

MODULE 9





RACE CARS: Hospital Response

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Carolinas Medical Center
February 23, 2012



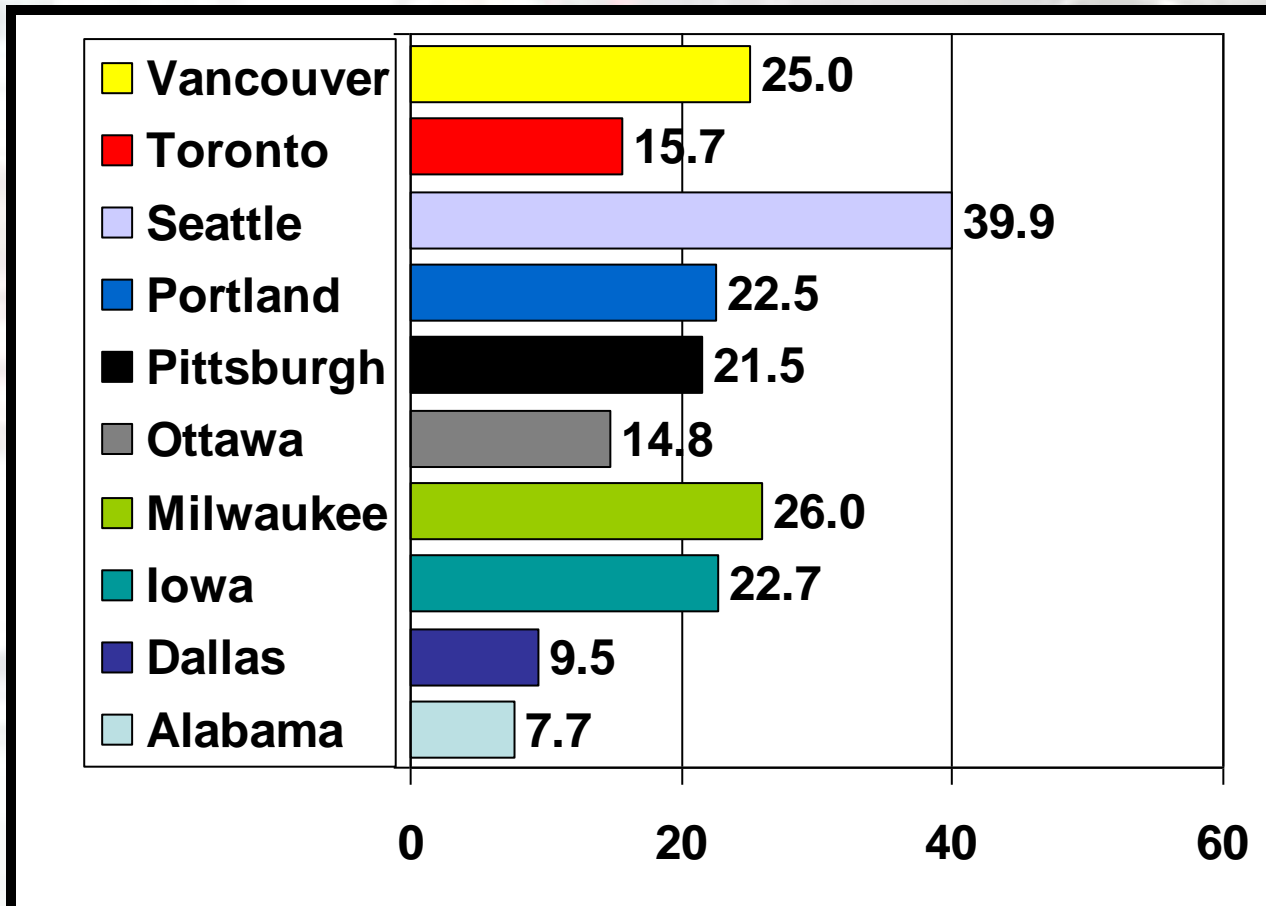
Objectives:

- Post-cardiac arrest syndrome
- Therapeutic hypothermia
- Regionalization
- RACE CARS

Variation in Survival VF Arrest

Resuscitations Outcomes Consortium

Survival to discharge





Post-Cardiac Arrest Syndrome:

- Brain injury
- Myocardial dysfunction
- Systemic ischemia/reperfusion
- Persistent precipitating pathology



Brain Injury:

- CPR restores ROSC in 30 - 70%
- > 65% die a neurological death
- Out-of-hospital arrest < 6% survival

Landmark Trials

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NUMBER 8



MILD THERAPEUTIC HYPOTHERMIA TO IMPROVE THE NEUROLOGIC OUTCOME AFTER CARDIAC ARREST

THE HYPOTHERMIA AFTER CARDIAC ARREST STUDY GROUP*

INDUCED HYPOTHERMIA AFTER OUT-OF-HOSPITAL CARDIAC ARREST

TREATMENT OF COMATOSE SURVIVORS OF OUT-OF-HOSPITAL CARDIAC ARREST WITH INDUCED HYPOTHERMIA

STEPHEN A. BERNARD, M.B., B.S., TIMOTHY W. GRAY, M.B., B.S., MICHAEL D. BUIST, M.B., B.S.,
BRUCE M. JONES, M.B., B.S., WILLIAM SILVESTER, M.B., B.S., GEOFF GUTTERIDGE, M.B., B.S., AND KAREN SMITH, B.Sc.

HEART - LUNG RESUSCITATION

I FIRST AID: OXYGENATE THE BRAIN IMMEDIATELY

IF UNCONSCIOUS

Airway - TILT HEAD BACK

IF NOT BREATHING

Breathe - INFLATE LUNGS 3-5 TIMES,
MAINTAIN HEAD TILT
MOUTH-TO-MOUTH, MOUTH-TO-NOSE,
mouth-to-advent, bag-mask

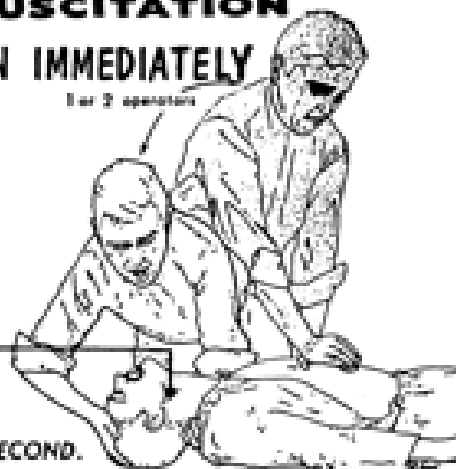
o FEEL PULSE

o IF PRESENT - CONTINUE LUNG INFLATIONS

o IF ABSENT -

Circulate - COMPRESS HEART ONCE A SECOND.

1 or 2 operators



III SUPPORT RECOVERY

(physician - specialist)

Gauge

Hypothermia

Intensive Care

EVALUATE AND TREAT CAUSE OF ARREST

START WITHIN 30 MINUTES IF NO SIGN OF CNS RECOVERY

SUPPORT VENTILATION: TRACHEOTOMY, PROLONGED CONTROLLED VENTILATION, GASTRIC TUBE AS NECESSARY

SUPPORT CIRCULATION
CONTROL CONVULSIONS
MONITOR

SHOCK EVERY 1-3 MINUTES UNTIL FIBRILLATION REVERSED
• IF ASTYLE OR WEAK BEATS: EPINEPHRINE OR CALCIUM I.V.

Fluids - I.V. PLASMA, DEXTRAN, SALINE

Do not interrupt cardiac compressions and ventilation.
Tracheal intubation only when necessary.

AFTER RETURN OF SPONTANEOUS CIRCULATION USE VASOPRESSORS AS NEEDED,
e.g. NORADRENALINE (Largactin) I.V. DRIP



III SUPPORT RECOVERY

(physician - specialist)

Gauge

Hypothermia

Intensive Care

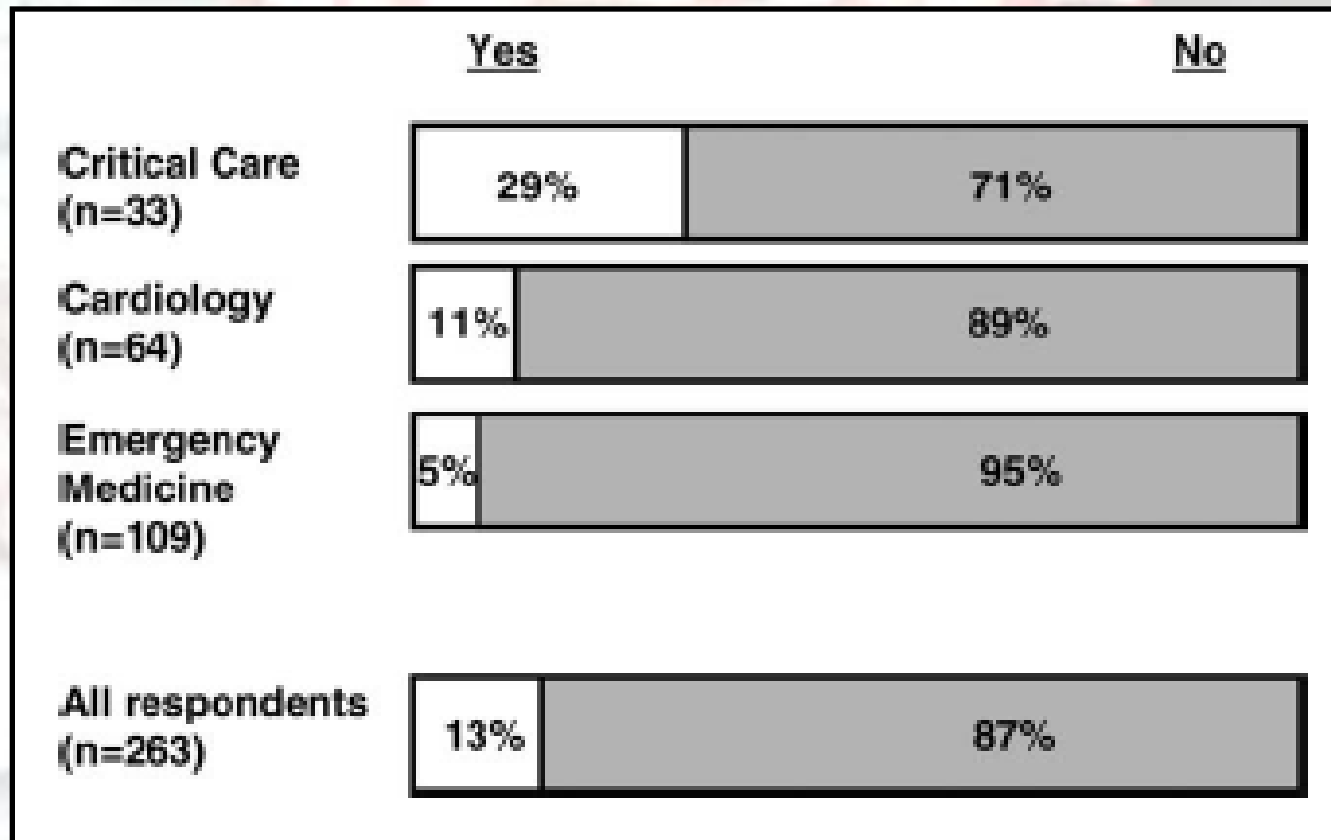
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SUPPORT CIRCULATION
CONTROL CONVULSIONS
MONITOR

U.S. Implementation 2005



Abella B, et al. *Resuscitation* 2005.
Merchant RM, et al. *Crit Care Med* 2006.
Laver SR, et al. *Anaesthesia* 2006.
Bigham BL, et al. *Resuscitation* 2009.
Toma A, et al. *Crit Care Med* 2010.



AHA: 2010

“Patients who are comatose following resuscitation from cardiac arrest should be cooled to 32°C to 34°C for 12 to 24 hours.”

IB Patients with pre-hospital VT/VF

IIB Patients with in-hospital cardiac arrest
or pre-hospital PEA or asystole

Therapeutic Hypothermia:

1. Induction

- Infuse NS 30 cc/kg IV bolus over hour
- Initiate cooling device
- Ice packs

2. Maintenance

- Achieve goal temp 33° C
- Maintain for 24 hours

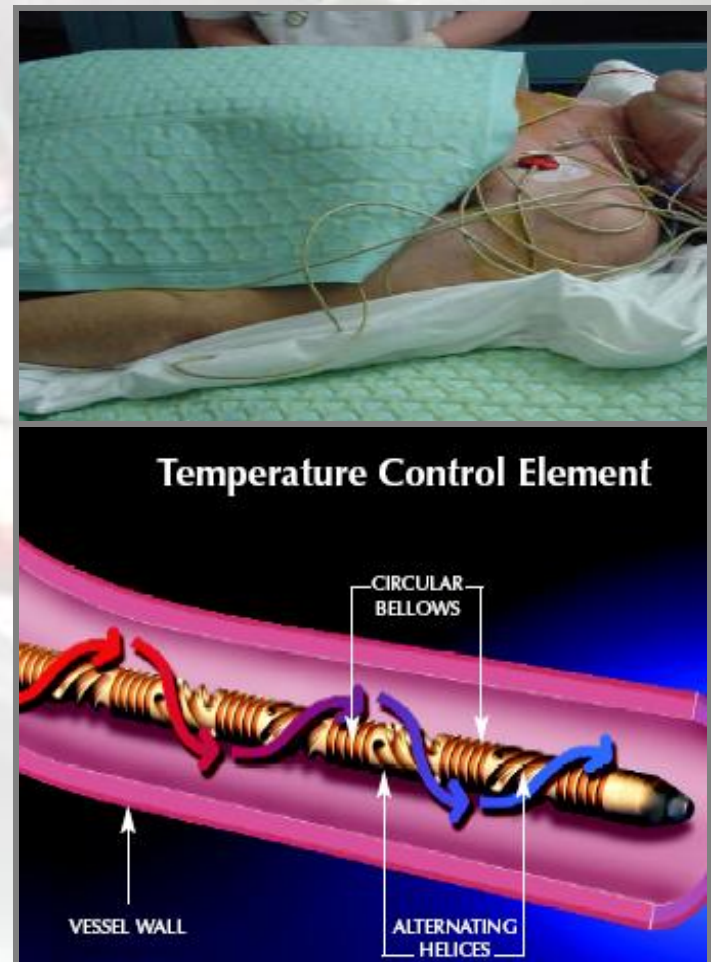
3. Rewarming

- Controlled rewarming



Cooling Techniques:

- Surface cooling
 - Ice packs
 - Cooling pads
- Internal cooling
 - Cold (4°C) IVFs
 - Endovascular catheters





Cool Questions:



- Are cold fluids efficacious?
- Intra-arrest cooling?
- Time to goal temperature?





Are Cold Fluids Efficacious?

- Decreased temp by 2°C over 30 minutes
- Improved BP, acid base, renal function
- Simple, inexpensive
- Pulmonary edema rare & easily managed

Bernard SA, et al. *Resuscitation* 2003; 56:9-13.

Kim F, et al. *Circulation* 2005; 112:715-9.

Polderman, KH et al. *Crit Care Med* 2005; 2744-2751.

Kim F, et al. *Circulation* 2007; 115:3064-70.



Intra-arrest Cooling & ROSC:



- Retrospective, 551 patients
- Average fluids infused: 544 mL
- Pre-hospital ROSC:
 - 36.5% intra-arrest hypothermia
 - 26.9% normothermia
- Linear relationship between amount of cold IVF and ROSC



How Fast To Cool - *Animals?*



- Faster cooling improves neurological outcomes
- Very rapid cooling best (< 2 hours)
- Numerous animal studies:
 - Sterz F. et al. *Crit Care Med* 1991; 19:379-389
 - Kuboyama K. et al. *Crit Care Med* 1993; 21: 1348-1358
 - Abella B., et al. *Circulation* 2004; 109:2786-2791
 - Nozari A., et al. *Circulation* 2006; 113:2690-2696

Intra-arrest Cooling?

- 17 dogs
- VF arrest, CPR, 50 minutes ALS
- Early (10 min) vs. late (20 min) cooling

	Delayed hypothermia	Early hypothermia
OPC 5 or death	oooooooo	o
OPC 4		o
OPC 3		o
OPC 2		o
OPC 1	o	oooo



Intra-arrest Cooling?



- Ice packs
 - 34 pigs, CPR for 8 minutes, compared vs normothermia
 - *First shock success* in 6 of 8 at 33C (1 of 8 at normothermia)
 - Boddicker KA, et al. Hypothermia improves defibrillation success and resuscitation outcomes from ventricular fibrillation. *Circulation* 2005; 111: 3195-3201.
- Cold fluids
 - 20 piglets, CPR for 9 minutes
 - All pigs had ROSC except one on hypothermia group
 - Nordmark J, et al. Induction of mild hypothermia with infusion of cold (4 degrees C) fluid during ongoing experimental CPR. *Resuscitation*. 2005; 66: 357-65.

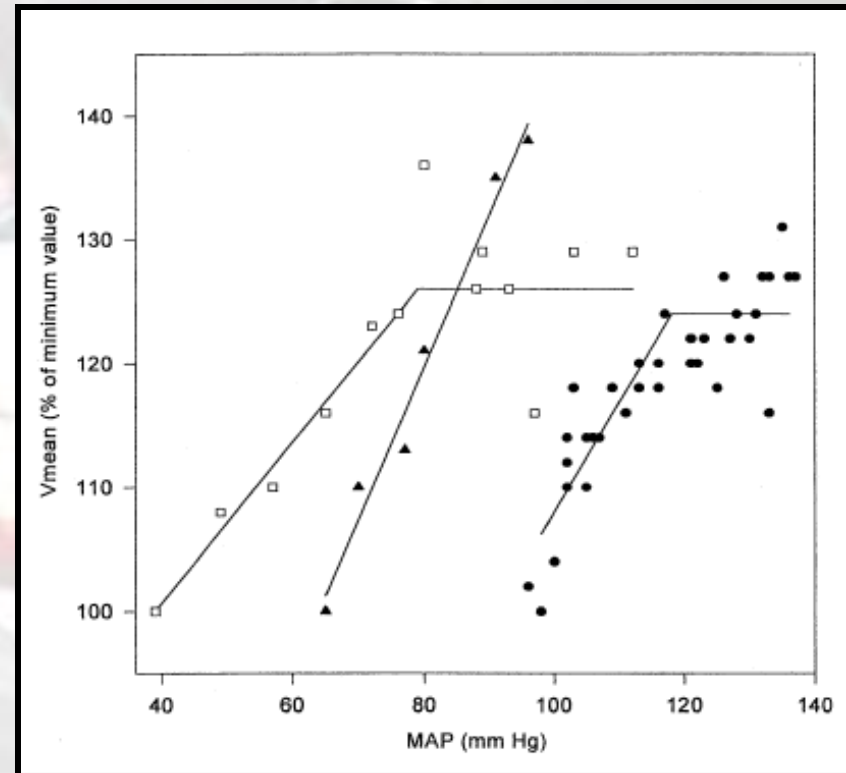


How Fast To Cool - *People?*

- Haugk et al. (3/2011), retrospective, 588 patients
 - Faster cooling rate lead to less favorable outcome
 - Time to goal temp: 209 min. (favorable neuro outcome)
 - Time to goal temp: 158 min. (poor neuro outcome)
- Mooney et al. (7/2011), retrospective, 144 patients
 - 20% increase risk of death for each hour delay in initiation
 - No association with time to goal temperature

Cerebrovascular Resuscitation:

- Post-ROSC hypotension
 - Secondary brain injury
 - Worsens prognosis
- Hypertension ($MAP < 130$)
 - Maintains cerebral flow
 - Pressor support?



Hypertension & Neurological Recovery:

- Retrospective review
- 136 post-cardiac arrest patients
- Epi to keep MAP > 70 by protocol
- Positive association between good neurologic recovery & MAP *within 2 hours* after ROSC



**BALTIMORE CITY HOSPITAL
DEPARTMENT OF ANESTHESIOLOGY
RESUSCITATION EXPERIMENT, JULY 13, 1957
VOLUNTEER: FELIX STEICHEN, M.D.
RESIDENT IN SURGERY**



Ventilator Management:



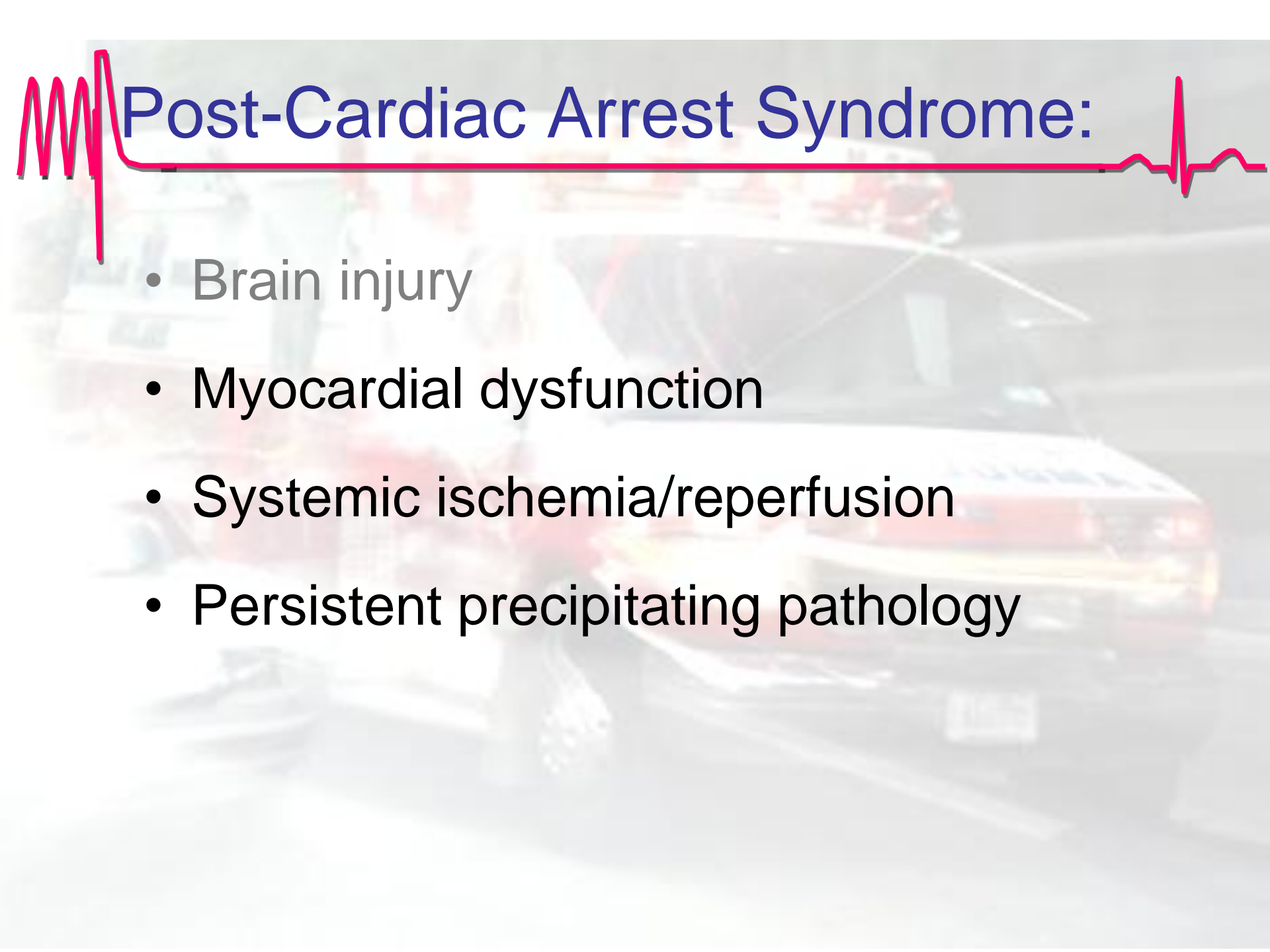
- Avoidance of hyperoxia
 - Titrate FIO₂ rapid to maintain oxygen sats > 94%
 - Hyperoxia OR for death 1.8
- Avoidance of hyperventilation
 - Maintain high-normal PaCO₂ (40 to 45 mm Hg)

Kilgannon JH, et al. *JAMA*, 2010.

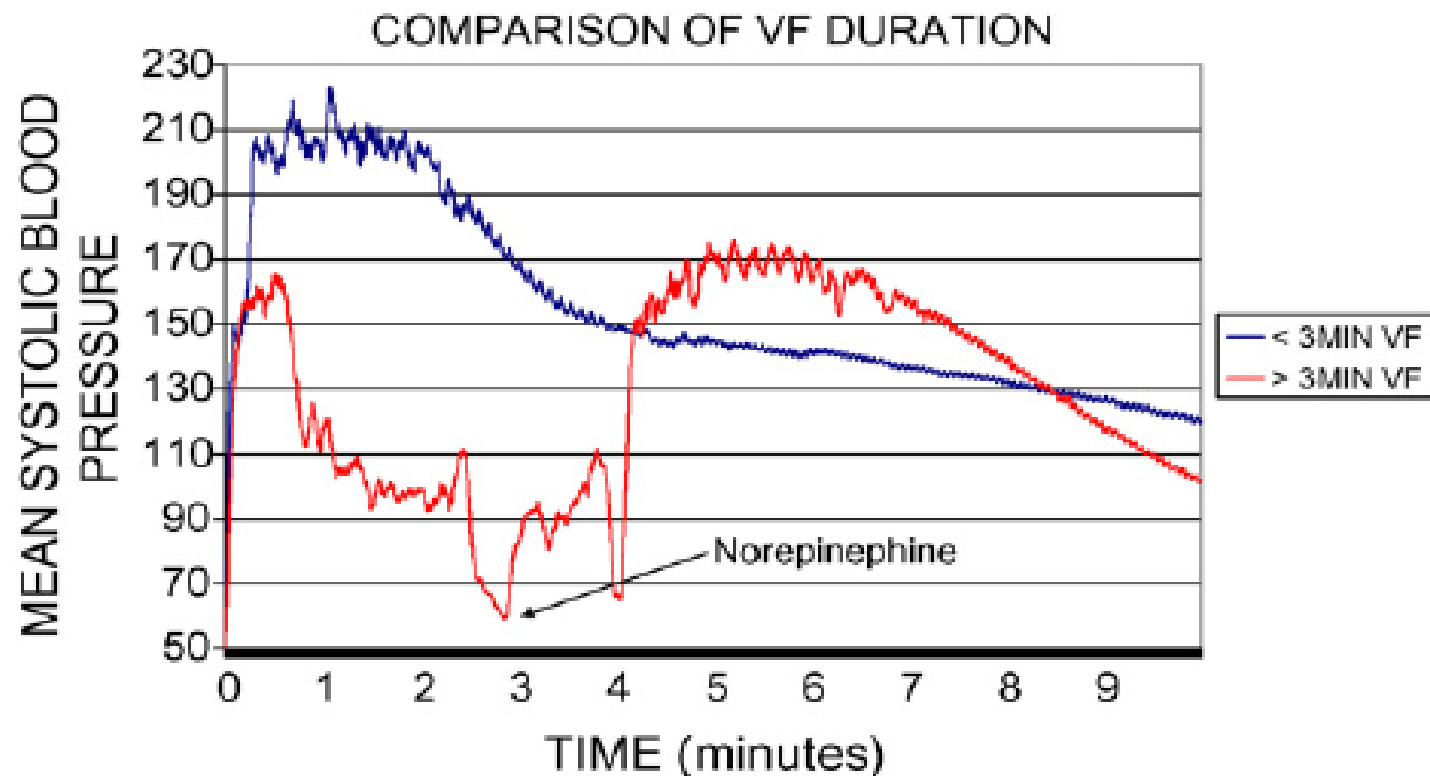
Peberdy et al, *Circulation*, 2010.



Post-Cardiac Arrest Syndrome:

- Brain injury
 - Myocardial dysfunction
 - Systemic ischemia/reperfusion
 - Persistent precipitating pathology
- 

Hemodynamic Instability:





Myocardial Dysfunction:

- 165 patients with OHCA
- HD instability at 6.8 hours
- Initial cardiac index low
- Cardiac index improved at 24 hrs
- Superimposed vasodilation

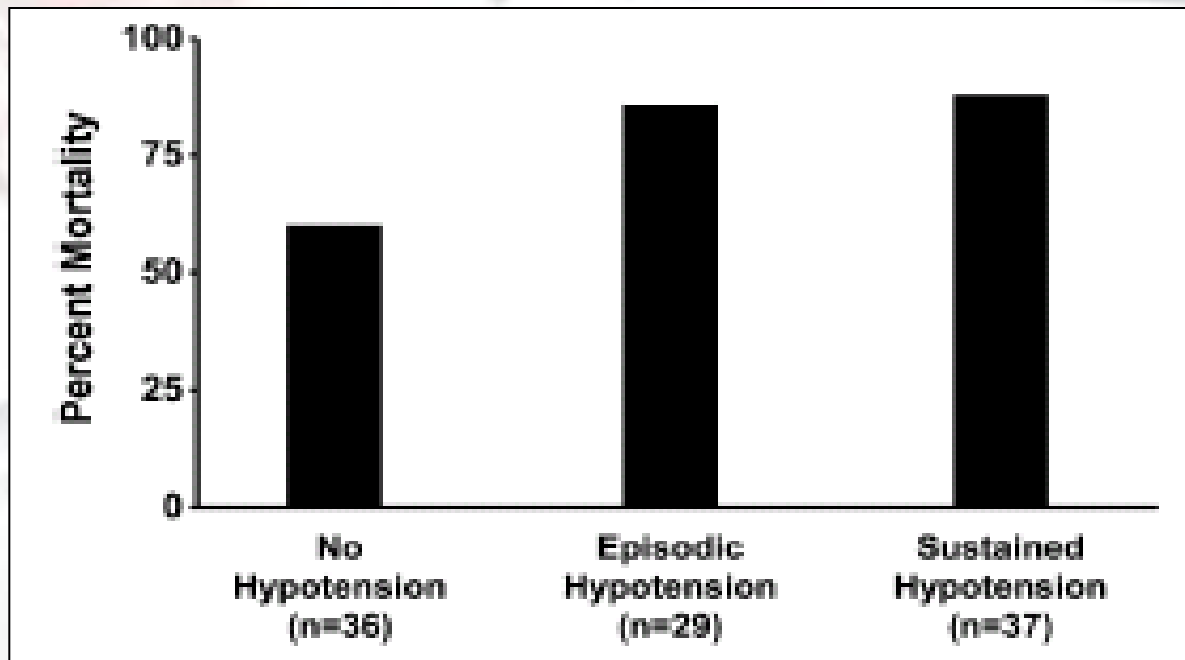
The background of the slide is a faded image of an ambulance with its emergency lights on. A red ECG (heart rate) line is superimposed over the top of the slide, starting with a series of peaks and then leveling out.

Post-Cardiac Arrest Shock:

- Multi-factorial shock:
 - Cardiogenic
 - Circulatory
 - Distributive
- *A sepsis-like syndrome*

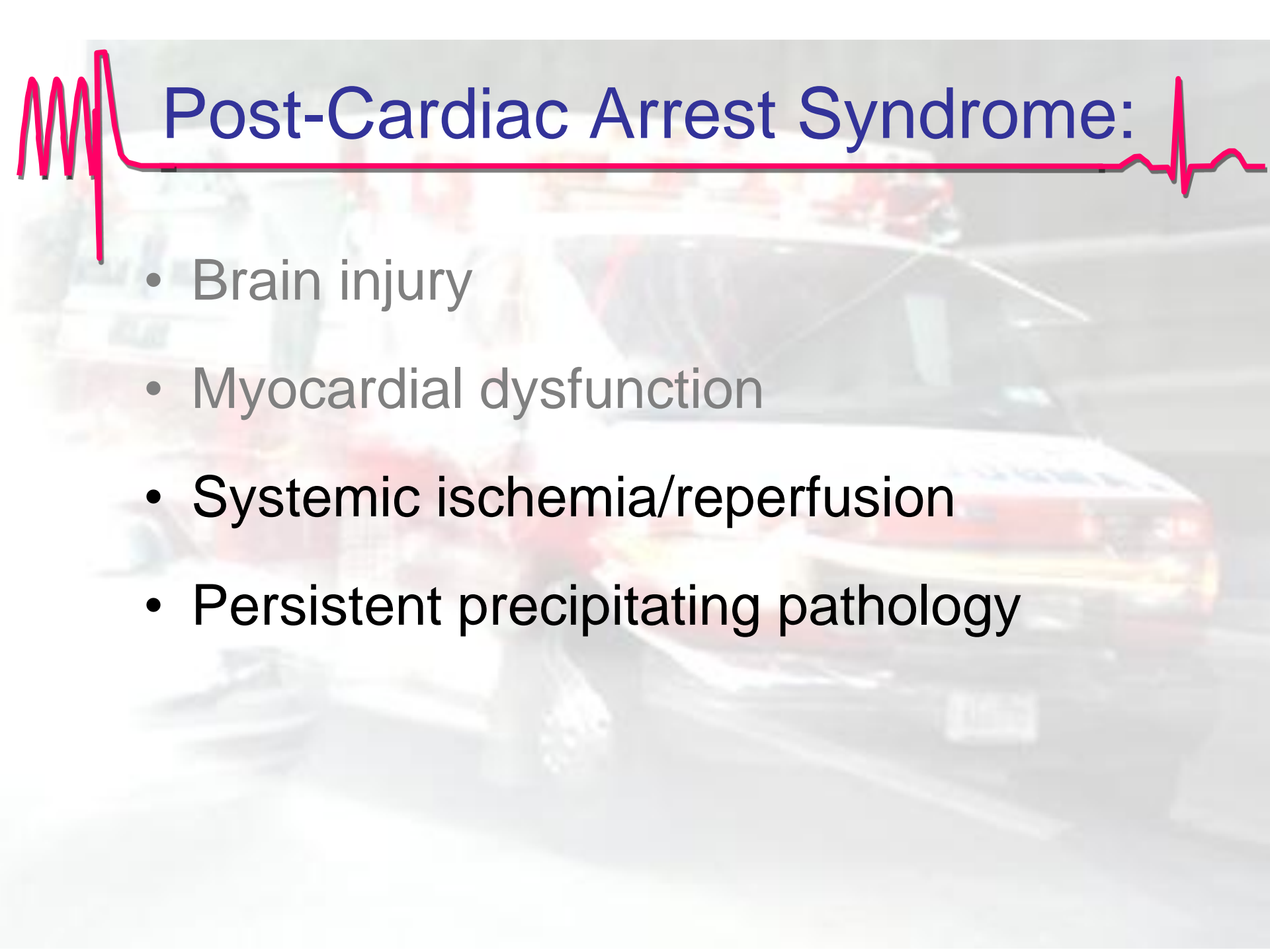
Early Hypotension Predicts Mortality:

- Single-center retrospective study
- 102 post-cardiac arrest patients





Post-Cardiac Arrest Syndrome:

- Brain injury
 - Myocardial dysfunction
 - Systemic ischemia/reperfusion
 - Persistent precipitating pathology
- 

Early-Goal Directed Hemodynamic Optimization:

- Preload optimization
- Perfusion pressure support
- Perfusion optimization



Early-Goal Directed Hemodynamic Optimization:

- Feasibility study
- Concurrently with hypothermia
- CVP > 8
- MAP 80 to 100 mmHg
- ScvO₂ $> 65\%$
- Goal: 6 hours of ED presentation



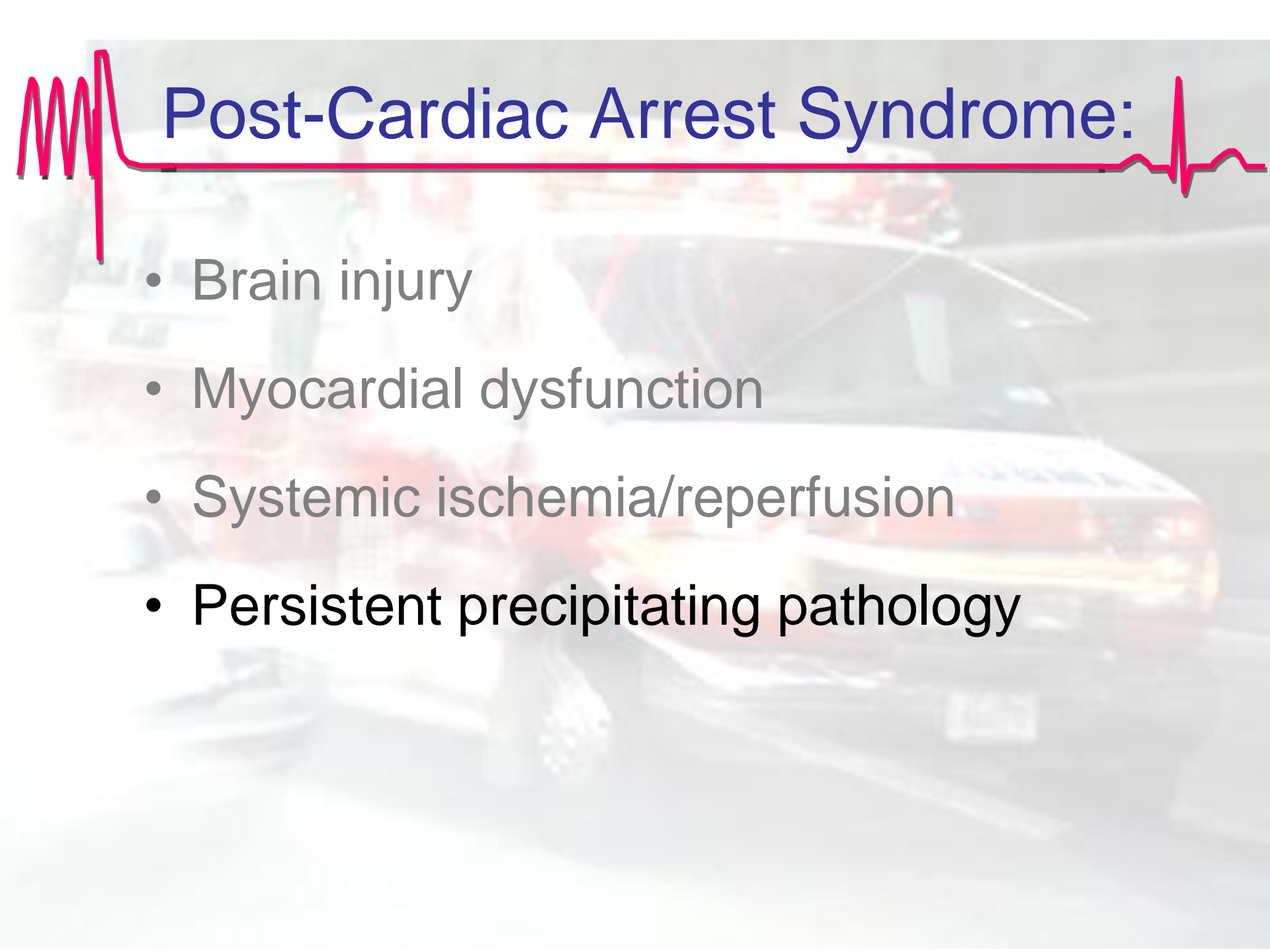
Early-Goal Directed Hemodynamic Optimization:



- Historical controls (n=18)
- Prospective protocol (n=20)
- 72% reached EGDHO goals
- 78% mortality historical controls
- 50% mortality in EGD protocol (p=0.15)
- 28% absolute mortality reduction

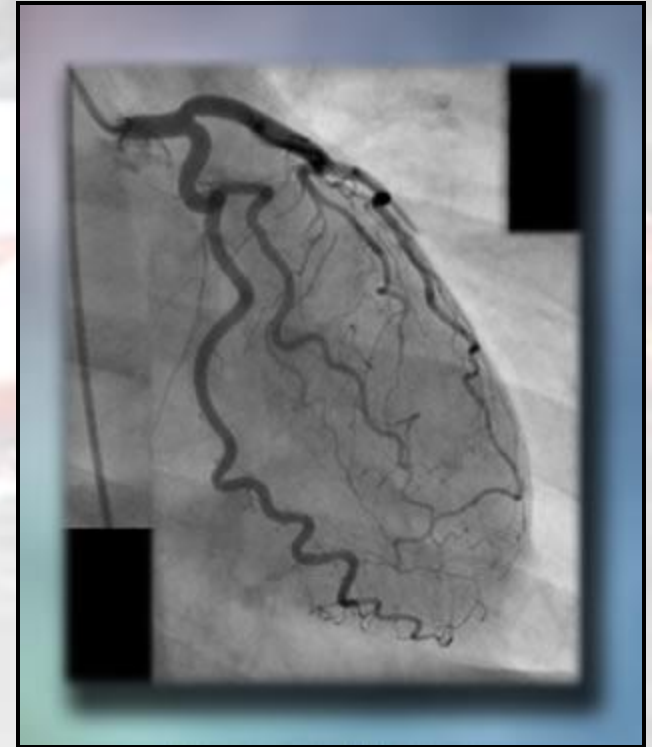


Post-Cardiac Arrest Syndrome:

- Brain injury
 - Myocardial dysfunction
 - Systemic ischemia/reperfusion
 - **Persistent precipitating pathology**
- 

Percutaneous Coronary Intervention (PCI):

- Pre-arrest symptoms unreliable
- ST-elevation MI
- Acute coronary syndrome
- Initial rhythm



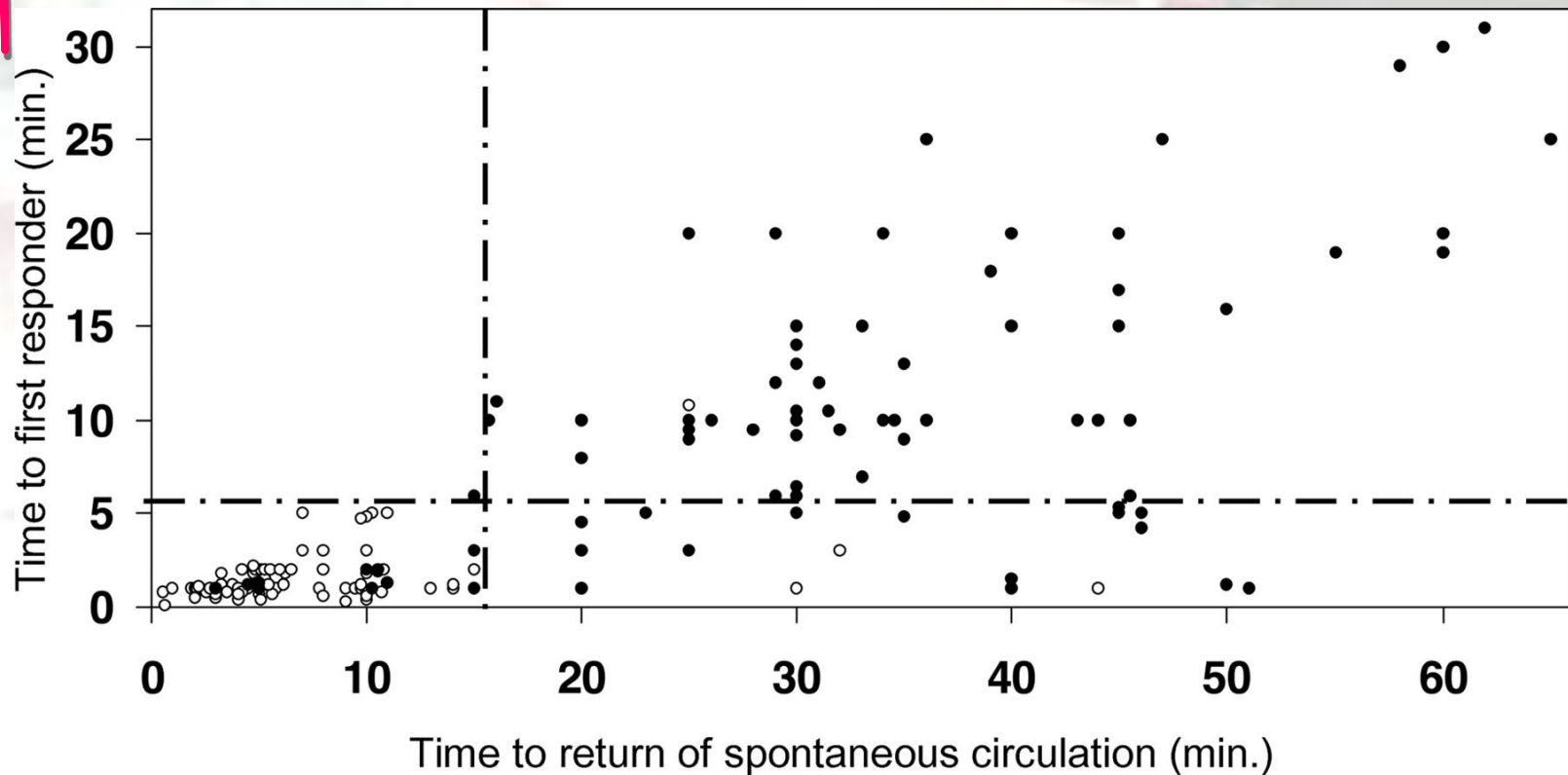



Emergency PCI:



- Retrospective, case series
- 186 witnessed arrest patients with STEMI
- *Shock in 52%*
- PCI successful in 87%
- Good neuro outcome at six months in 46%

Cardiac Arrest & STEMI: Who Survives?





PCI & Non-STEMI:

- Retrospective, Paris, 714 patients
- STEMI: 96% had lesion
- Non-STEMI: 58% had lesion
- Hospital survival: 40%
- Successful PCI independent predictor of survival

PCI, Cardiogenic Shock, & Hypothermia:

# of arrests	Coronary Angiogram	PCI	IABP	Overall Survival	CPC 1 or 2	CPC 3 to 5
50	49 (98%)	36 (72%)	23 (46%)	41 (82%)	34 (68%)	16 * (32%)

23 with IABP

CPC 1/2: 14 (61%)

27 without IABP

CPC 1/2: 20 (74%)

* Patients with CPC 3 to 5 had less bystander CPR, longer time to ROSC, and more defibrillations before ROSC



Post-Cardiac Arrest Syndrome:

- Brain injury
- Myocardial dysfunction
- Systemic ischemia/reperfusion
- Persistent precipitating pathology

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"Is it just me or is it a bad idea to eat at a place that prints CPR instructions on their placemats?"



AHA 2010: Guidelines:



- Optimize perfusion
- Identify & treat precipitating cause
- Transport to comprehensive post-cardiac arrest treatment system
 - Acute coronary interventions
 - Goal-directed critical care
 - Hypothermia



Regionalization Rationale:



- IOM & AHA endorse regionalized systems
- Increase utilization of proven interventions
- Specialized resources at certain centers
- Correlation between case volume and patient outcome

Therapeutic Hypothermia After Out-of-Hospital Cardiac Arrest

Evaluation of a Regional System to Increase Access to Cooling

Michael R. Mooney, MD; Barbara T. Unger, RN; Lori L. Boland, MPH;
M. Nicholas Burke, MD; Kalie Y. Kebed, BS; Kevin J. Graham, MD; Timothy D. Henry, MD;
William T. Katsiyannis, MD; Paul A. Satterlee, MD; Sue Sendelbach, PhD, RN, CCNS;
James S. Hodges, PhD; William M. Parham, MD

- 140 out-of-hospital cardiac arrest patients
- ROSC < 60 minutes, presumed cardiac
- Included regardless of initial rhythm, HD instability, STEMI
- Excluded: DNR, active bleeding, comatose before arrest

Regional System: Arrest Characteristics

- Witnessed: 82%
- Bystander CPR: 66%
- VT/VF 76%
- PEA/asystole 24%
- STEMI 49%
- Shock 44%
- Downtime 22 minutes



Regional System: Outcomes

- 56% survived
- 51% good neurological outcome
- 20% increased risk of death with every hour delay in initiation of cooling
- Time to goal temperature not significantly associated with survival

Minneapolis Heart Institute's “Cool It”

Patient Group	Good Neurologic Outcomes
Local (n=17/33)	42%
Referred/Transfer (n=58/107)	54%
Age > 75 (n=9/30)	30%
Asystole/PEA (n=7/32)	22%
Downtime > 30 min (n=16/45)	36%



CMC's Code Cool

- Started November 2007
- Total patients to date: 265
- Transfers: 41%
- In-hospital arrests: 5%
- STEMI's: 12%

Code Cool: More Than Cooling

- Post-arrest resuscitation bundle
- Fluid resuscitation via cold IVF
- MAP > 70 mmHg
- Therapeutic hypothermia
- Avoid hyperoxia
- Avoid hyperventilation

Page 1 of 2

Carolinas Medical Center (CMC)
Therapeutic Hypothermia Post Cardiac Arrest
CMC Critical Care Committee

Initiate: CMC Therapeutic Hypothermia Post Cardiac Arrest
Verify Allergies: _____

Admit to: ICU under Dr.: _____ List: _____
Diagnosis: Cardiac Arrest
Condition: Critical
Notify Paging Operator at 355-2443 to activate Code Cool

Consults:
Pulmonary and Critical Care Consultants (PCCC) : page #3767 immediately, unless previously notified
Sanger Cardiology
Physical Medicine and Rehabilitation - List 66287
Activate Group Page 8760 for family support referral

Treatment Parameters
Refer to: CMC Therapeutic Hypothermia After Cardiac Arrest Guideline
Goal Temperature 33° C
Minimize FiO₂ to maintain SpO₂ greater than 95%
Maintain Mean Arterial Pressure (MAP) greater than 65 mmHg
Maintain PaCO₂ of 38 - 42 mmHg

Pharmacy/Treatments and Interventions: Weight: _____ kg
Hold all orders for Beta Blockers and Antihypertensive medications
Maintenance IV Fluids: _____ at _____ ml per hour
Norepinephrine (Levophed) 5 mcg/min; titrate to maintain MAP greater than 65 mmHg

Induction Phase (if not completed in the ED)
Place Temperature monitoring Foley catheter
Initiate refrigerated (4° C) IV NS 30 ml/kg bolus over 1 hour as tolerated
Apply Cooling Device with goal temperature set to 33° C

Pantoprazole (Protonix) 40 mg IV Q24H, first dose upon admission to ICU

Shivering Protocol
Initiate sedation per CMC Sedation and Analgesia for the Mechanically Ventilated Non Paralyzed Patient (MD to initiate)
For refractory shivering: Vecuronium (Norcuron) 0.1 mg/kg IV Push Q1H PRN shivering

Maintenance Phase
Maintain temperature of 33° C for 24 hours via Cooling Device

Re-warming Phase
Begin controlled re-warming at less than 0.5° C per hour to 37° C via Cooling Device
Discontinue sedation once 36° C is achieved
Cooling Device to remain operational with goal temperature of 37° C until order received to discontinue
Refer to: CMCC Subcutaneous Insulin Orders for the Non-Pregnant Patient (MD to initiate)
Implement: SO CMC Tight Glucose Control for the Adult Patient in MICU SICU TICU DHU CVRU or Neuro ICU (EndoTool®) if 2 consecutive blood glucose checks greater than 150 mg/dL



Code Cool Implementation Timeline

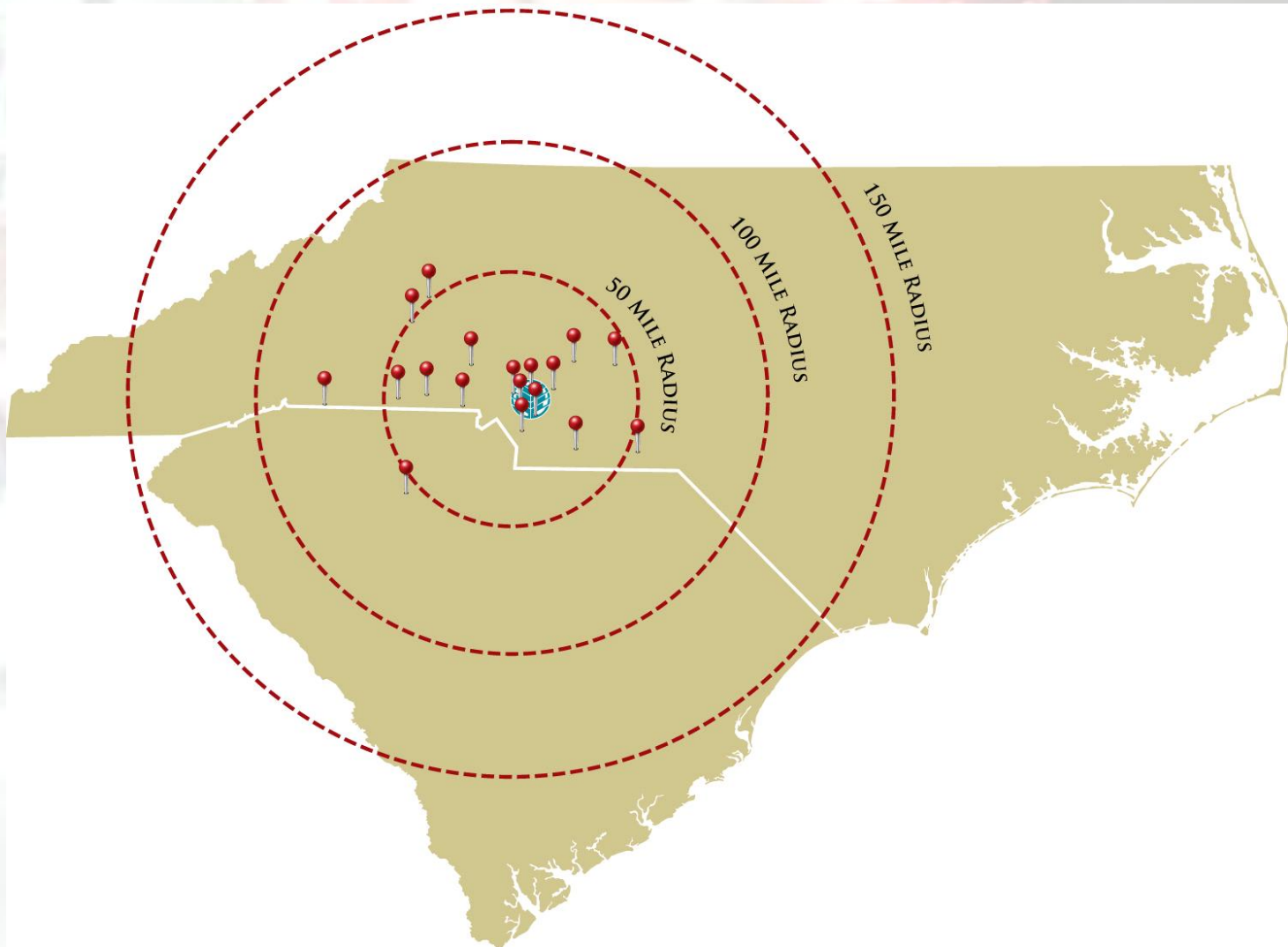
Nov-07
Code Cool Pathway Activation

Sep-08 - Jun-10
Regional Outreach Campaign

Oct-06 Jan-07 Apr-07 Jul-07 Oct-07 Jan-08 Apr-08 Jul-08 Oct-08 Jan-09 Apr-09 Jul-09 Oct-09 Jan-10 Apr-10 Jul-10

Nov-06 - Jul-07
Preparation and Planning

Regionalization





Post-Cardiac Arrest Resuscitation Carolinas Medical Center CODE COOL™

For Code Cool Transfer, contact CMC Physician Connection Line (PCL)
704-512-7878, Toll Free 877-262-6397 or Yellow Phone



PHYSICIAN CONNECTION LINE
LEO CENTER AIR



Carolinas Medical Center

Inclusion Criteria

- Adults (age ≥ 18 years)
- Return of spontaneous circulation (ROSC) within 30 minutes of arrest
- Persistent coma: inability to follow commands and/or GCS < 8

Exclusion Criteria

- Severe or terminal illness with anticipated non-aggressive care
- Active hemorrhage
- Systemic infection/sepsis
- Severe refractory shock

Resuscitation Priorities

- Airway: Intubation
- Breathing
 - Avoid hyperventilation (goal P_{aCO_2} of 38–42 mmHg)
 - Avoid hyperoxia (rapidly decrease FiO_2 to maintain $SpO_2 > 95\%$)
- Circulation
 - Goal MAP > 70
 - Anticipate and avoid hypotension
 - Norepinephrine is the preferred vasopressor
 - ECG screen for STEMI

Cooling Induction

- Initiate cooling as soon as possible after ROSC
- Refrigerated (4°C) NS 30 cc/kg IV bolus as tolerated
- Ice packs to groin, axilla and neck
- Shivering control with Propofol 30 mcg/kg/min
- Paralyze patient with Vecuronium 0.1 mg/kg q1 hr

Do

- Initiate transfer early
- Use paralytics during induction phase of cooling
- Document time of arrest, time of ROSC and neuro exam

Don't

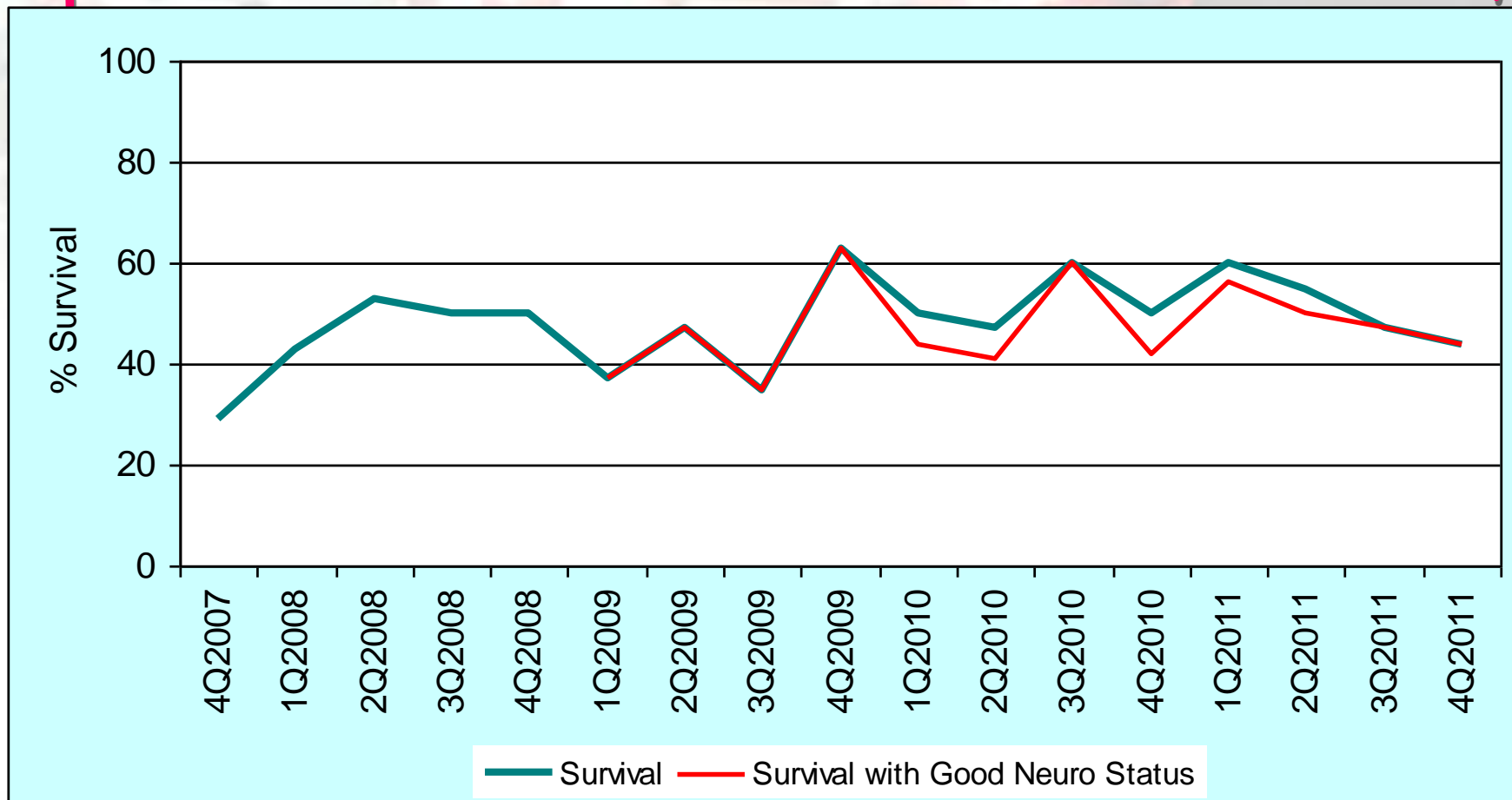
- Delay cooling for CT scanning or extensive testing before transfer, unless clinically indicated



Code Cool Outcomes: 2011

Initial Rhythm	Survived	Good Neuro Status
VT/VF (N=55)	34 (62%)	33(60%)
PEA (N=11)	3 (27%)	3 (27%)
Asystole (N=12)	4 (33%)	3(25%)

Code Cool Outcomes: *% Survival*



CMC Code Cool

Patient Group	Good Neurologic Outcomes
Local (n=99)	43%
Referred (n=67)	34%





Every second counts. Every action matters.



ARE YOU READY TO SAVE MORE LIVES?

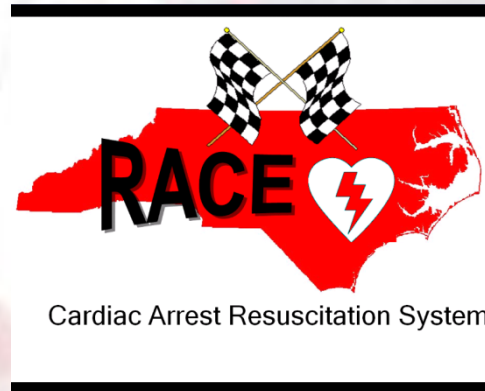


**"We aim above the mark
to hit the mark."**

Ralph Waldo Emerson

Regional Approach to Cardiovascular Emergencies

Cardiac Arrest Resuscitation System



Goal: To improve the survival from cardiac arrest by 50%

Heart Rescue

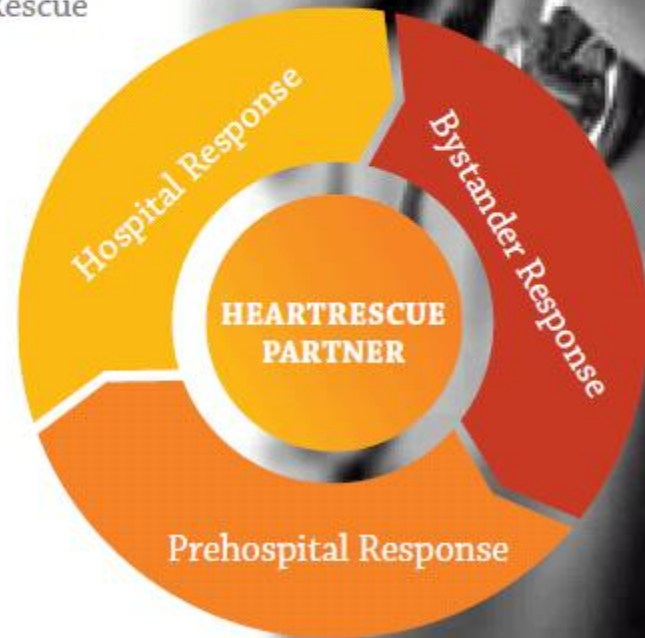
THE IMPORTANCE OF MEASUREMENT

To see real improvement, we must measure outcomes and performance at every level of response.

Currently, there are no national standards for SCA performance and outcomes measurement. One of the goals of the HeartRescue Project is to promote commonality in data collection.

HOSPITAL RESPONSE

1. Patient triage to a Resuscitation Center of Excellence
2. Hypothermia
3. 24/7 access to catheterization laboratory
4. Post-survival treatments
5. Post-survival patient and family education and support





Hospital Response:

Resuscitation

Capable Hospital

- Resuscitate
- Initiate cooling
- Transfer

Cardiac Arrest

Center

- Hypothermia
- PCI
- ICD assessment & placement



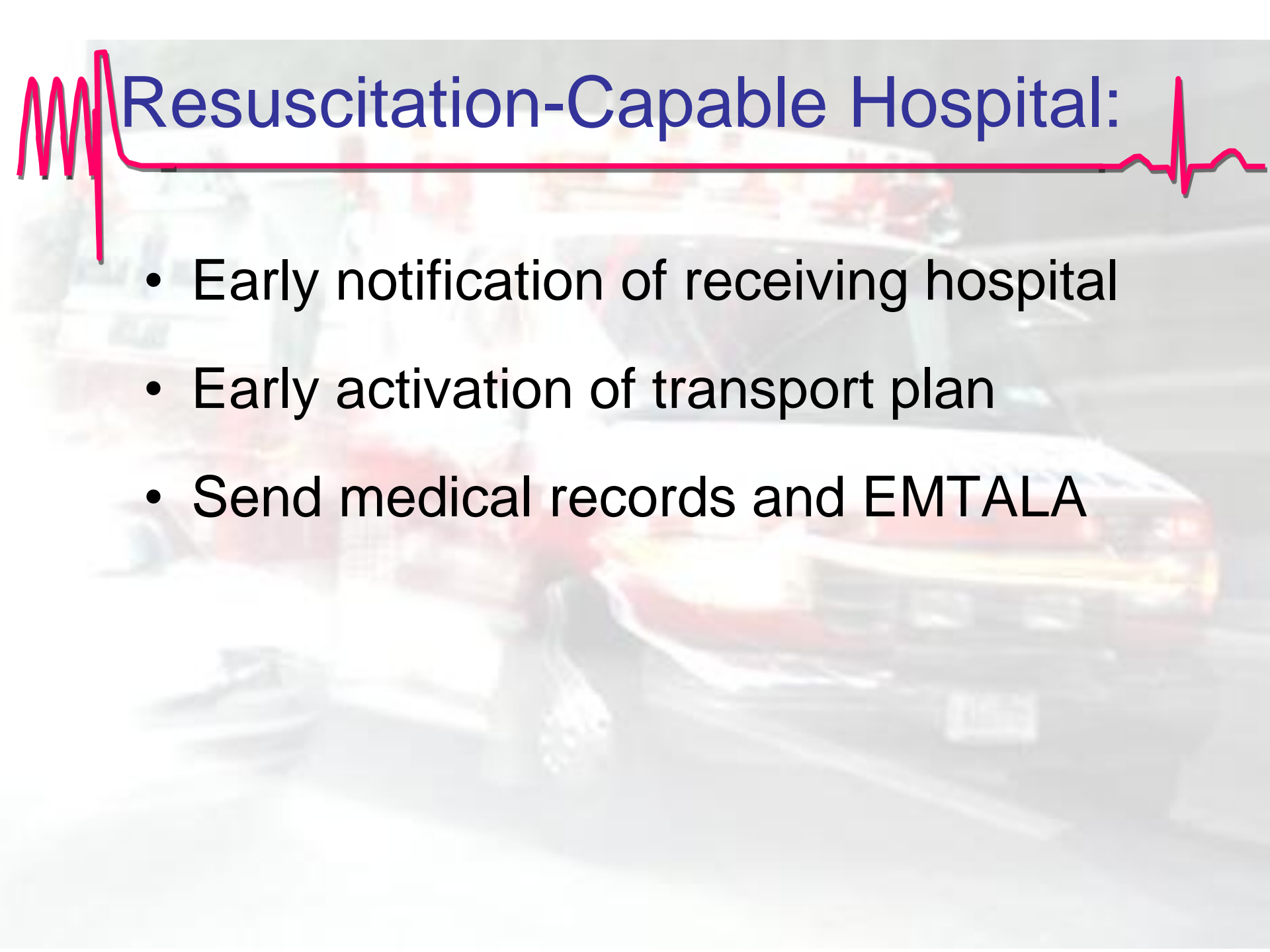
Resuscitation-Capable Hospital:




- ACLS protocols
- Baseline neurologic exam
- 2 large bore IV
- ECG = STEMI: activate STEMI plan
- Implement treatment protocols for STEMI and cardiac arrest




Resuscitation-Capable Hospital:

- Early notification of receiving hospital
 - Early activation of transport plan
 - Send medical records and EMTALA
- 



Resuscitation-Capable Hospital:



- Optimize BP to MAP > 80 mmHg
- Titrate EtCO₂ for 35-40
- Consider CT imaging
- Induction of hypothermia (cold IVF)
- Sedation and paralysis
- Family & staff support
- Data measurement and feedback



Cardiac Arrest Center:

- Ongoing neurological assessment & care
- Early coronary angiography if not a STEMI
- ICD evaluation
- 24/7 cath lab availability for STEMI
- Rehabilitation Plan



Hospital Response:

Resuscitation

Capable Hospital

- Resuscitate
- Initiate cooling
- Transfer

Cardiac Arrest

Center

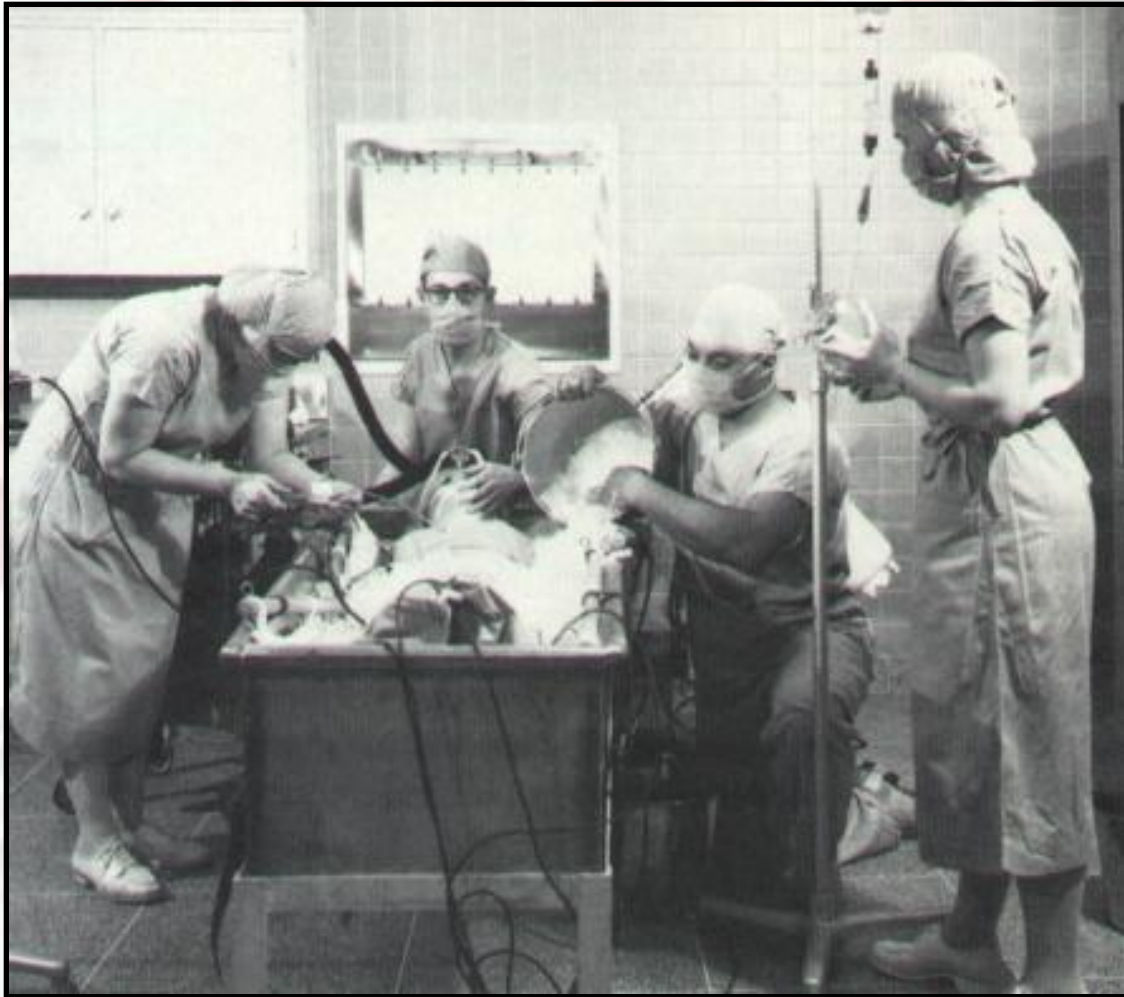
- Hypothermia
- PCI
- ICD assessment & placement



Take Home:

- Aggressively resuscitate
- Establish hypothermia protocols
- Establish transfer protocols
- Cardiac arrest centers

Thanks RACE CARS



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