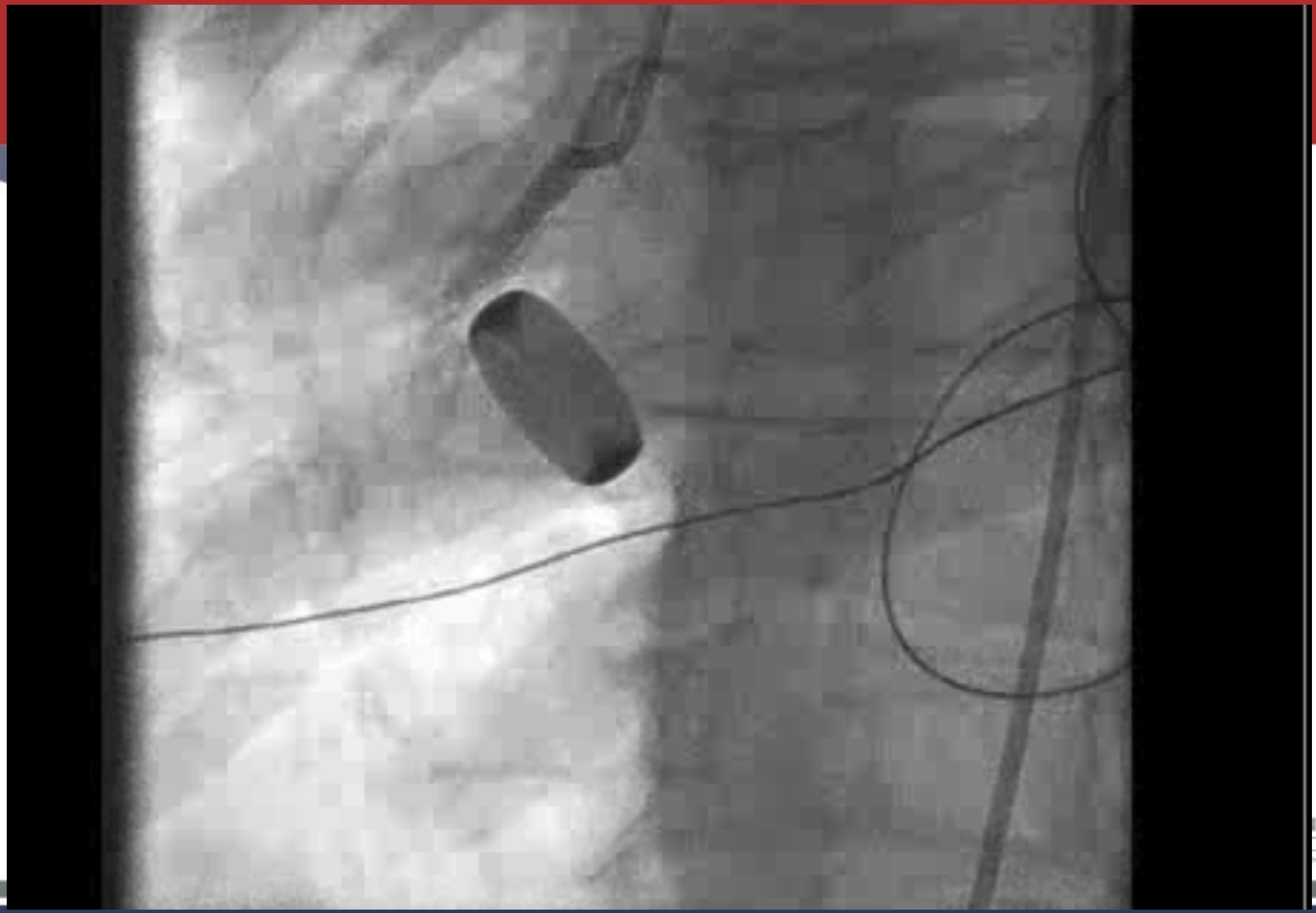
Rescue PCI for Refractory VFCA

Case Records of the Massachusetts General Hospital

Case 28-2013 — A 52-Year-Old Man with Cardiac Arrest after an Acute Myocardial Infarction

David F.M. Brown, M.D., Farouc A. Jaffer, M.D., Ph.D.,
Joshua N. Baker, M.D., and M. Edip Gurol, M.D.

N Engl J Med
Volume 369(11):1047-1054
September 12, 2013



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PCI for Refractory VFCA

- Unsuccessful defib
- Decision for ECMO
- Hypothermia begun and continued for 24 hours
- ECMO removed after 72 hours
- Long, complicated hospital course
  - 2.5 months: trach, feeding tube, gangrenous toes, and dialysis. Complete neurological recovery.
- Returned to his profession (musician) and as father of two children

Dramatic, but …

- But not all arrests in front of medical providers
- Are there better ways ?…
  - Mechanical Chest Compressions vs Manual CPR in Cath Lab
  - Circulatory Pump Support
    - ECMO vs PCBP vs Others

Manual Chest Compressions in the Cath Lab

- Difficult to Perform:
  - Limited space at the cath table
  - Over reaching or stretching
  - Table itself unstable in the “working” position
  - May require lengthy periods of compressions

- Extensive radiation exposure to the rescuer
  - Hands in the beam, overall exposure high

New AHA 2010 Guidelines on resuscitation in the cath lab

The Problem:

“Although high-quality chest compressions improve the chance of successful resuscitation and survival, **it is difficult to perform effective, high-quality chest compressions during PCI**. “

AHA Page S849: Part 12. Cardiac arrest in special circumstances

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2015 AHA class IIb recommendation for mechanical CPR during PCI

"The use of mechanical piston devices may be considered in specific settings where the delivery of high-quality manual compressions may be challenging or dangerous for the provider (eg, limited rescuers available, prolonged CPR, during hypothermic cardiac arrest, in a moving ambulance, in the angiography suite, during preparation for extracorporeal CPR [ECPR]), provided that rescuers strictly limit interruptions in CPR during deployment and removal of the devices (Class IIb, LOE C-EO)".

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Mechanical CPR During PCI

- Positives:
  - Uninterrupted CC-No fatigue or changing rescuers
  - No hands in beam (radiation exposure)
  - Less crowded at the cath table
  - Better compressions

- Challenges:
  - Time to place the device
  - Limited views due to the mechanical device
    - Hardware in the baseboard (AutoPulse)
    - Piston (LUCAS)

AutoPulse® in the Cathlab

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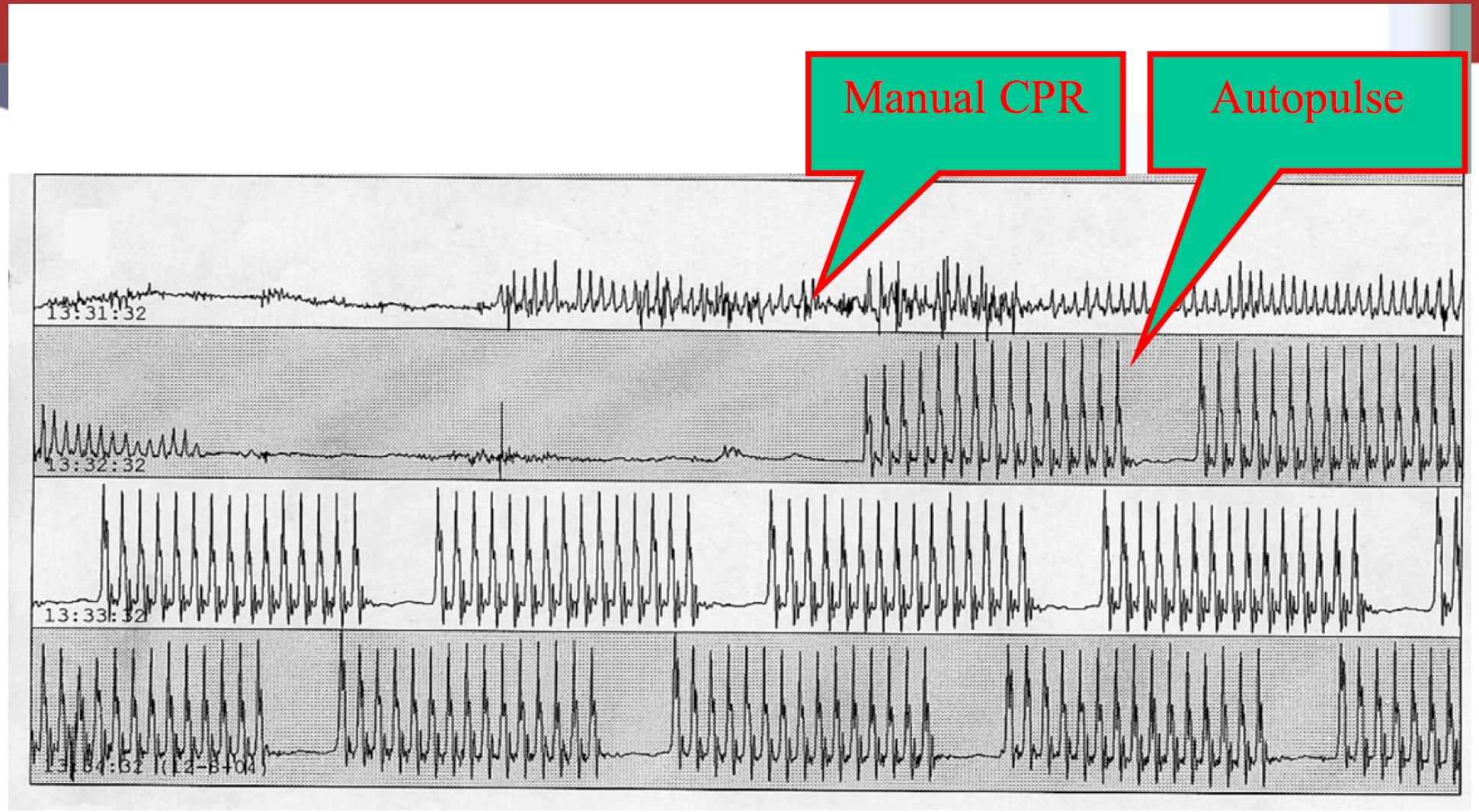
Manual CPR
Autopulse
13:31:32
13:32:32
13:33:32

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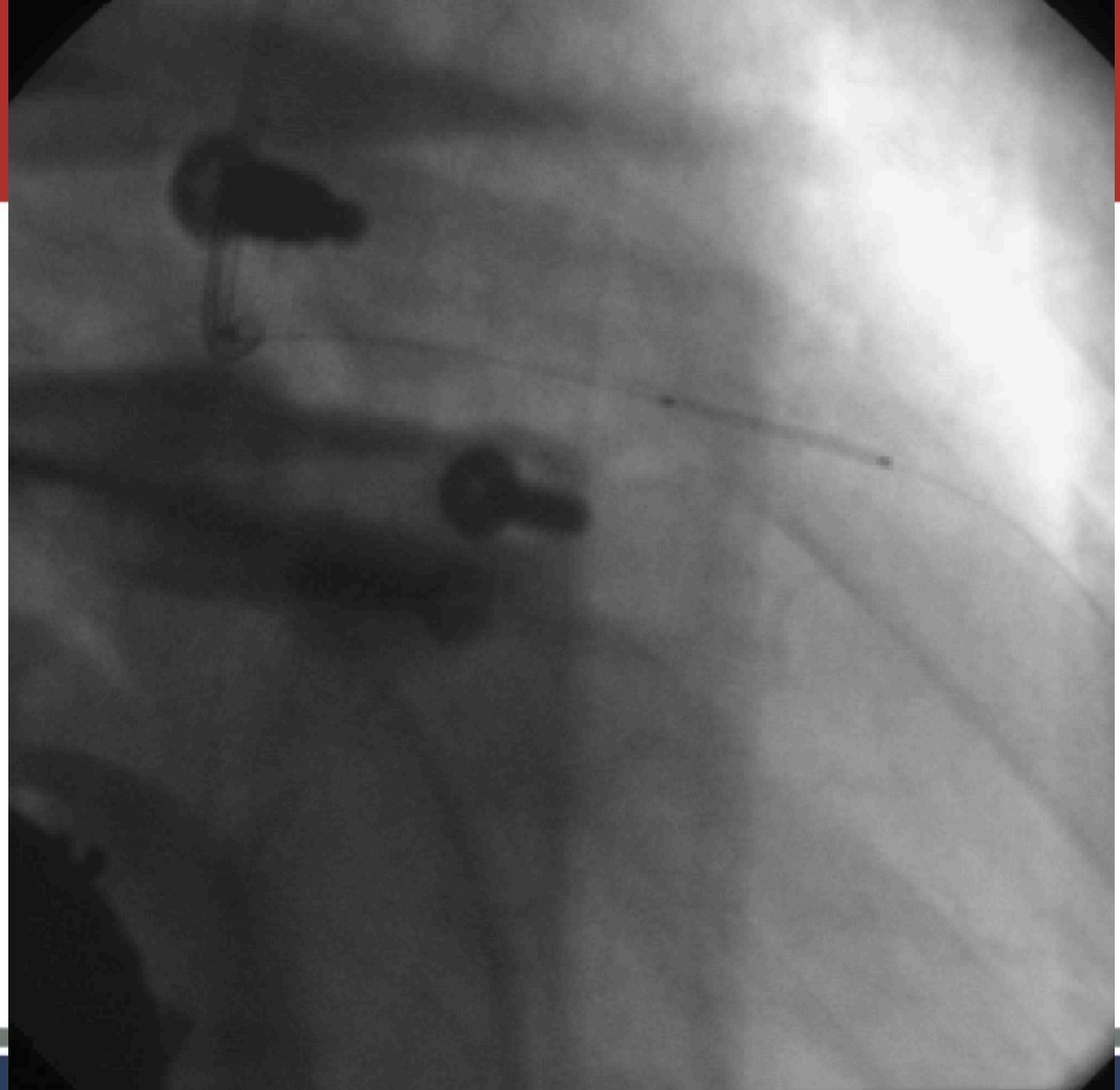
Points of attention using the Autopulse:

* Device has to be installed under the patient
* Autopulse does have it's radio opacity limitations



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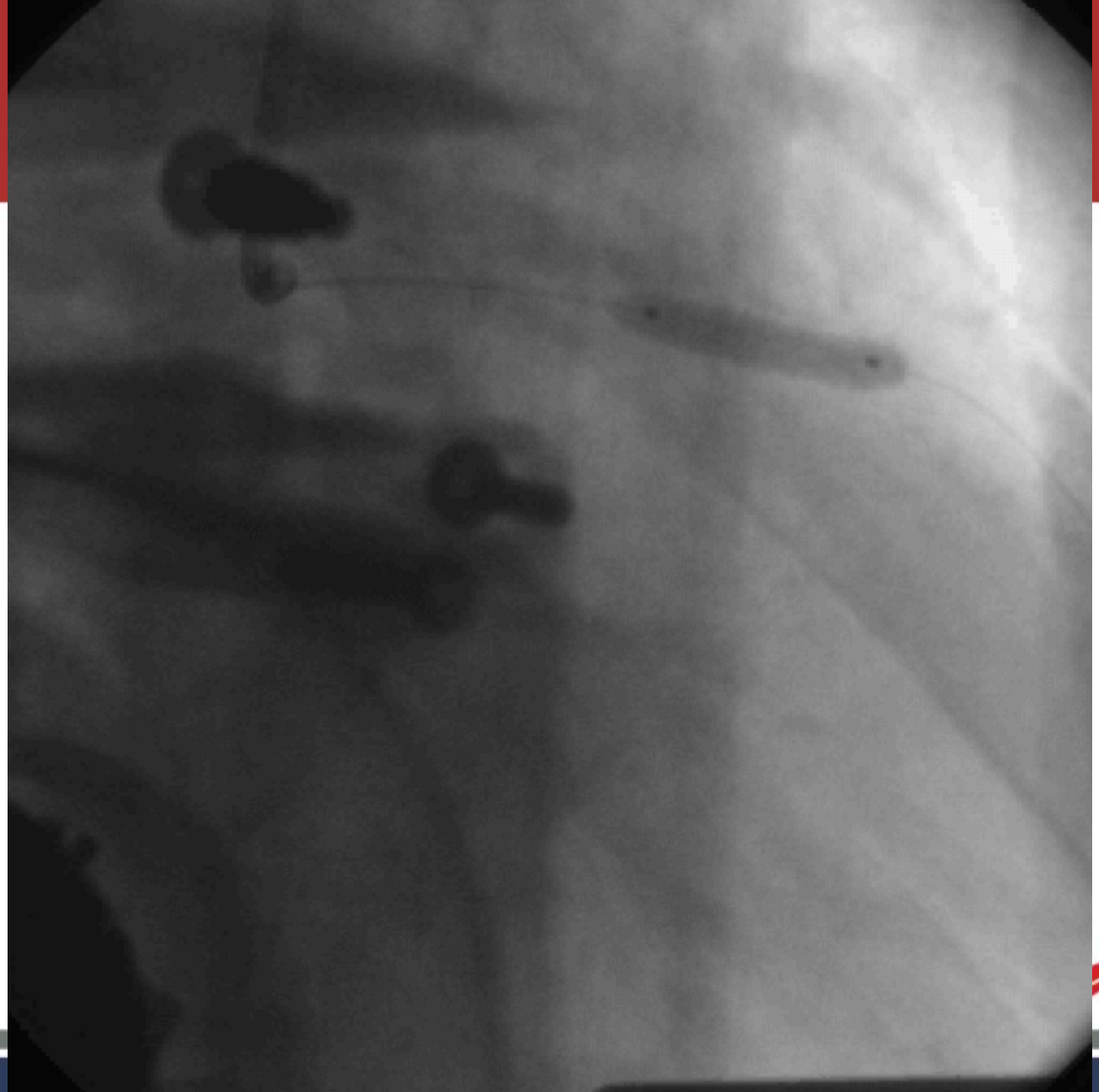

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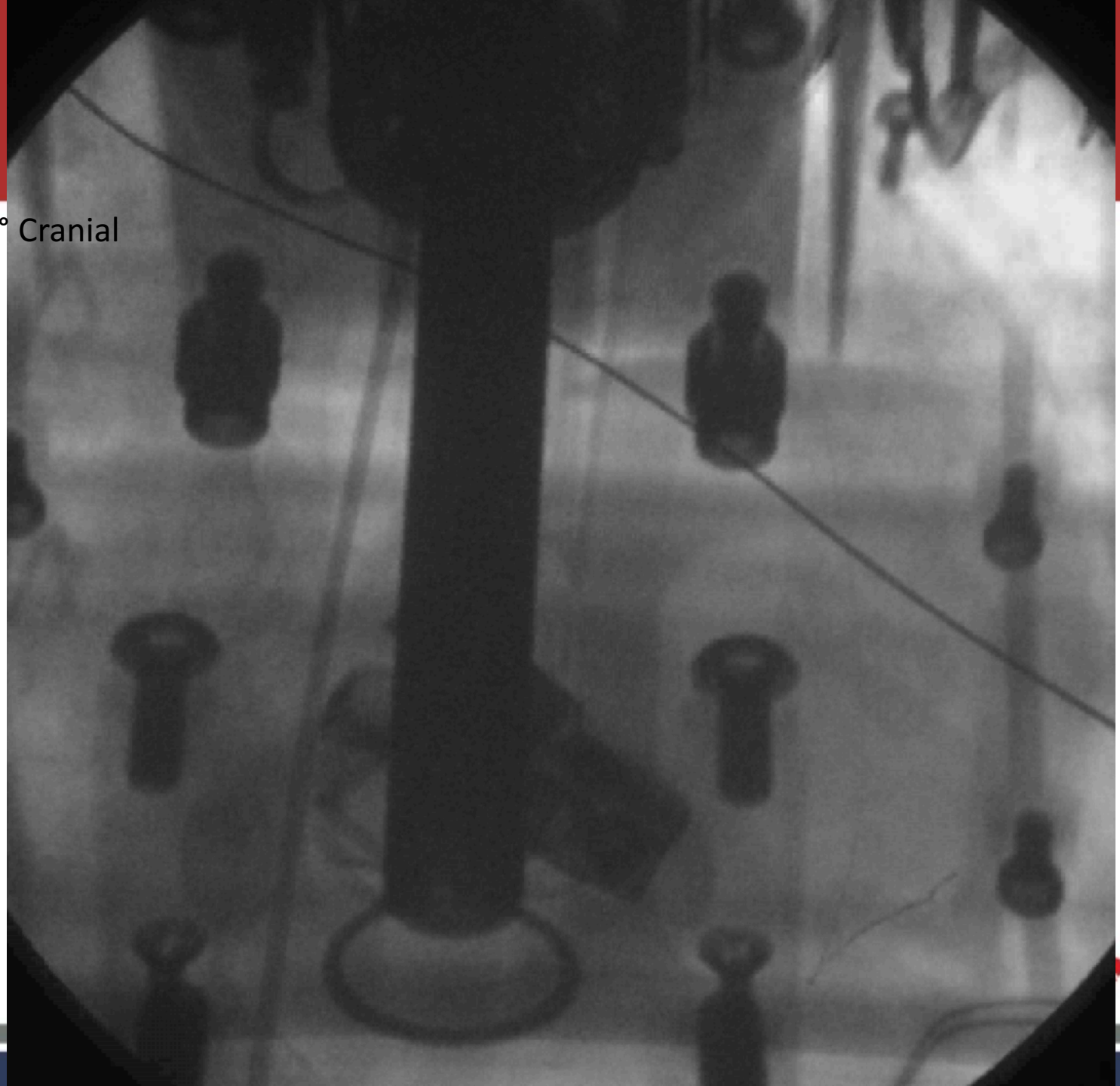
AP

35° Cranial



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PCI during LUCAS CPR

"The mood in the cath lab was calm at all times despite the ongoing VF. This is quite contrary to what usually happens in such situations when manual compressions are used."

Dr. Olivecrona,
Lund, Sweden

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LUCAS is designed with the cath lab in mind

A radiotranslucent Back Plate in carbon fibre

LUCAS allows for most projections

Enables life-saving PCI during CPR






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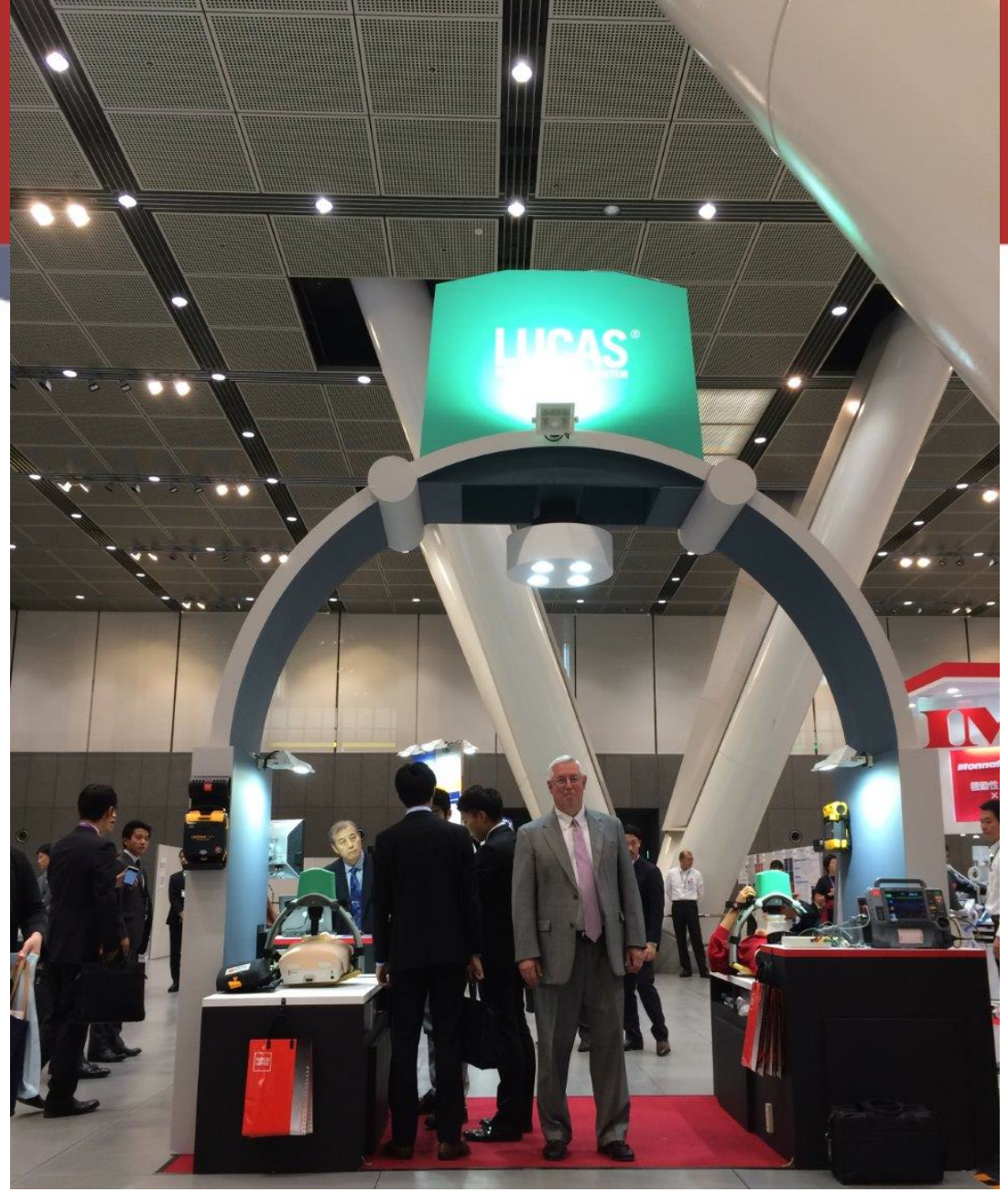

At last a LUCAS
to fit even
the largest patient

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Emergency Cardiovascular Care Update

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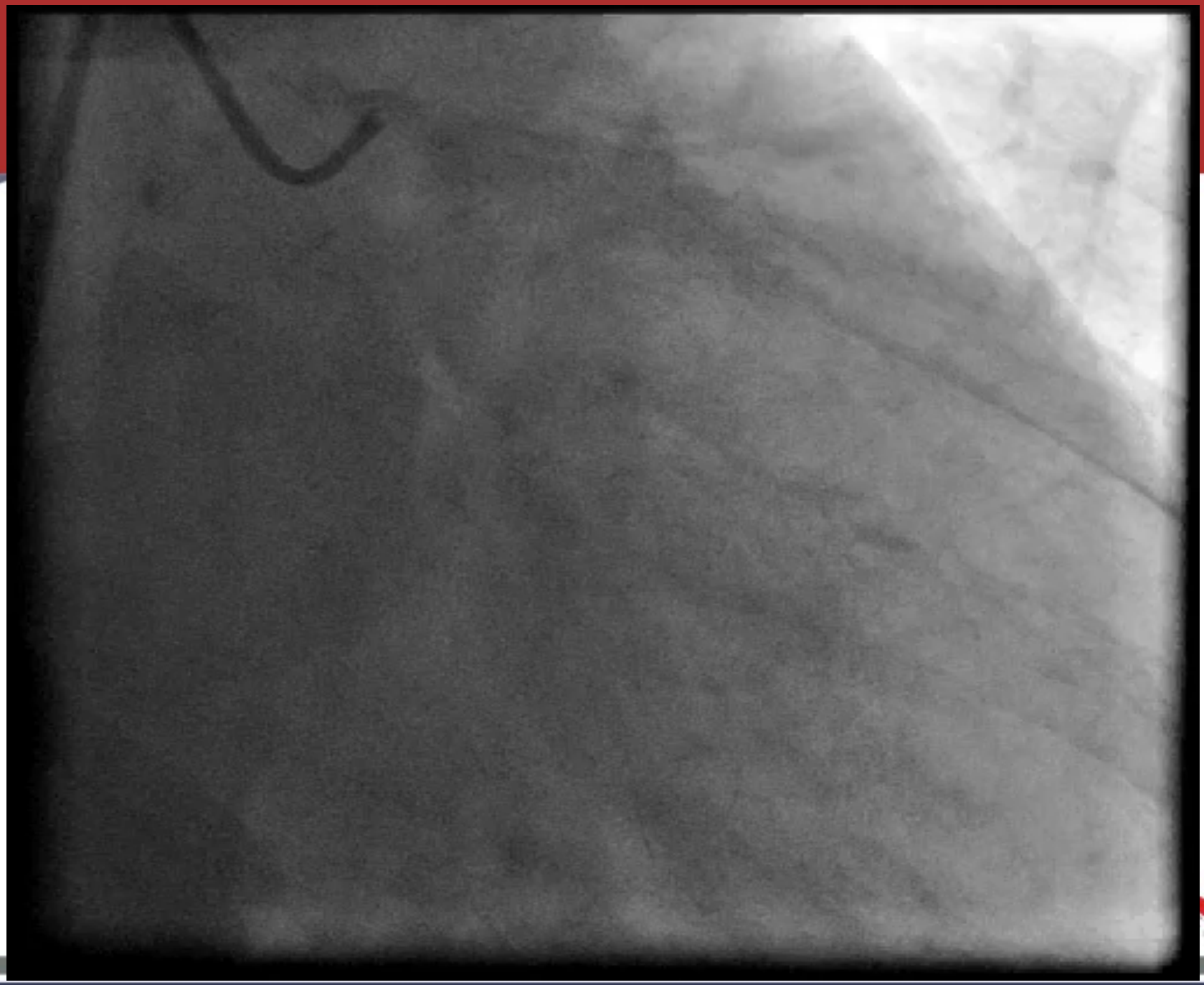

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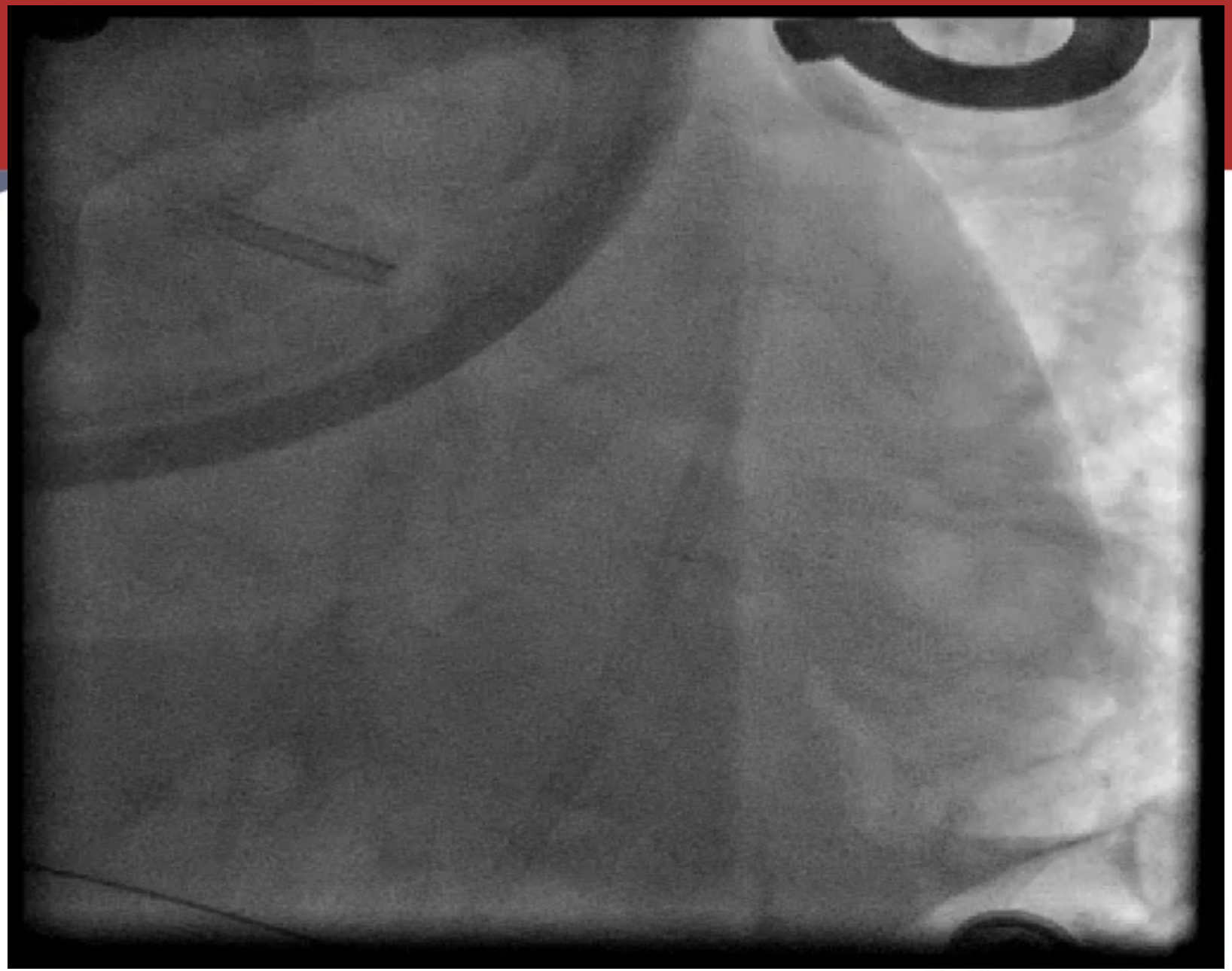

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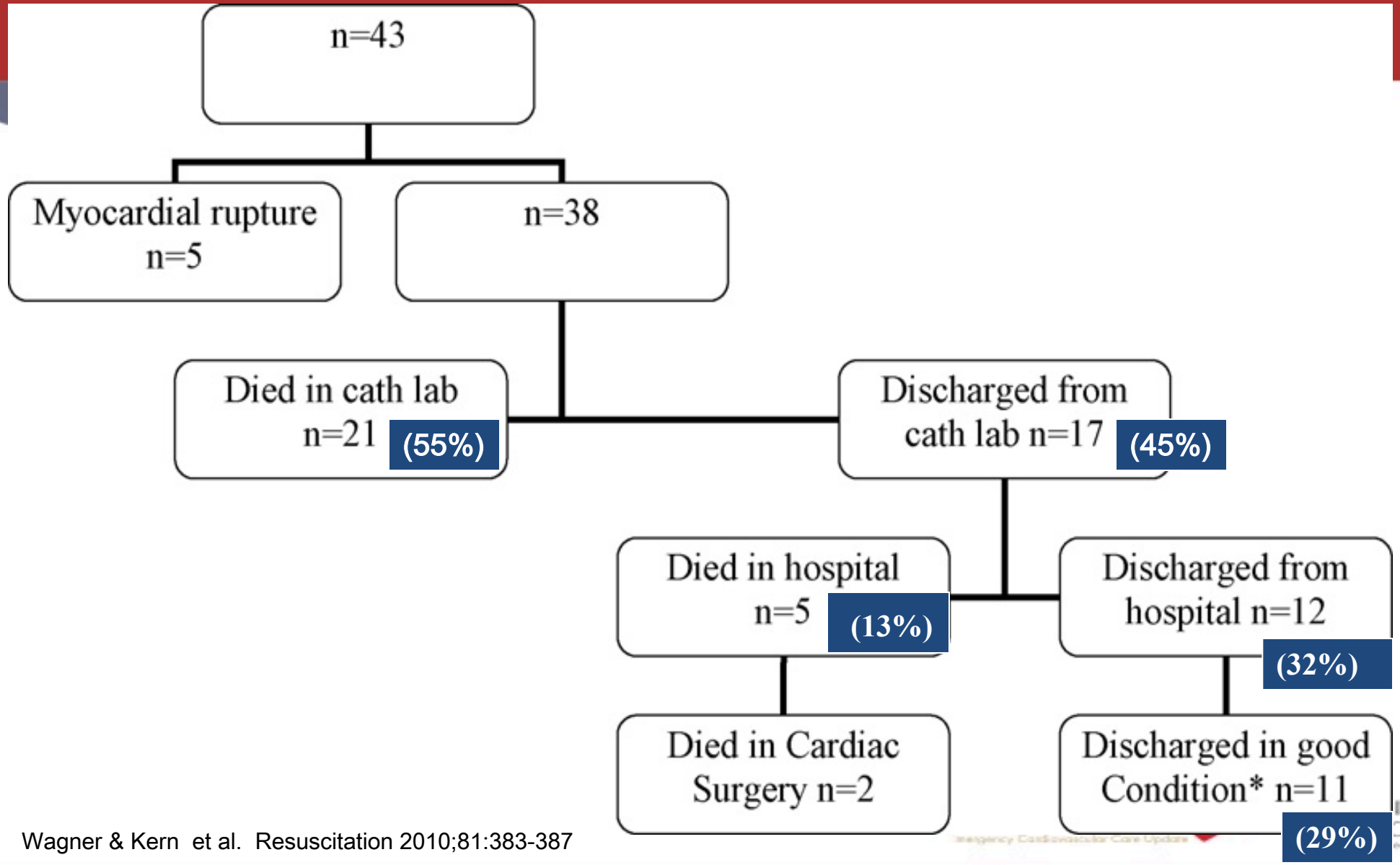
Mechanical CPR in the Cardiac Catheterization Laboratory

- N = 43 pts
  - All suffered CA in the CCL
  - 5 had spontaneous myocardial rupture with their MI
    - All of these five died
  - 38 had PCI or pericardiocentesis during LUCAS CPR

Wagner and Kern et al. Resuscitation 2010;81:383-387



Wagner & Kern et al. Resuscitation 2010;81:383-387

Outcome per Rhythm

	n	Survival
VF	6	4 (67%)
PEA	28	3 (11%)
Asystole	9	5 (56%)

Wagner and Kern et al. Resuscitation 2010;81:383-387

A Structured Approach for Treatment of Prolonged Cardiac Arrest Cases in the Coronary Catheterization Laboratory Using Mechanical Chest Compressions

Henrik Wagner[1]*, Malin Rundgren[2], Bjarne Madsen Hardig[3], Karl B Kern[4], David Zughaft[1], Jan Harnek[1], Matthias Götberg[1] and Goran K Olivecrona[1]

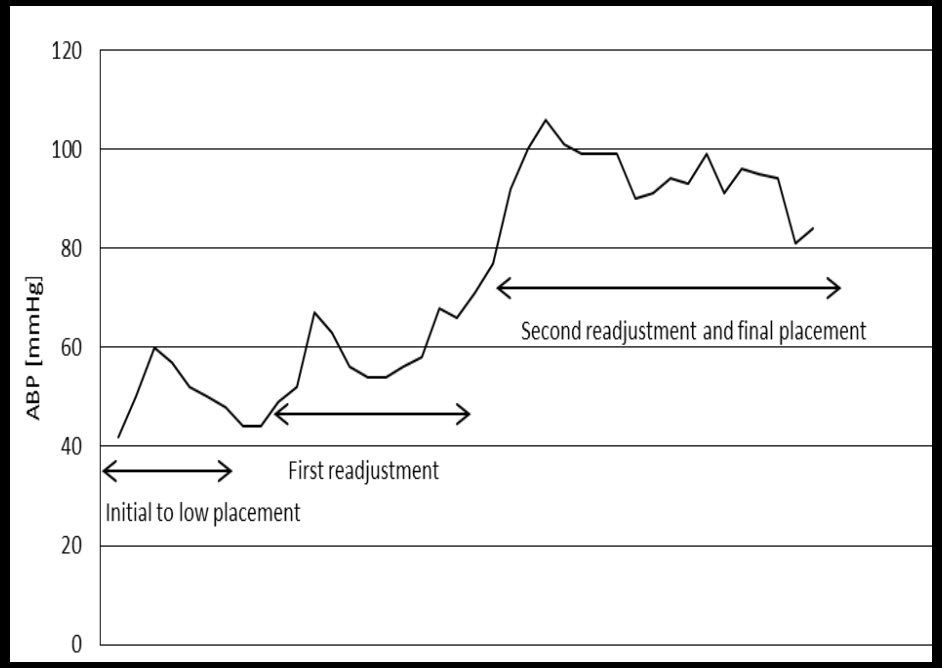
Wagner et al., Int J Cardiovasc Res 2013, 2:4
http://dx.doi.org/10.4172/2324-8602.1000135

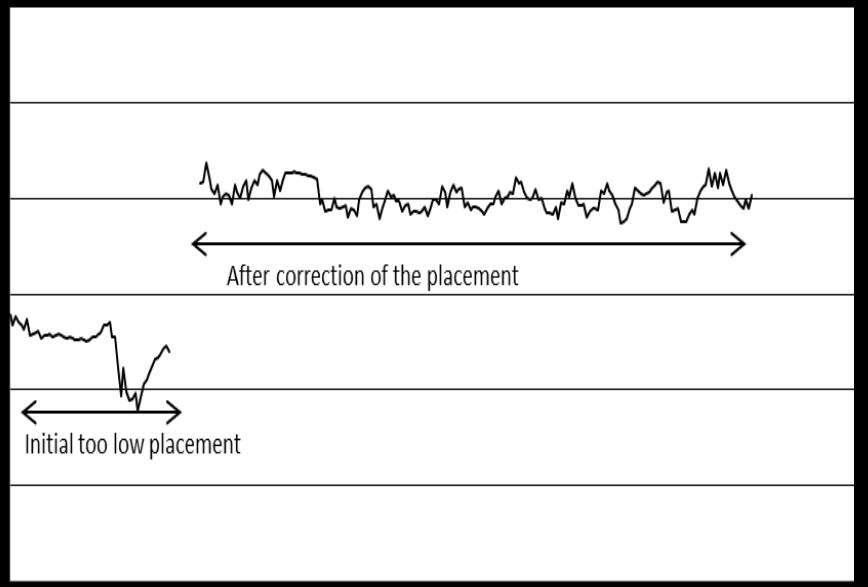
Important Key Concepts

- **If the patient has a shock resistant VF, continue MCC and precede with PCI in order to open the occlusion, rather than continue with further defibrillation attempts while the culprit coronary vessel remains occluded.**

- Optimize physiological parameters

- If systolic ABP is below 70 mmHg, rule out cardiac tamponade, reposition the LUCAS-device, consider change in ventilation rate, or administer inotropic/ vasoactive medications.

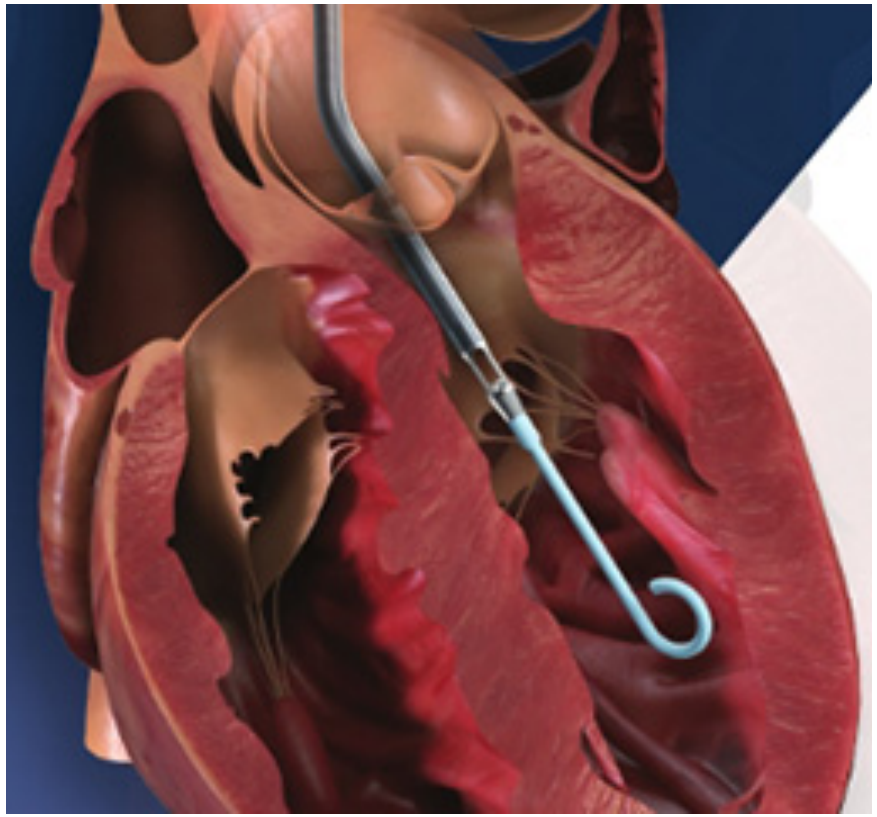


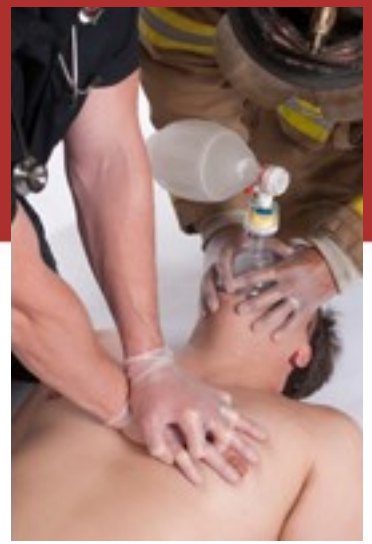


Cardiology Issues:

- Early Coronary Angiography & PCI
- Mechanical CPR & Rescue PCI
- LVADs for CA in the CCL
- Hyper-invasive Approach for Refractory Cardiac Arrest

What's the Role of a Left Ventricular Assist Device in Treating Cardiac Arrest in the Cath Lab?





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Mechanical Chest Compression Or Percutaneous Left Ventricular Assist Devices Improve Survival After Cardiac Arrest In The Cath Lab

Nicole Smith, Huu Tam Truong, Koungchul Cha, Renan Oliveira, Tyler Bien, Prashant Rao, Shaun Chatelain, Matthew Kern, Kapildeo Lotun, Karl Kern
The University of Arizona Sarver Heart Center Resuscitation Research Group, Tucson, AZ

Background

Cardiac arrest can occur in the cardiac catheterization laboratory during high-risk percutaneous coronary intervention (PCI). As the complexity of both the interventions performed and the patient population being treated continues to expand, cardiac arrest occurring in this setting remains an important risk.

While the operator attempts to reopen the acutely occluded vessel, vital organ perfusion must be maintained. High-quality manual chest compressions, however, are difficult to perform during emergent PCI and are often interrupted. Other options include mechanical chest compressions and percutaneous left ventricular assist devices (PLVAD).

In this study we compared hemodynamic support using these different strategies in a large porcine model of acute coronary occlusion and ventricular fibrillation (VF) cardiac arrest. We hypothesized that mechanical devices would yield superior clinical outcomes compared to manual chest compressions.

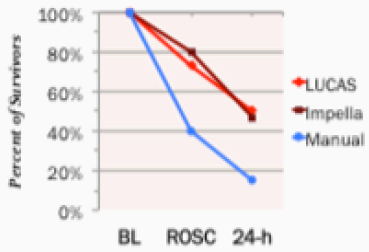
Methods

Figure 1. Selective angiography depicting induction of acute LM-LAD coronary occlusion. A 0.014-inch coronary guide wire is placed in the LAD with its tip extending to the distal aspect of the vessel. Over the wire a 5.0 X 20 mm standard angioplasty balloon is advanced to the distal LM and proximal LAD. The balloon is fully inflated and complete LAD occlusion is confirmed by angiography, as depicted in the figure. Also shown in the figure: an Impella 2.5 PLVAD placed via the femoral artery into the left ventricle, a Swan-Ganz catheter in the pulmonary artery, solid state pressure monitoring catheters in the descending aorta and right atrium, and a pacing wire in the right ventricle for induction of VF.

Results

Results cont.

A



B

ECCU2017 Emergency Cardiovascular Care Update

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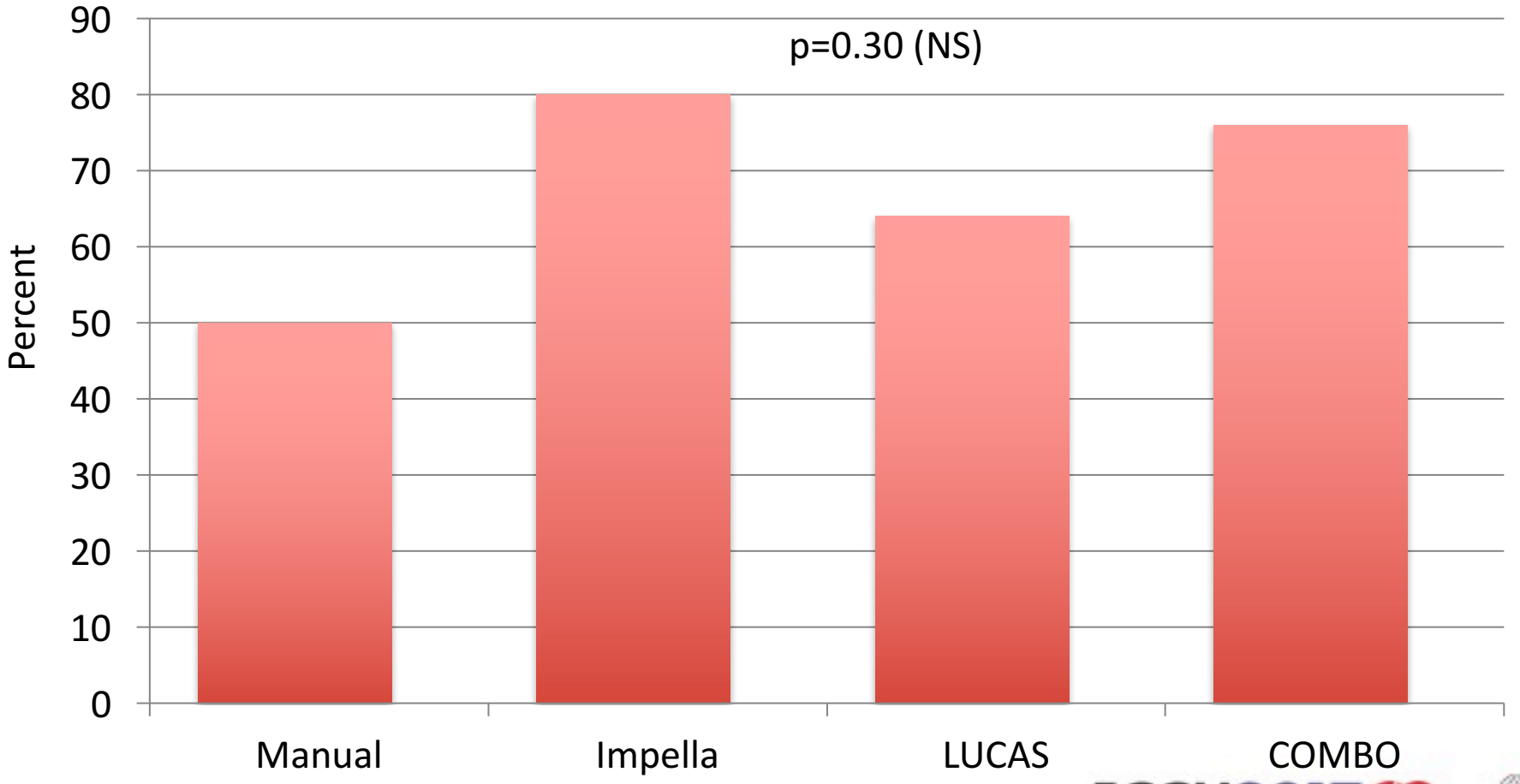
Return of Spontaneous Circulation (ROSC)



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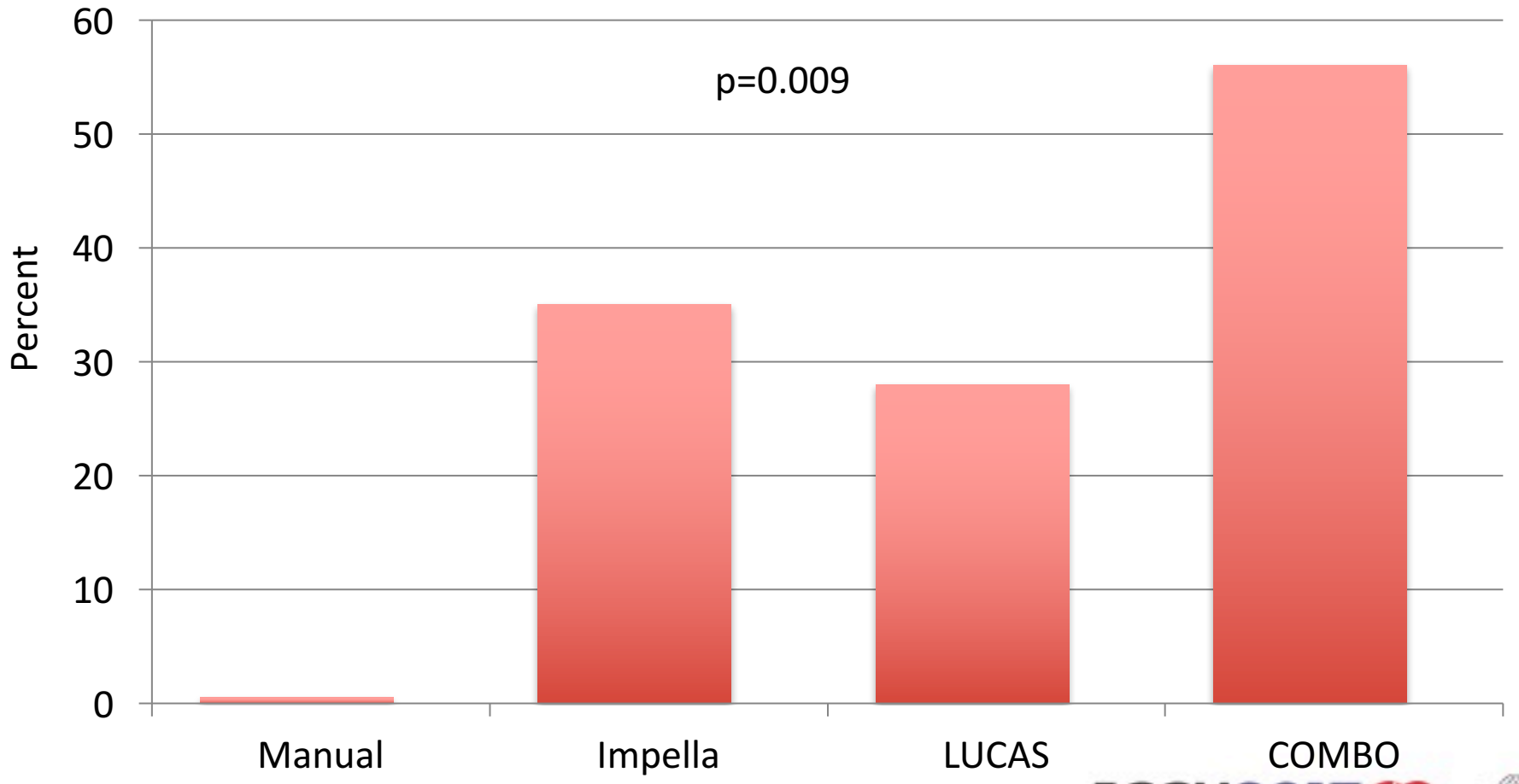
24 Hour Favorable Neurological Function (CPC 1 or 2)



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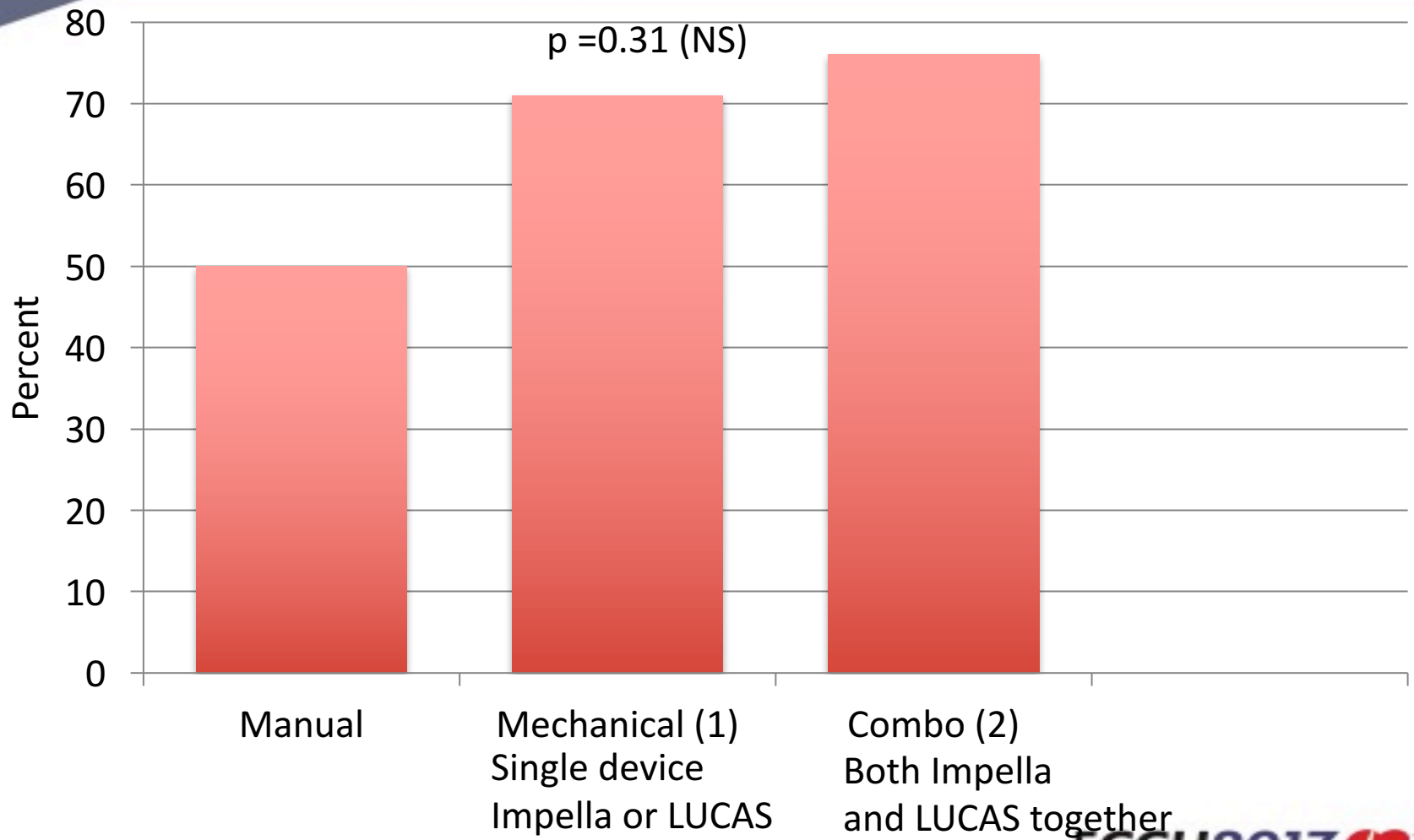
Return of Spontaneous Circulation (ROSC)



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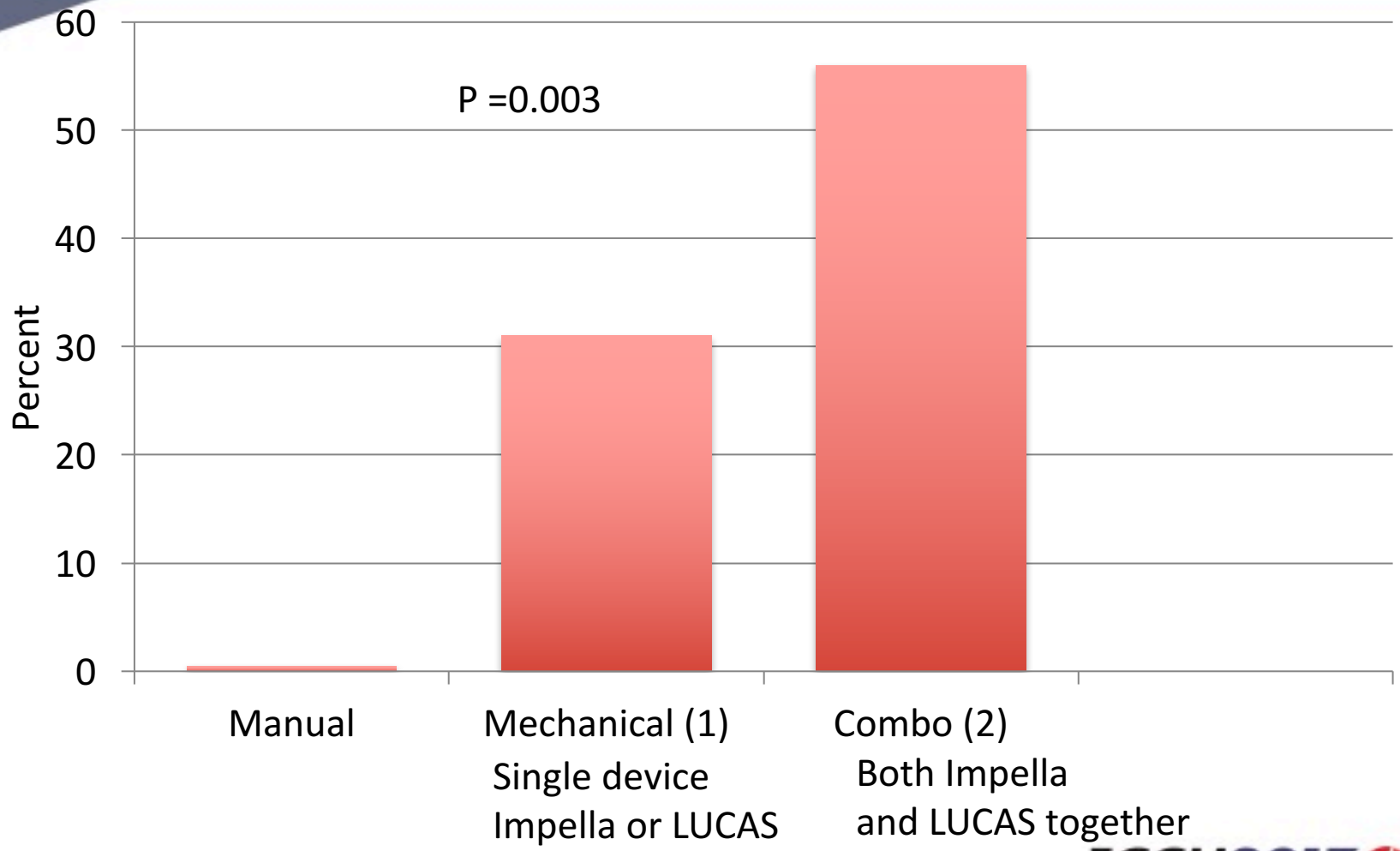
24 Hour Favorable Neurological Function (CPC 1 or 2)



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Cardiology Issues:

- Early Coronary Angiography & PCI
- Mechanical CPR & Rescue PCI
- ECMO & LVADs
- Hyper-invasive Approach for Refractory Cardiac Arrest

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CHEER Trial-Stub & Bernard et al.

- Phase 1 trial (NCT01186614) Clinical Trial
- n=26 patients (11 out of hospital & 15 in-patients)
- Unsuccessful Resuscitation
  - Age 18-65
  - Cardiac etiology of CA
  - Chest compressions begun w/i 10 min of collapse
  - Mechanical CPR available
- Intervention: Mech (AP) CPR & TH in field, ECMO in ED then PCI before ICU
- Primary endpt: Survival to DC with CPC 1 or 2
- Secondary endpt: ROSC, weaning ECMO, and LOS

Stub et al. Resuscitation 2015;86:88-94.

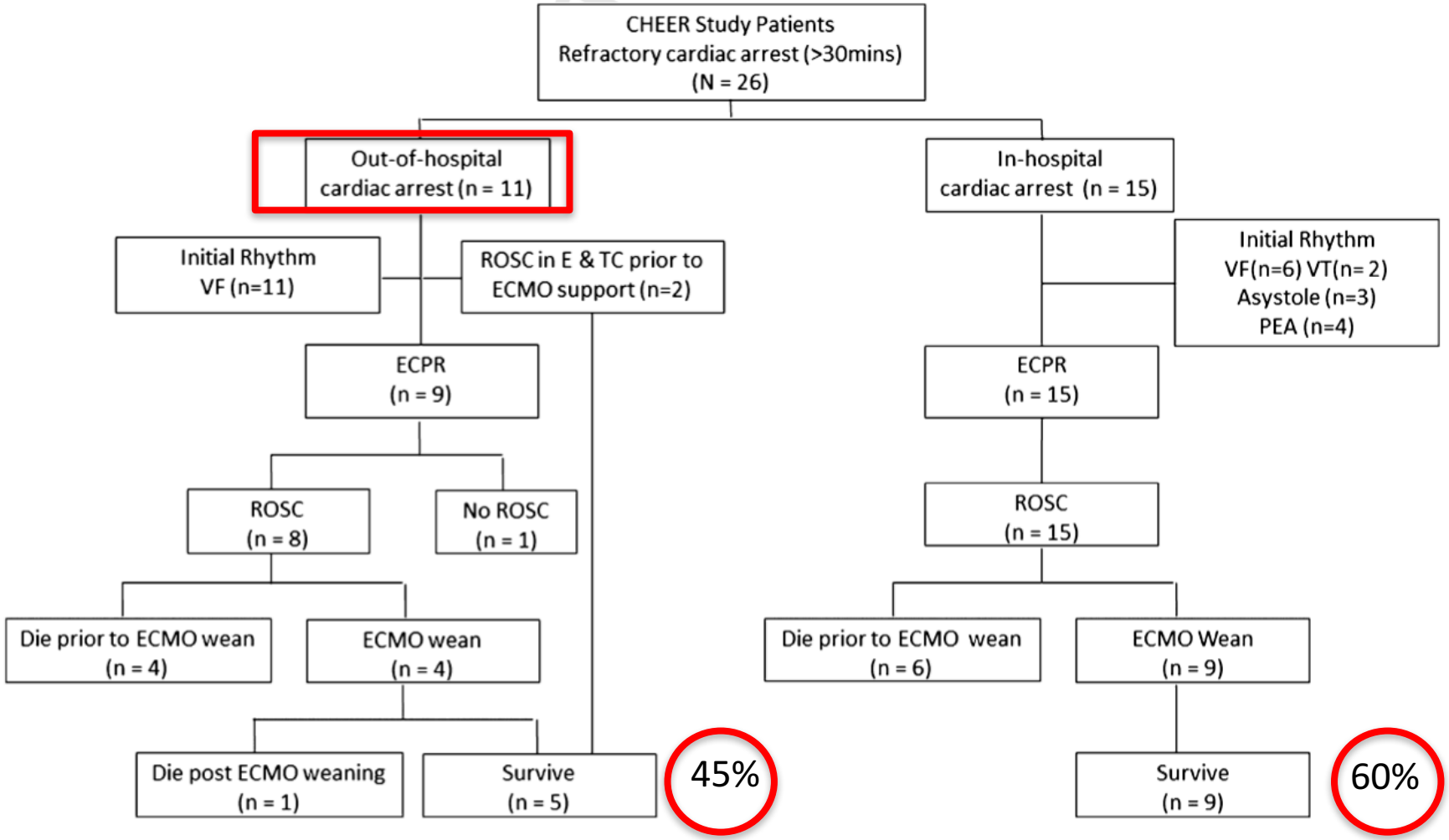

Fig. 1. Outcome of 26 non-postcardiotomy patients with refractory cardiac arrest. CHEER – Mechanical CPR, Hypothermia, ECMO and Early Reperfusion, E&TC – Emergency and Trauma Center, VF – ventricular fibrillation, ROSC – return of spontaneous circulation, ECMO – extracorporeal membrane oxygenation, ECPR – extracorporeal membrane oxygenation facilitated cardiopulmonary resuscitation.

Stub et al. Resuscitation 2015;86:88-94.

Outcomes-Stub/Bernard

- ROSC 25/26 (96%)
- Surv to DC 14/26 (54%)
  - OOHCA 5/11 (45%)
  - Inpt CA 9/15 (60%)
- CPC 1 or 2 of survivors 14/14 (100%)

Stub et al. Resuscitation 2015;86:88-94.

ORIGINAL RESEARCH

Minnesota Resuscitation Consortium's Advanced Perfusion and Reperfusion Cardiac Life Support Strategy for Out-of-Hospital Refractory Ventricular Fibrillation

Demetris Yannopoulos, MD; Jason A. Bartos, MD, PhD; Cindy Martin, MD; Ganesh Raveendran, MD, MPH; Emil Missov, MD, PhD; Marc Conterato, MD; R. J. Frascone, MD; Alexander Trembley, BS; Kevin Sipprell, MD; Ranjit John, MD, PhD; Stephen George, MD, PhD; Kathleen Carlson, MD; Melissa E. Brunsvold, MD; Santiago Garcia, MD; Tom P. Aufderheide, MD

JAHA 2016;5:e003732

Minneapolis Protocol

1. n = 18
2. OHCA with presumed cardiac etiology cardiac arrest.
3. First presenting rhythm was shockable (VF or VT).
4. Age 18 to 75 years.
5. Received at least 3 direct current (DC) shocks without sustained ROSC.
6. Received amiodarone 300 mg.
7. Body could accommodate a Lund University Cardiac Arrest System (LUCAS) automated CPR device.
8. Transfer time from the scene to the CCL of <30 minutes.
9. ECMO in the CCL
10. PCI

Yannopoulos D, et al. JAHA 2016;5:e003732

Refractory VF/VT Patients	Survivors With CPC 1&2 (9)	Deaths and Survivors With CPC >2 (9)	*P* Value
Age, y	57±11	56±9	0.2
911 call to first response arrival	3.8±2.5 min	8±3 min	0.004*
Bystander CPR	8/9	4/9	0.13
911 call to CCL entry	54±7.6	66±10.5	0.019
CCL entry—on ECMO	6±2	5.4±4	0.2
$ETCO_2$ on arrival	32±12	35±8	0.5
pH on ECMO opening ABG	7.05±0.1	7.07±0.3	0.4
Lactate at CCL arrival	9.9±2.8	14.6±5.5	0.041*
Presence of CAD	9/9	4/9	0.029*
Witnessed arrest	5/9	6/9	0.6
Intermittent ROSC before ECMO	6/9	1/9	0.049*

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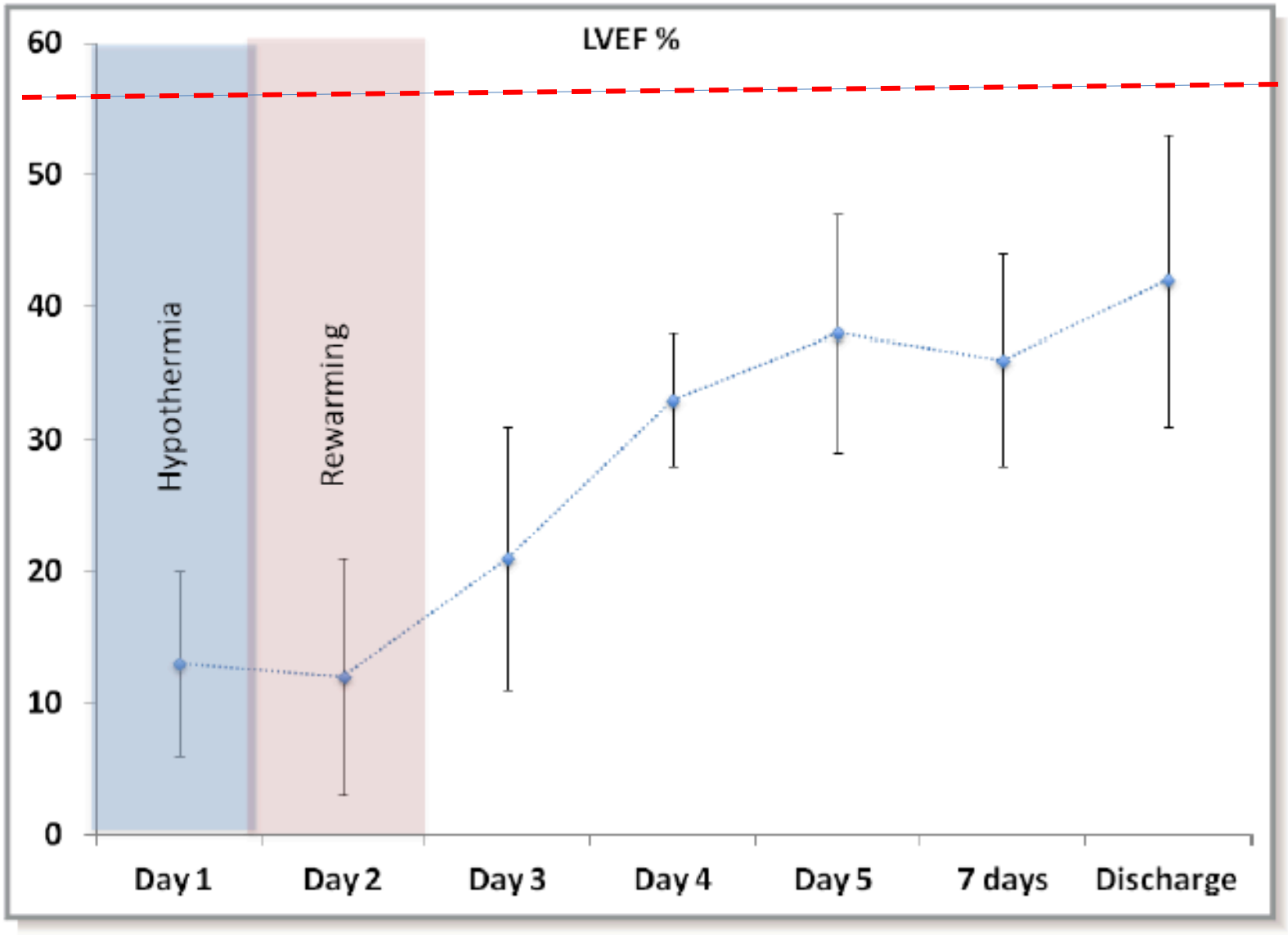


Figure 3. Left ventricular ejection fraction (LVEF) temporal evolution in patients that were admitted after refractory ventricular fibrillation/ventricular tachycardia arrest. A 2-day period of severe left ventricular depression was evident in the whole cohort. Recovery was observed after 3 days. Values are shown as mean±SD.

Outcomes-Yannopoulos/Aufderheide

- ROSC 25/18 (96%)
- Surv to DC 10/18 (54%)
  - All were OOHCA
- CPC 1 or 2 9/10 (90%)
  of survivors

Yannopoulos D, et al. JAHA 2016;5:e003732

Refractory OOH VFCA Studies

	CHEERS[1]	MRC[2]	Sum Together
N	11	18	29
24 Hr Surv	5/11 (45%)	10/18 (53%)	15/29 (52%)
Favorable Neuro among Survivors	5/5 (100%)	9/10 (90%)	14/15 (93%)

1 Resuscitation 2015;86:88-94
2 JAHA 2016;5:e003732

Refractory OOH VFCA Studies

	CHEERS	*MRC's	Sum Together
N	11	34	45
24 Hr Surv	5/11 (45%)	18/34 (53%)	23/45 (51%)
Favorable Neuro among Survivors	5/5 (100%)	16/18 (89%)	21/23 (91%)

* Update via personal communication 7/1/16

Prague OHCA Study
"Hyperinvasive Approach to CA"

- Randomized Trial
  - Standard CPR vs
  - Mech CPR (LUCAS) with nasal-TH in field & ECMO/PCI at Cath Lab
- n=200-400 (goal)
- Unsuccessful ACLS for at least 5 min
- Primary endpt: 6 mo survival with good neuro
- Secondary endpt: 30 day neuro and cardiac recovery

Sudden Cardiac Arrest in Young Adults: Common Causes

- Hypertrophic Cardiomyopathies
- Coronary anamolies
- Commotio cordis
- Arrythmogenic RV Dysplasia
- Myocarditis
- Marfan syndrome
- Dilated cardiomyopathies

Sudden Cardiac Arrest in Young Adults: Common Causes

- Valvular heart disease
- Atherosclerotic coronary artery disease
- W-P-W with rapid antegrade conduction
- Ion channel disorders such as long QT syndrome, familial catecholaminergic polymorphic ventricular tachycardia, and Brugada syndrome.6,2

Sudden Cardiac Arrest in Young Adults: Incidence

- 2.5X increase compared to non-athletes
- College and HS athletes: ≈ 1:25,000-50,000
- Military recruits: ≈ 1:10,000

Sudden Cardiac Arrest in Young Adults: Common Sports

- Basketball
- Soccer
- Baseball (Commotio)
- Hockey

Sudden Cardiac Arrest in Young Adults: Why So Deadly?

- Delay in recognizing SCD in young person
- Underlying structural heart disease
  - Young person should not be arresting, if they do it is a sign of substantial underlying heart issue

Sudden Cardiac Arrest in Young Adults: Why So Deadly?

- If resuscitated…

  Find the underlying structural heart issue:

  - –ECHO
  - –CTA or Cath
  - –Genetic testing
  - –EP study

21 yo M University Student

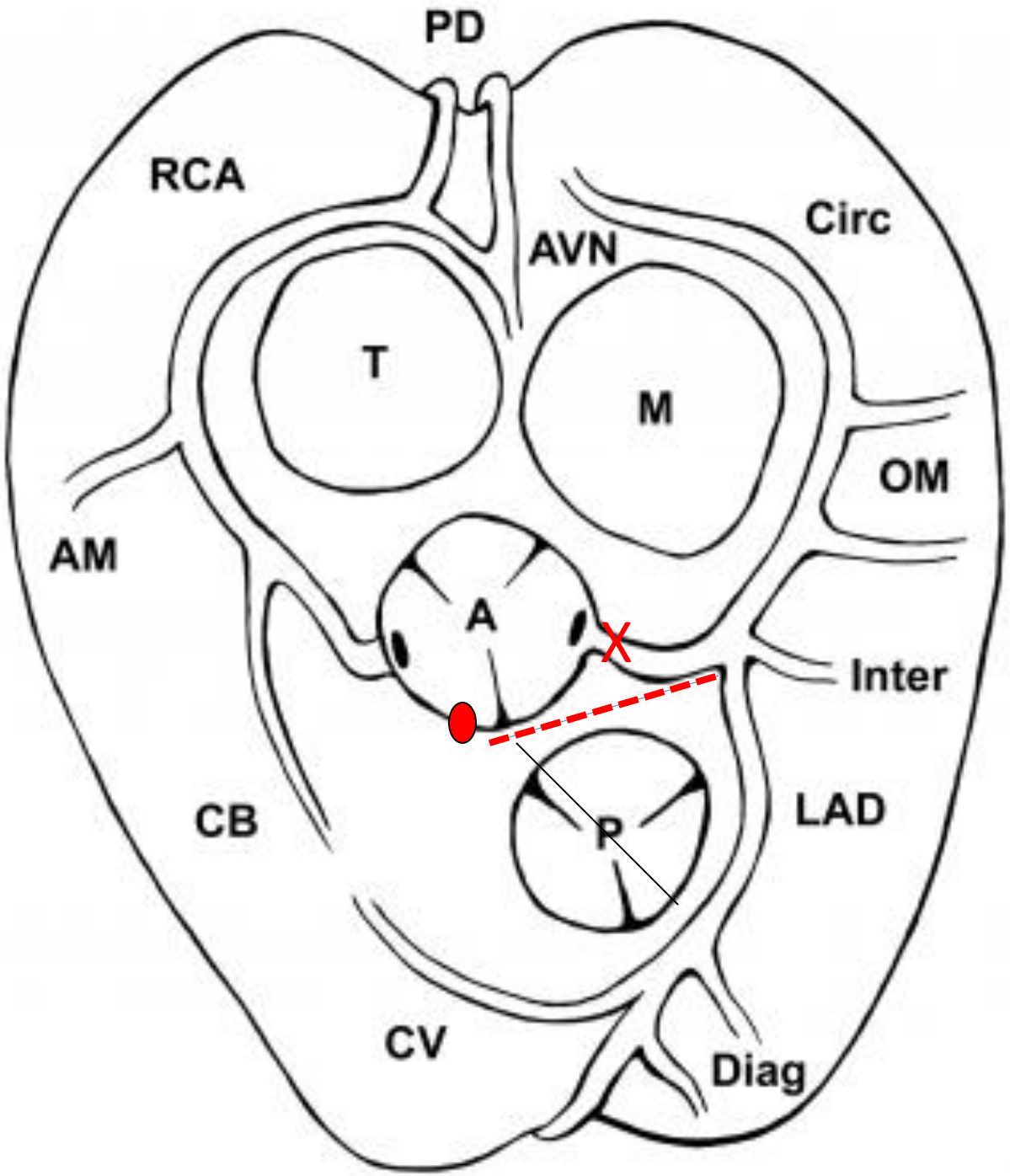
- HS football player
- Playing intramural football
- Collapsed on the field
- Gasping (?Asthma)
- Seized-(?Epilepsy)
- Finally (10 min after collapse) determined in SCA

21 yo M University Student

- AED at facility, but not be found initially
- Found, but battery dead
- EMS arrived continued resuscitation
- Transported – hospital continued resuscitation
- No ROSC, declared dead

21 yo M University Student

- Autopsy
  - "No HCM or dilated cardiomyopathy"
  - No description of actual coronaries, but noted, "peculiar two ostial openings in the R coronary cusp of the aorta"
  - Probably anomalous L coronary arising from the R cusp and presumably coursing between the PA and Ao



CITIZEN CPR FOUNDATION

27 yr old male, former Marine

- Training with the Tucson Fire Department
- Sudden witnessed collapse during training exercise
- Unresponsive without pulse
- CC-Only while AED retrieved
- VF per AED, shocked X 1, ROSC

ED Arrival

- 90/70 mmHg,
- 67 bpm,
- 36.4 °C

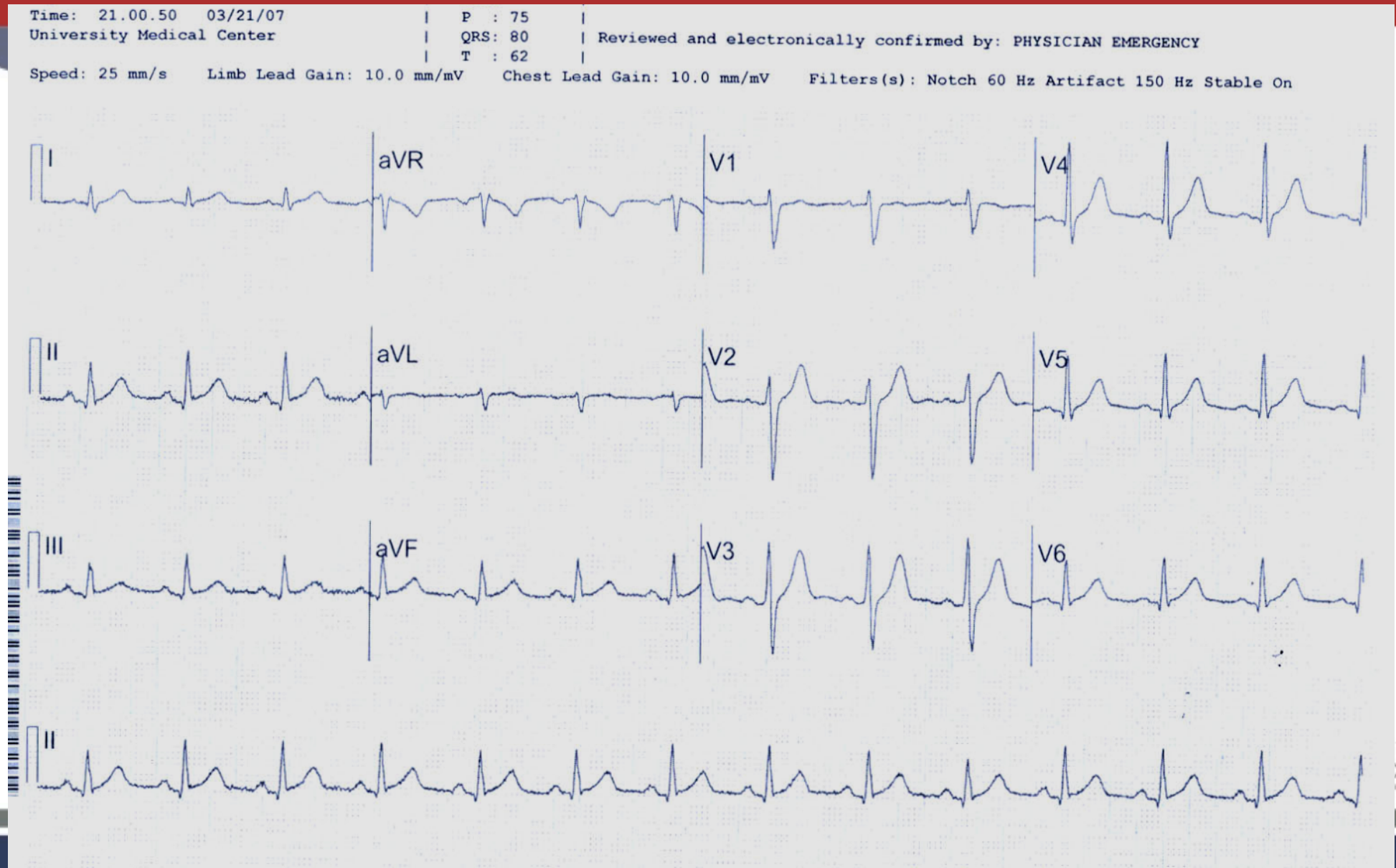
- GCS: 1 + 1 + 4 = 6

- Intubated for airway protection

Glasgow Coma Scale

BEHAVIOR	RESPONSE	SCORE
Eye opening response	Spontaneously	4
	To speech	3
	To pain	2
	No response	1
Best verbal response	Oriented to time, place, and person	5
	Confused	4
	Inappropriate words	3
	Incomprehensible sounds	2
	No response	1
Best motor response	Obeys commands	6
	Moves to localized pain	5
	Flexion withdrawal from pain	4
	Abnormal flexion (decorticate)	3
	Abnormal extension (decerebrate)	2
	No response	1
Total score:	*Best response*	15
	Comatose client	8 or less
	Totally unresponsive	3

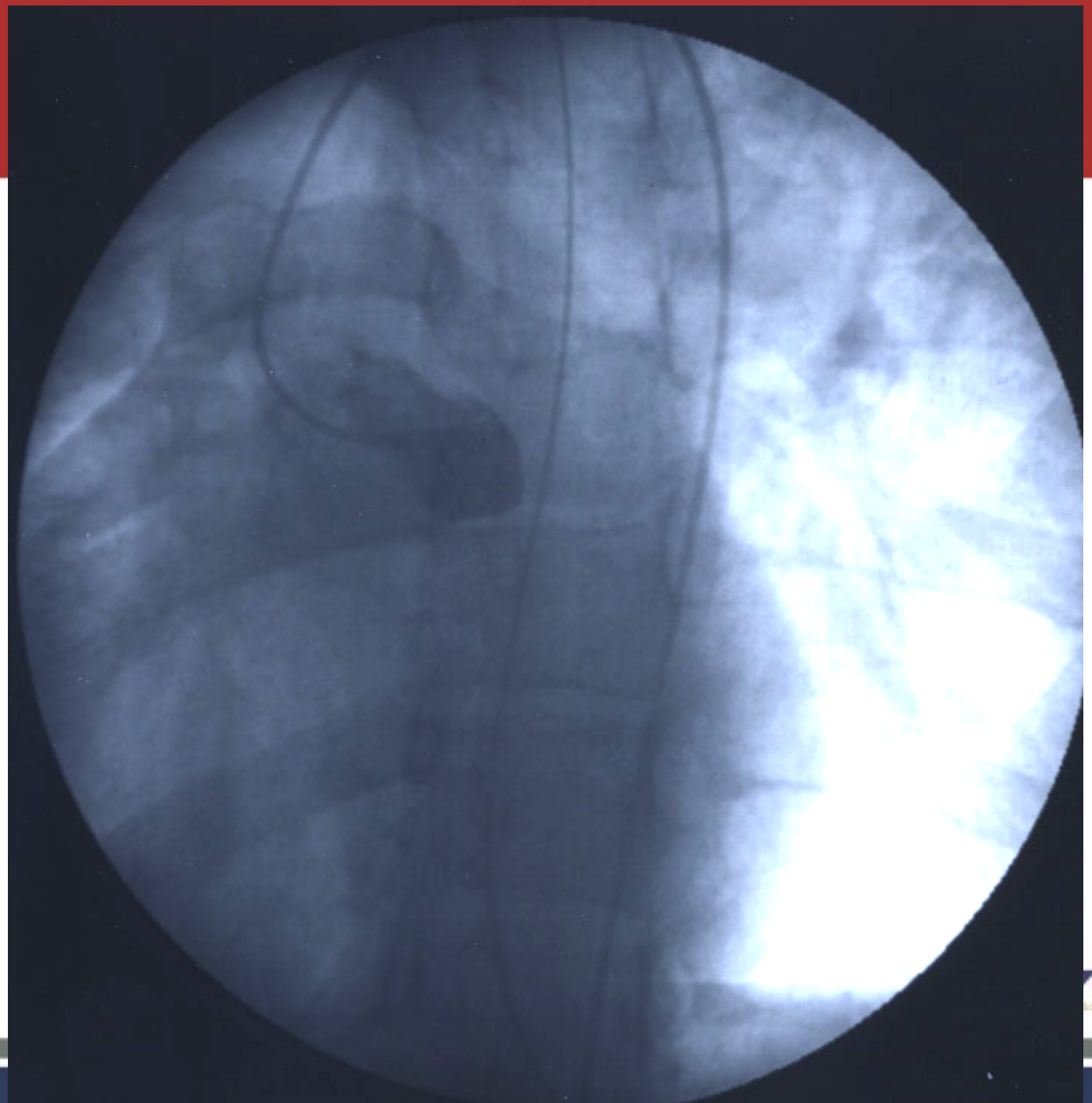
- ED Evaluation
  - Initial ABG post intubation/ventilation
    - 7.34/29/306
    - Bicarb =19; Lactate = 7.1
  - Head CT negative (3 cm scalp laceration)
  - Family declined Therapeutic Hypothermia
  - ECG on arrival



Etiology of VFCA ?

- Long QT?
- HCM ?
- Atherosclerosis ?

To Cath Lab or Not ??



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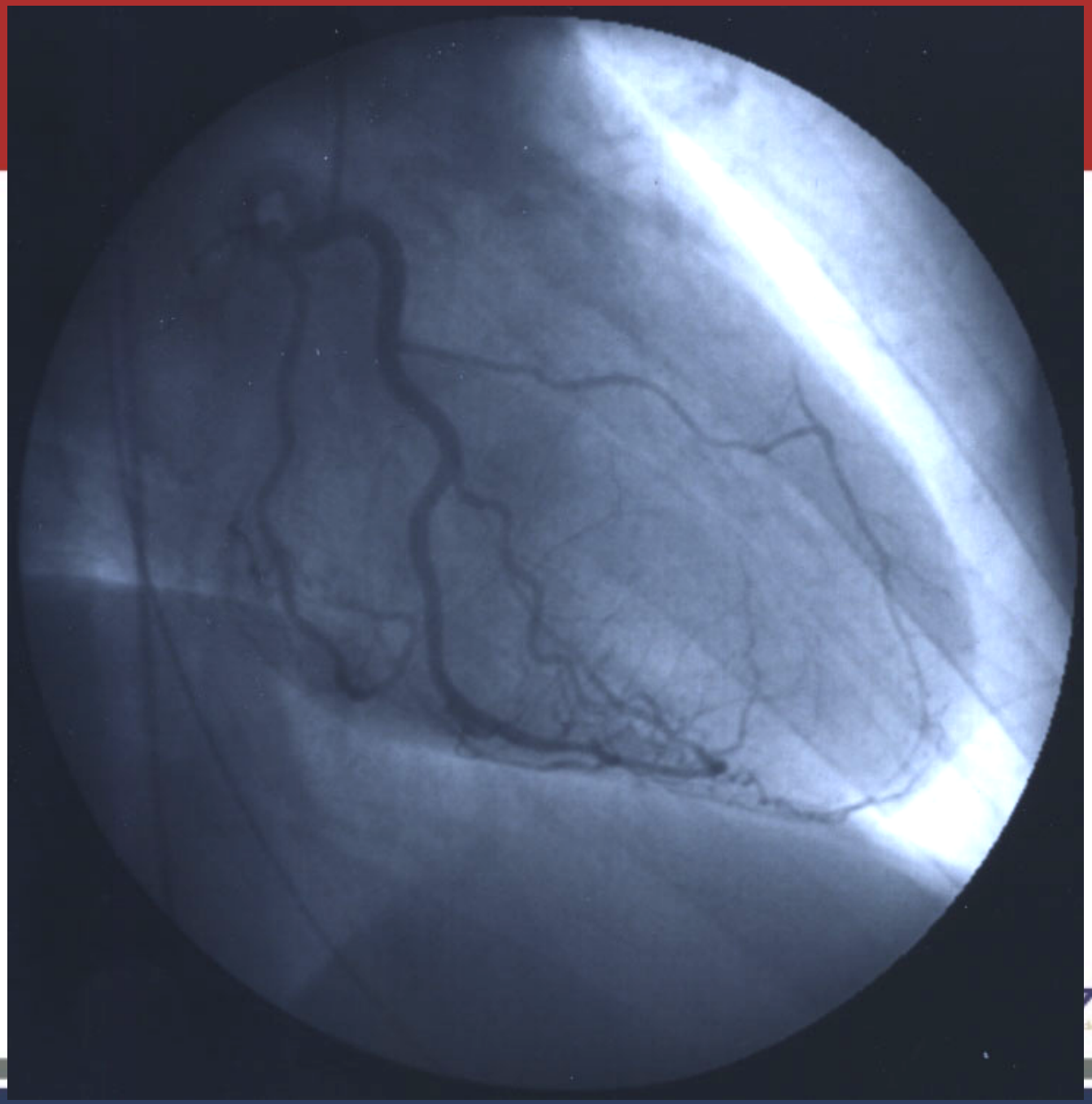

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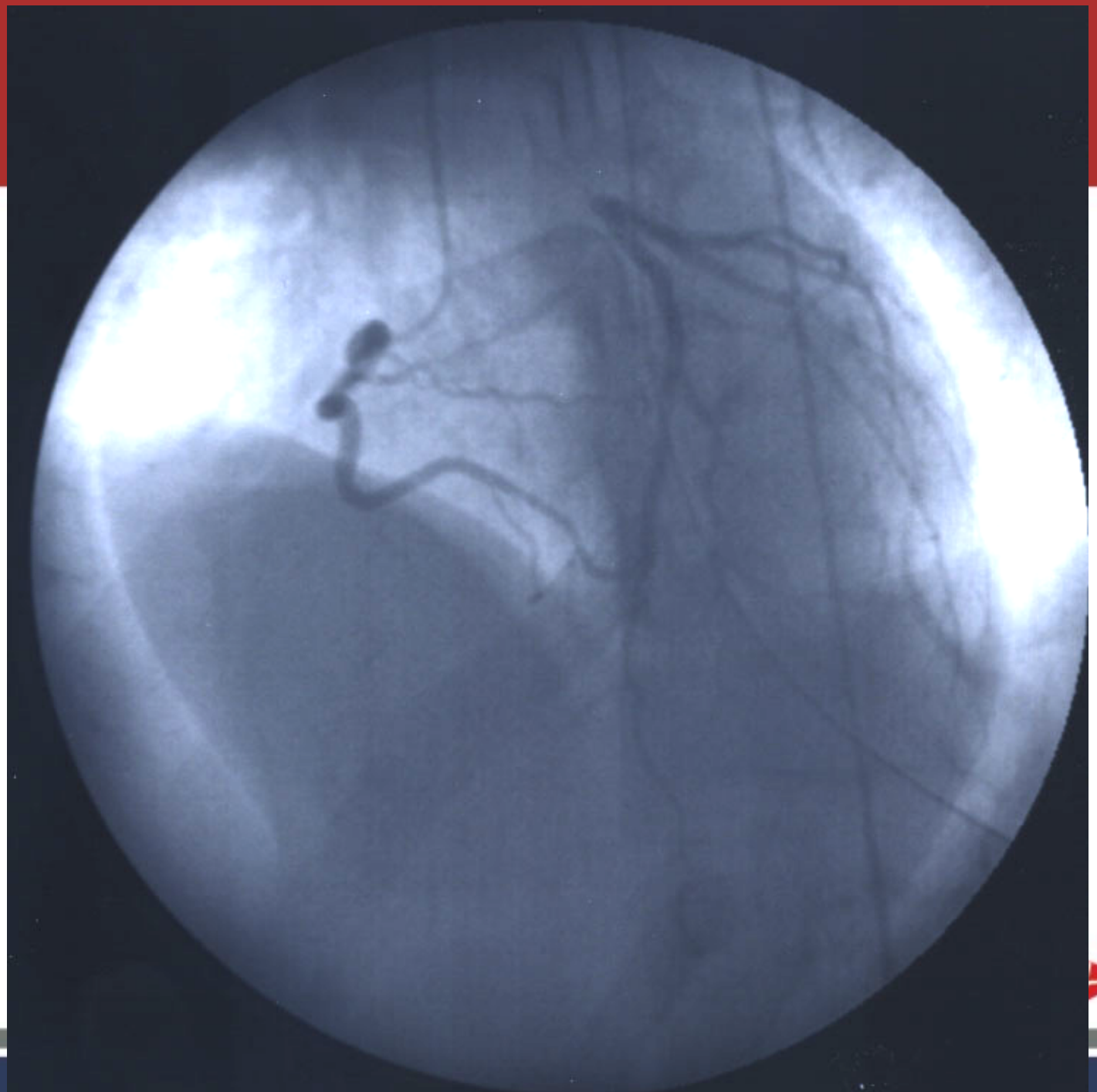

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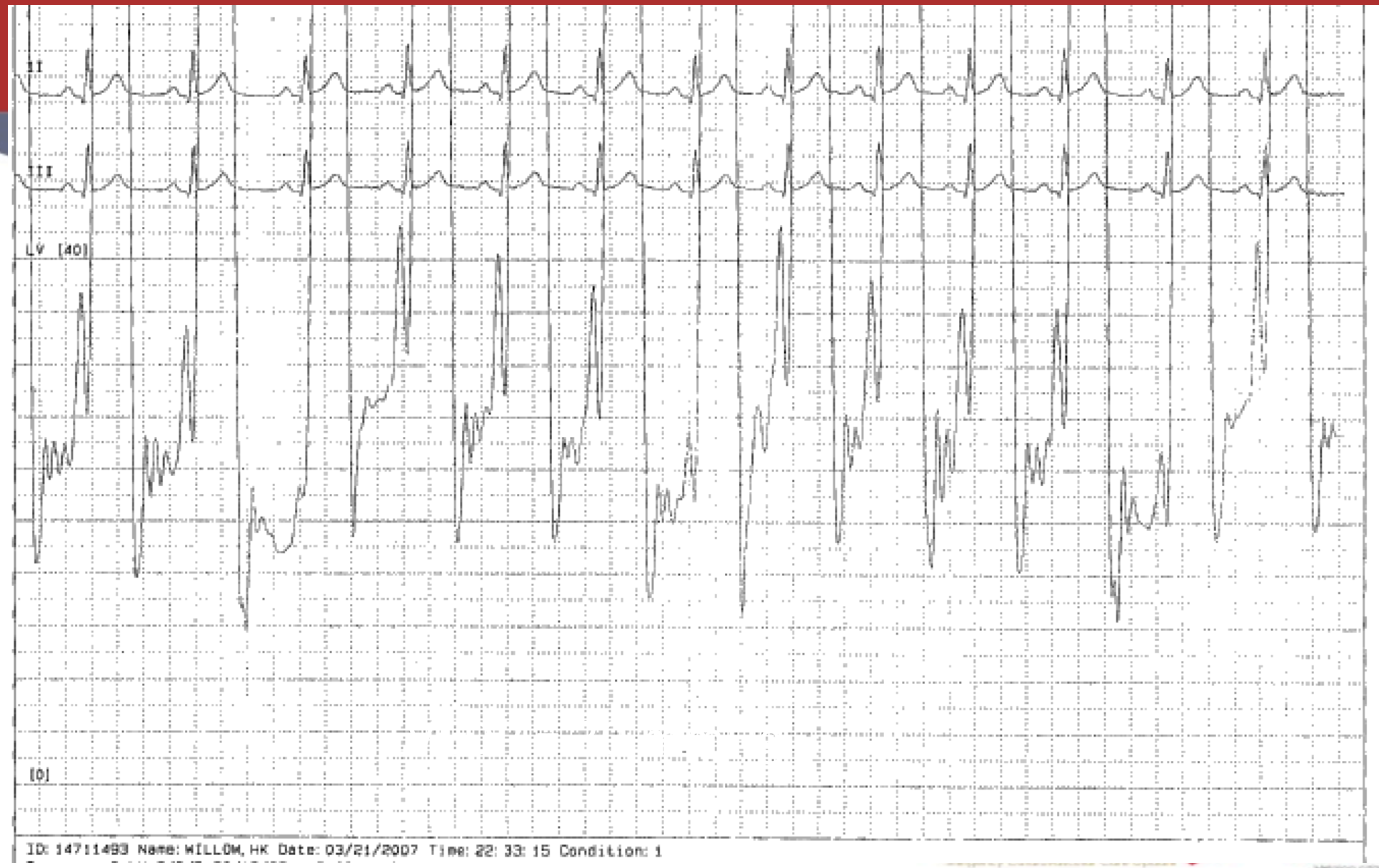
Follow-Up

- CABG X 1V: LIMA to LAD 3 months later
- TFD declined to hire him!
- Returned to College: studied Forestry

7 Years Later …

- Began to have exertional CPs
- NUC MPI:
  - "Med sized, mod intensity reversible defect in the Anterior/Lateral wall"
- Failed medical management
- Re-cathed



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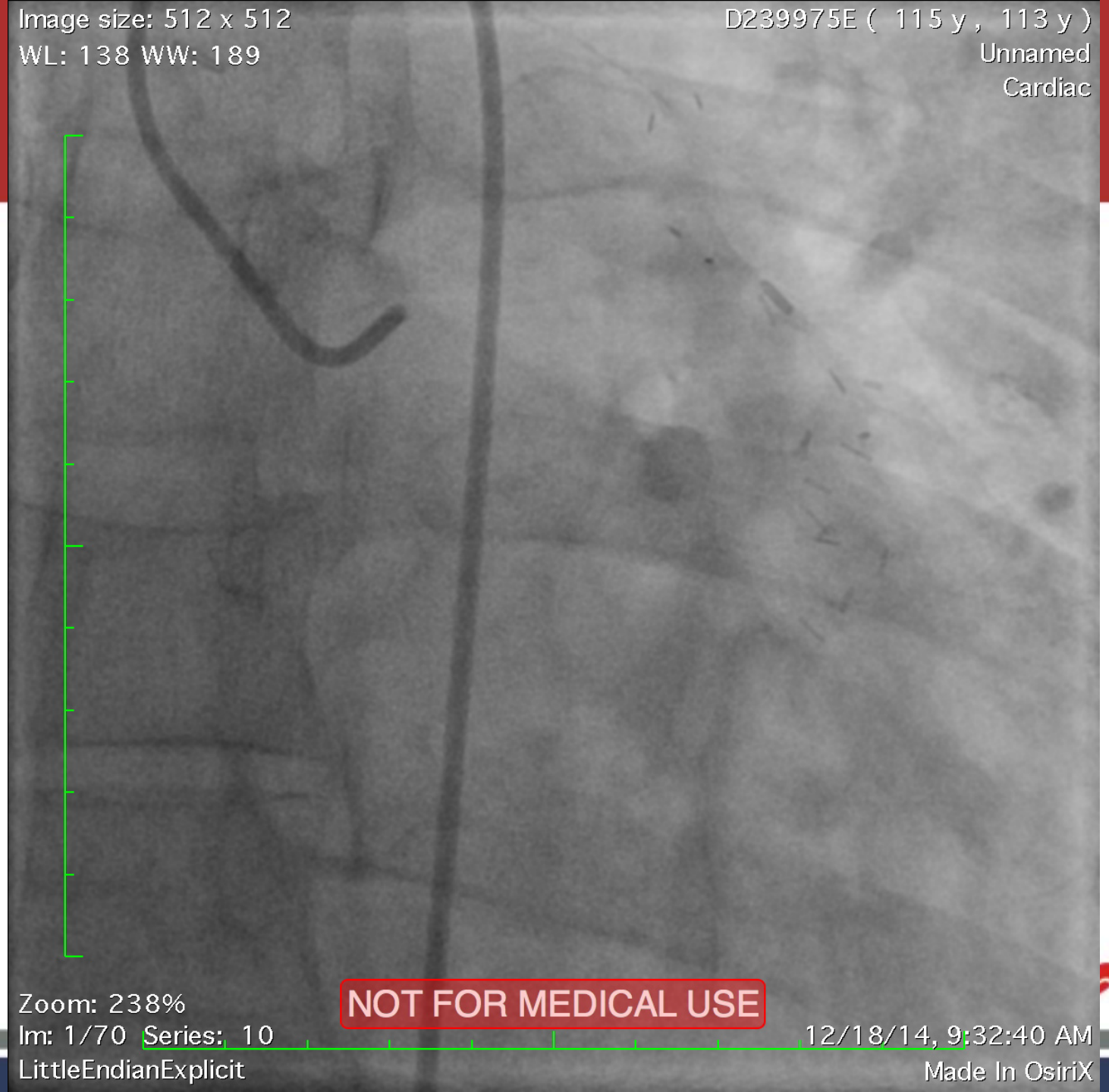

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Cardiology Issues:

- Early Coronary Angiography & PCI
- Mechanical CPR & Rescue PCI
- ECMO & LVADs
- Hyper-invasive Approach for Refractory Cardiac Arrest
- Not Just Atherosclerosis