In-hospital Care of the Post-Cardiac Arrest Patient

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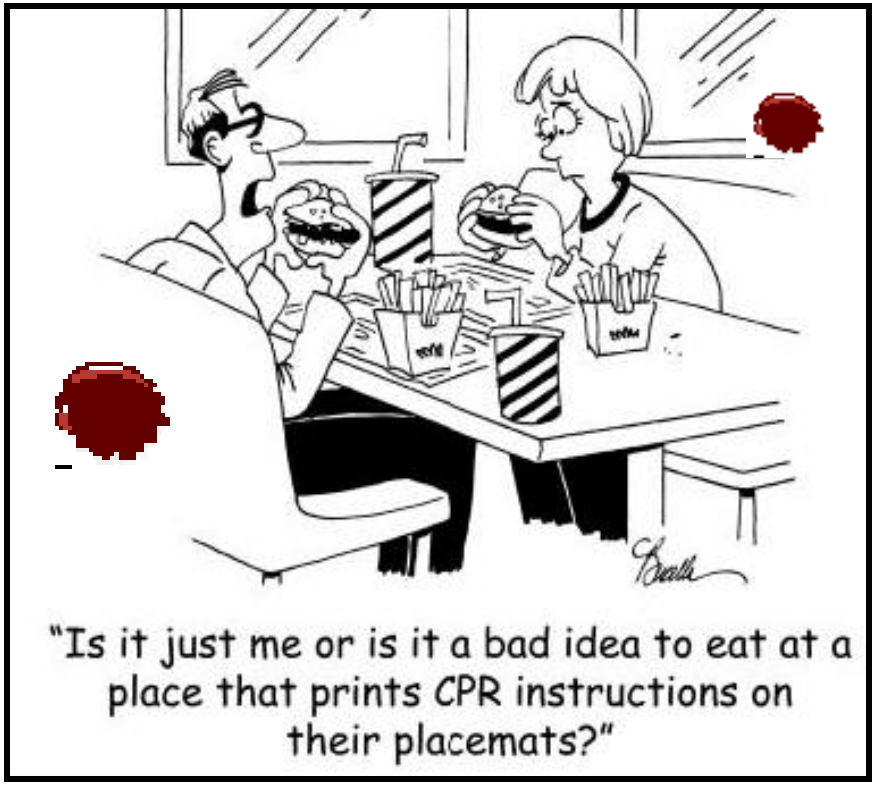
Uncompromising Excellence. Commitment to Care.

Disclosures

I have no financial interest, arrangement, or affiliations and no commercial interests, ties, or grants related to material covered in this lecture.



Objectives

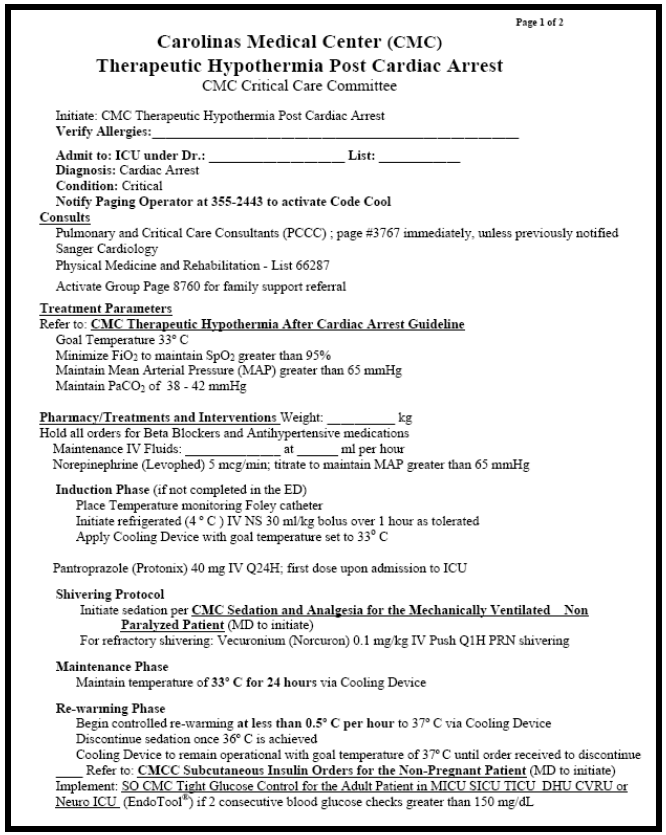
1. Post-cardiac arrest syndrome
2. Therapeutic hypothermia
3. Post-cardiac arrest shock
4. Cardiac catheterization

Post-Cardiac Arrest Syndrome

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

Carolinas Medical Center: Code Cool™

- ❑ Post-arrest resuscitation bundle
- ❑ Fluid resuscitation via cold IVF
- ❑ MAP > 70 mmHg
- ❑ Therapeutic hypothermia
- ❑ Avoid hyperoxia
- ❑ Avoid hyperventilation
- ❑ **Consideration for PCI**



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 FiO_2 to maintain SpO_2 greater than 95%
Maintain Mean Arterial Pressure (MAP) greater than 65 mmHg
Maintain $PaCO_2$ 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

Pantroprazole (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

Brain Injury

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

Zheng Z-J, et al. *Circulation* 2001.
Circulation 2005. IV-206.

Landmark Trials

VOLUME 346 FEBRUARY 21, 2002 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-adjunct, bag-mask

- FEEL PULSE
- IF PRESENT - CONTINUE LUNG INFLATIONS
- IF ABSENT -

Circulate – COMPRESS HEART ONCE A SECOND.

III SUPPORT RECOVERY (physician-specialist)

Gauge EVALUATE AND TREAT CAUSE OF ARREST

Hypothermia START WITHIN 30 MINUTES IF NO SIGN OF CNS RECOVERY

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

SUPPORT CIRCULATION
CONTROL CONVULSIONS
MONITOR

SHOCK EVERY 1-3 MINUTES UNTIL FIBRILLATION REVERSED

- IF ASYSTOLE 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. NOREPINEPHRINE (Levophed) I.V. DRIP

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SUPPORT CIRCULATION
CONTROL CONVULSIONS
MONITOR

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

Inclusion - Therapeutic Hypothermia

- ❑ Adults (age ≥ 18)
- ❑ ROSC after cardiac arrest regardless of initial rhythm
- ❑ Comatose (GCS < 9)
- ❑ Intubated / Mechanically Ventilated
- ❑ Out-of-hospital or In-hospital arrest

When To Stop?

- HACA Trial: Mean downtime 22 minutes
- Get-with-the-guidelines in-hospital arrest registry:
  CPR > 35 minutes, 60% good neurological outcome
- Minneapolis Heart:
  Downtime 30-60 min: 36% good neuro outcome
- Carolinas Medical Center:
  Downtime 30-60 min: 14% good neuro outcome

Absolute Contraindications: TH

- Severe terminal illness
- DNR/DNI

Relative Contraindications - TH

- ❑ Age < 18
- ❑ Pregnancy
- ❑ GCS > 9
- ❑ Persistent temperature < 30° C
- ❑ Trauma arrest
- ❑ Active bleeding
- ❑ Systemic infection/sepsis

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

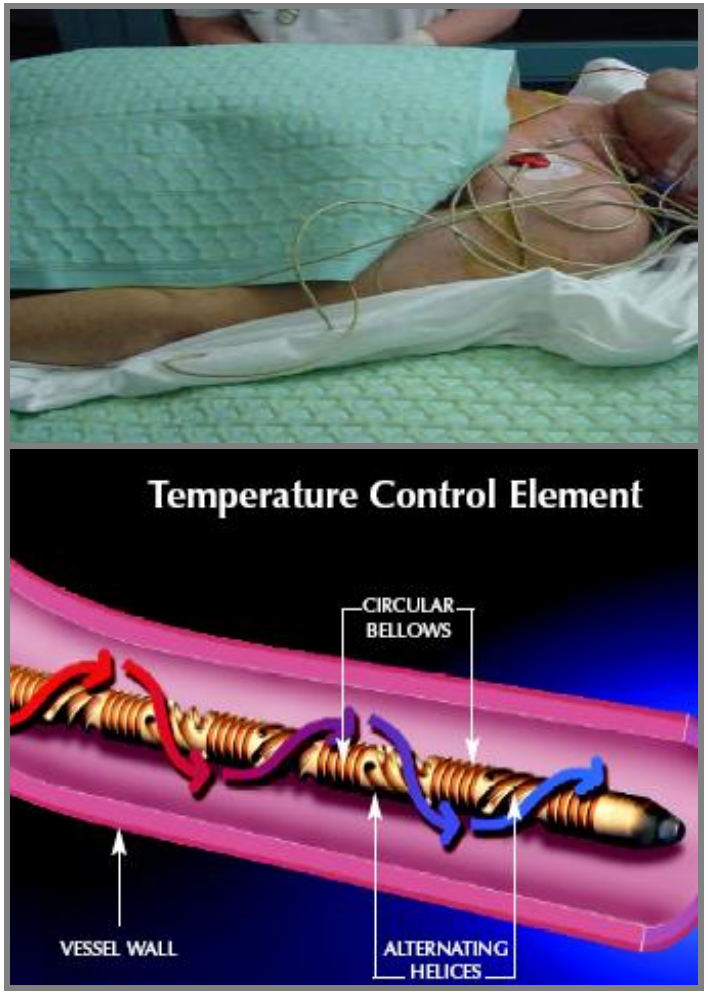
3. Rewarming

- Controlled rewarming

4. Controlled normothermia

Cooling Techniques

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



Physiological Effects of Hypothermia

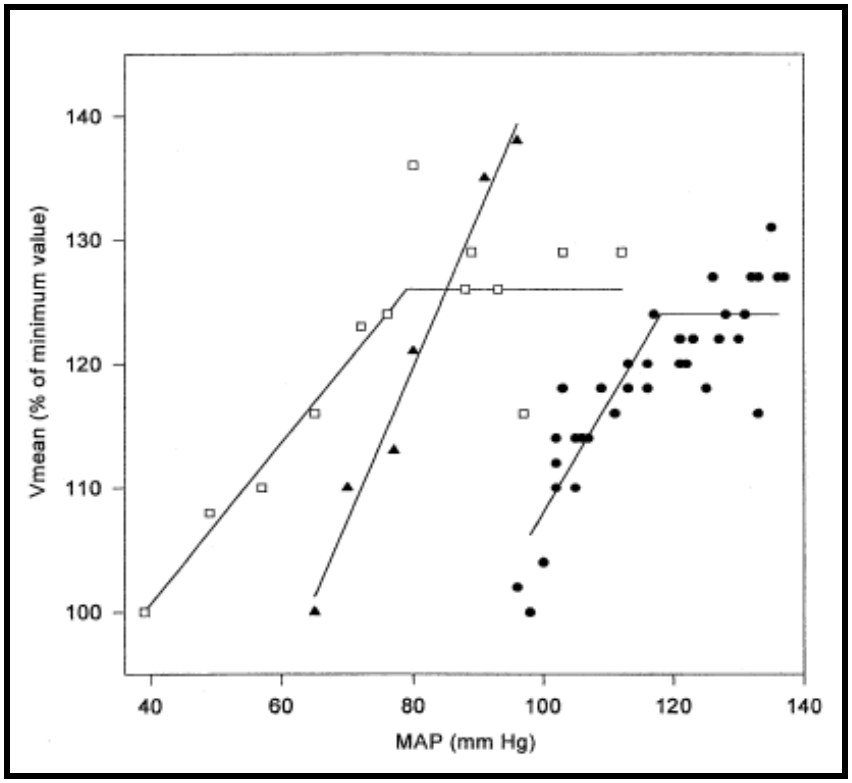
- ❑ Endocrine & metabolic
- ❑ Cardiovascular
- ❑ Hematologic
- ❑ Renal & electrolytes
- ❑ Musculoskeletal

Cool Questions

- ❑ Are cold fluids efficacious?
- ❑ Intra-arrest cooling?
- ❑ Optimal time to initiate cooling?
- ❑ Optimal rate of cooling?

Cerebrovascular Resuscitation

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



Sundgreen C, et al. Stroke 2001.

Hypertension & Neurological Recovery

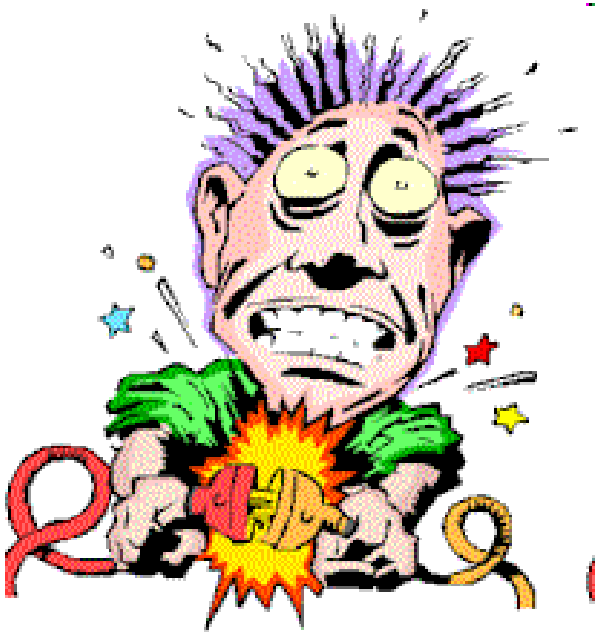
- Retrospective review
- 136 post-cardiac arrest patients
- Epi to keep MAP > 70 by protocol
- Positive association between good neurologic recovery & MAP *within 2 hours* after ROSC

Mullner et al. *Stroke*. 1996.

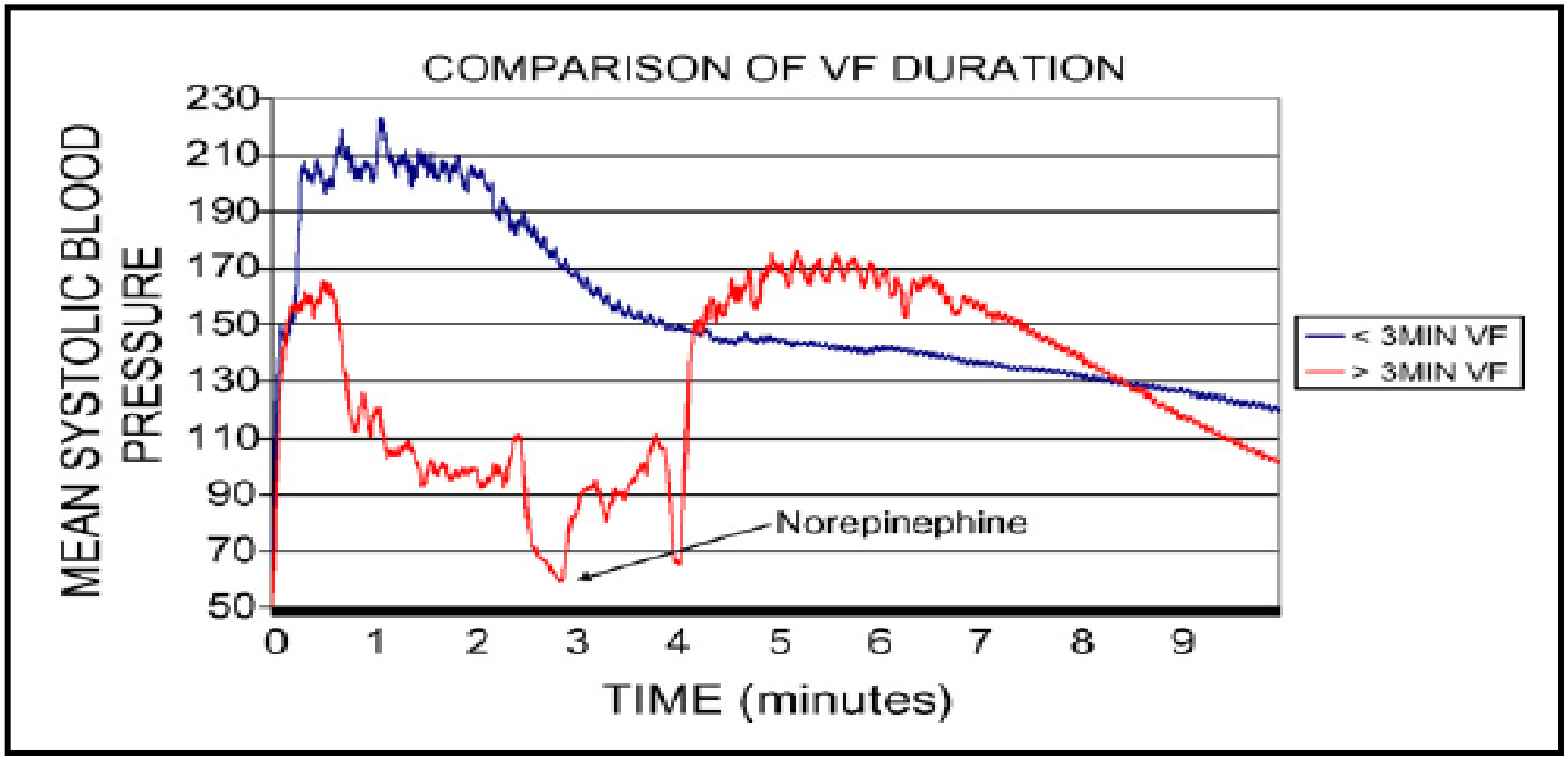
Post-Cardiac Arrest Syndrome

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

Anticipate hypotension & shock



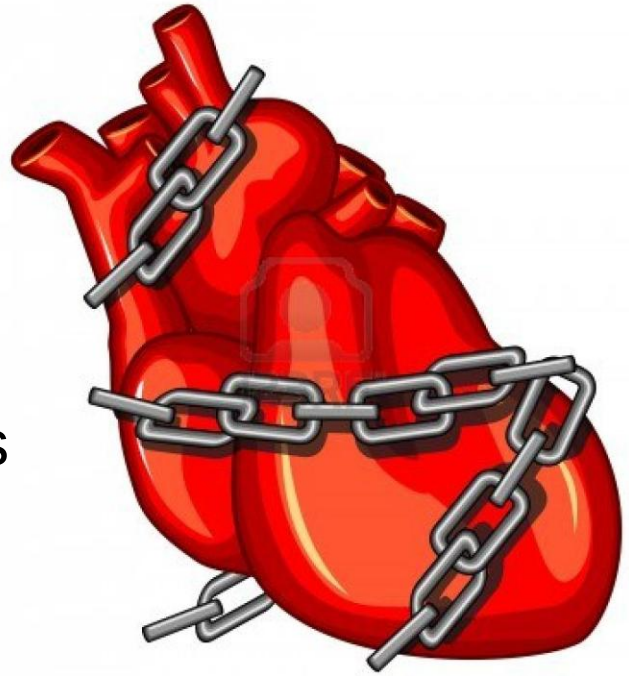
Hemodynamic Instability



Menegazzi JJ, et al. *Resuscitation* 2008.

Post-Arrest Myocardial Dysfunction

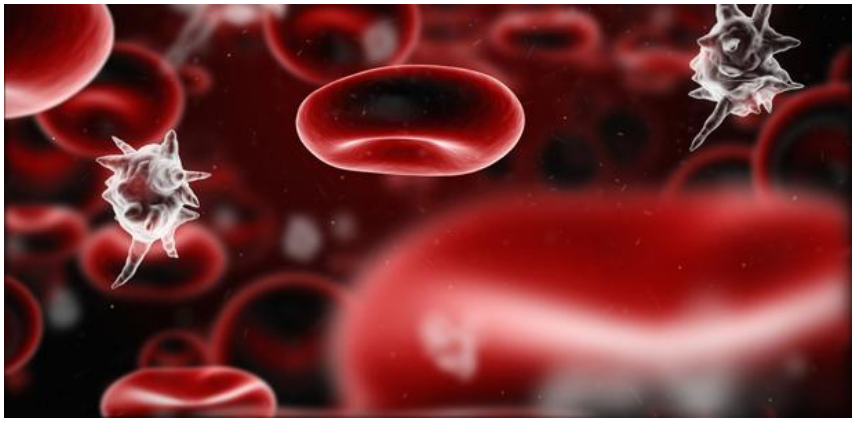
- ❑ 165 patients with OHCA
- ❑ HD instability at 6.8 hours
- ❑ Initial cardiac index low
- ❑ Cardiac index improved at 24 hrs
- ❑ Superimposed vasodilation



Laurent et al. *JACA*. 2002.

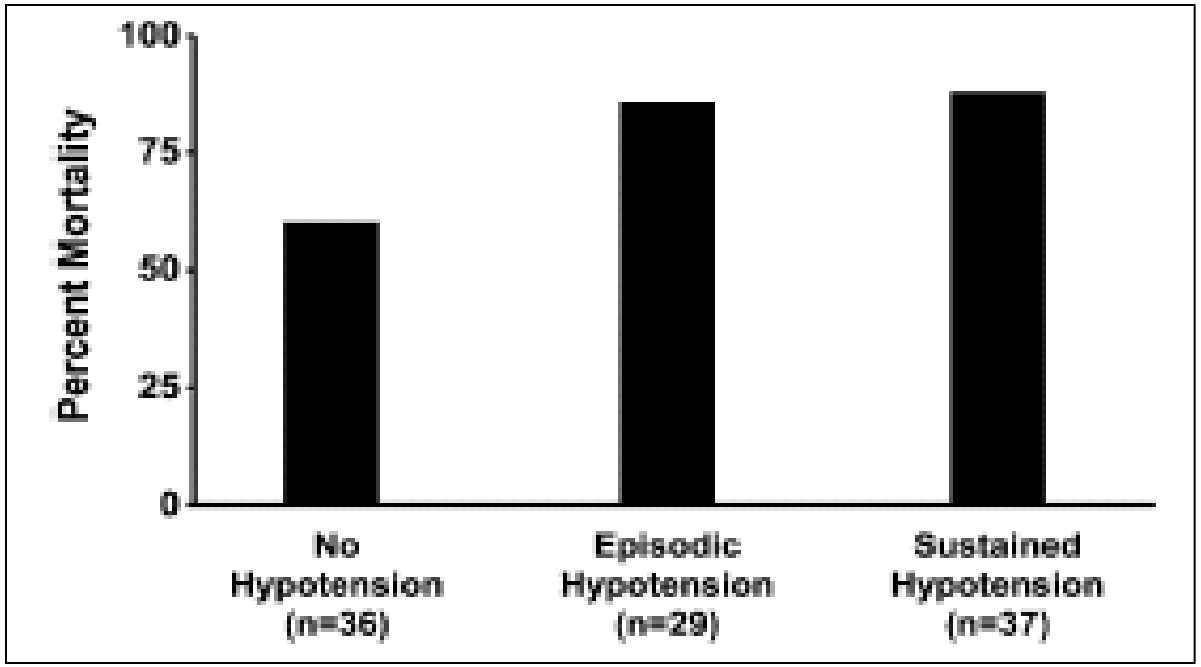
Post-Cardiac Arrest Shock

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



Early Hypotension: Predicts Mortality

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



Kilgannon, et al. Resuscitation 2008.

Dopamine vs Norepinephrine

- ❑ Comparable survival in sepsis, hypovolemia
- ❑ Dopamine increased arrhythmias
- ❑ Norepi improved survival in cardiogenic shock

De Backer, et al. NEJM. 2010.

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

Gaieski, DF, et al. Resuscitation 2009.

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

Gaieski, DF, et al. Resuscitation 2009.

Post-Cardiac Arrest Syndrome

- ❑ Brain injury
- ❑ Myocardial dysfunction
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Pulmonary Embolus

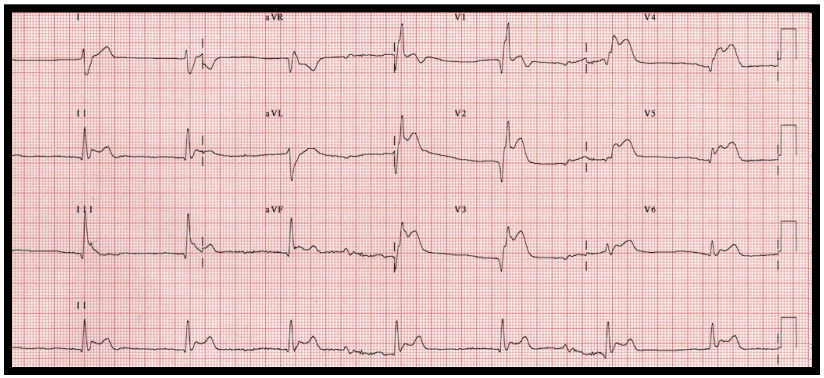
- 1246 cardiac arrests
- 5% etiology – pulmonary embolus
- Initial rhythm:
  - Pulseless electrical activity – 63%
  - Asystole - 32%
  - Ventricular fibrillation - 5%

Cardiac Arrest & Cardiac Catheterization

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

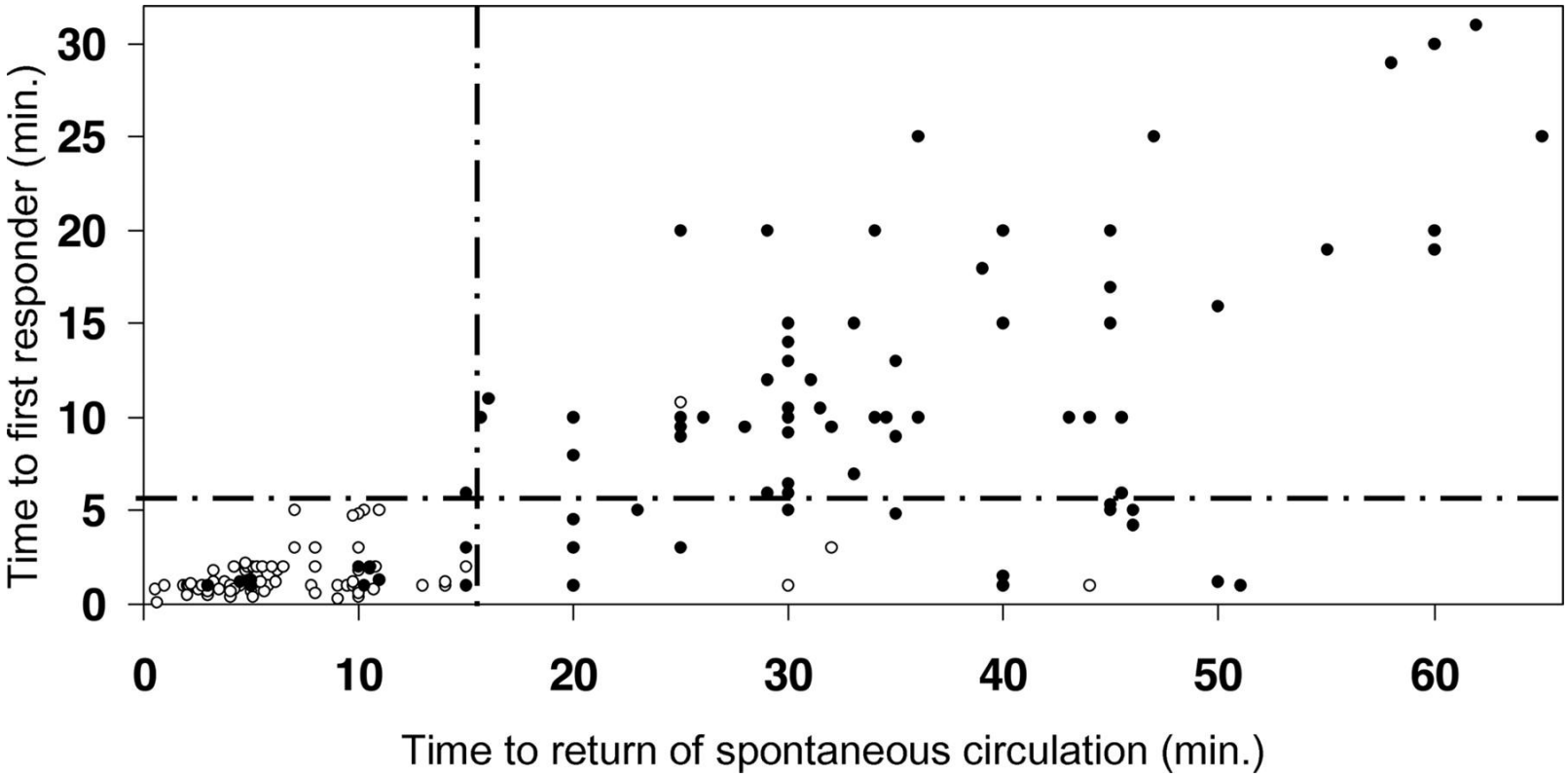
STEMI & Cardiac Arrest

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



Garot P, et al. *Circulation*. 2008.

Cardiac Arrest & STEMI: Who Survives?



Garot et al. Circulation 2007; 115: 1354.

PCI for STEMI & Non-STEMI

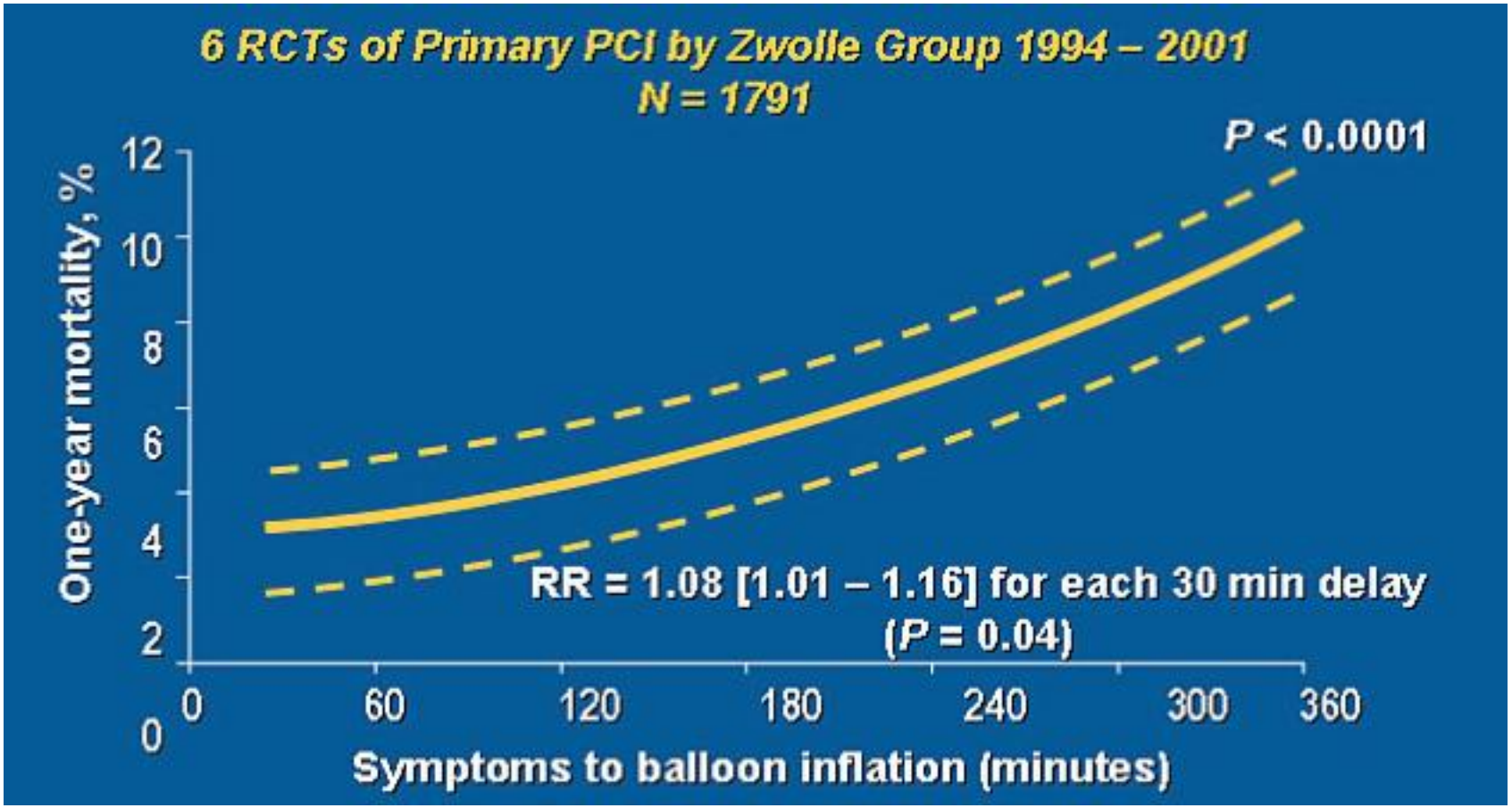
- Retrospective, Paris, 714 OHCA patients (435 cath)
- **STEMI (134 patients): 96% had lesion**
- **Non-STEMI: 58% had lesion**
- Hospital survival: 40%
- Successful PCI independent predictor of survival

Dumas, et al. *Circ Cardiovasc Interv*. 2010.

Code STEMI & Code Cool

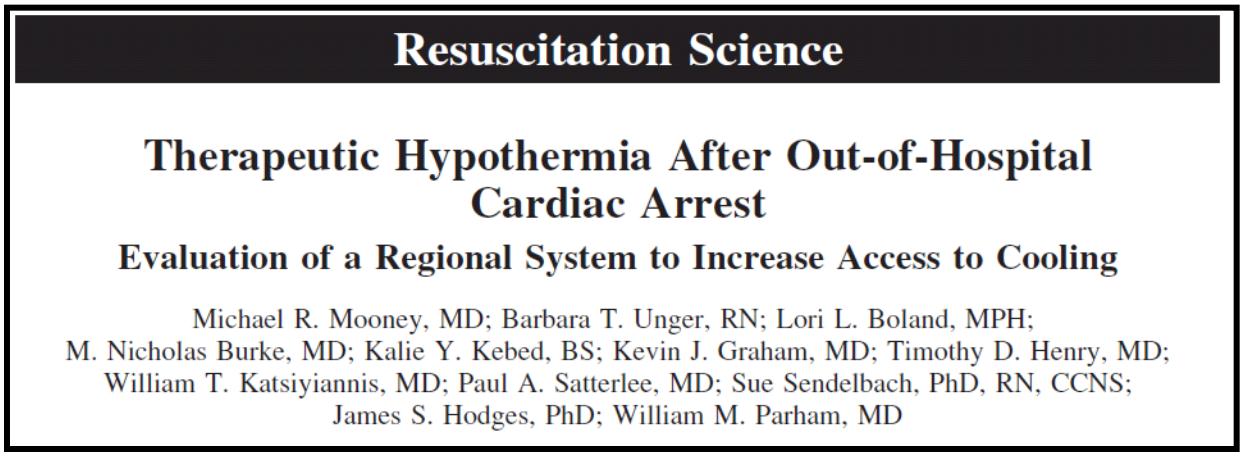
&

Time is Muscle



Deluca et al. Circulation 2004; 109: 1223.

Time is Brain?



Resuscitation Science

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. Katsiyiannis, MD; Paul A. Satterlee, MD; Sue Sendelbach, PhD, RN, CCNS; James S. Hodges, PhD; William M. Parham, MD

- 140 OOH cardiac arrest patients, ROSC < 60 minutes
- Included regardless of initial rhythm, HD instability, STEMI
- 51% survived with good neurological outcome
- **20% increased death** each hour delay in cooling initiation

Practical Concerns: Cooling & PCI

- ❑ Cooling: Ice Packs, Cold Fluids, Devices
- ❑ Delays in cardiac catheterization
- ❑ Bleeding complications

Additional Literature: STEMI & Cooling

- Knafel (2008): n = 40, STEMI & TH; improvement
  - Survival with CPC 1/2 better in TH group (55% versus 16%)
- Wolfrum (2008): n=16; STEMI & TH; improvement
  - Survival with CPC ½ better in TH group (69% vs 47%) (p=0.30)
- Maze (2012): n=50; STEMI &TH, 47 were stented,
  - 60% good neuro outcome

Concurrently cool & cath post-arrest patients

Cardiac Arrest and Code Cool: CHS Guideline

- Proceed with emergent PCI in patients under age 75 years with ≤ 20 minutes from arrest to return of spontaneous circulation

- Discuss others with the interventionalist on call without calling Code STEMI.

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- ❑ Avoid hyperventilation
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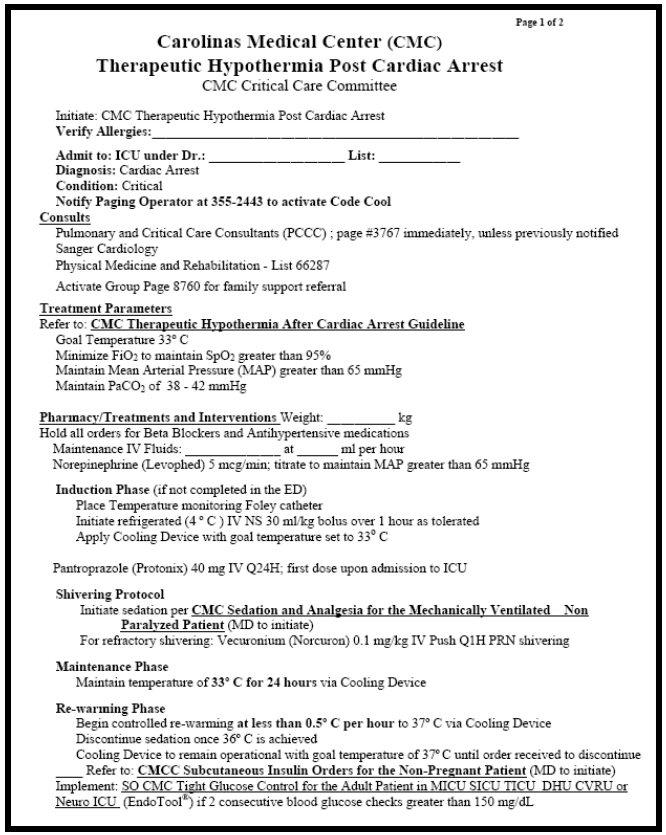

Page 1 of 2

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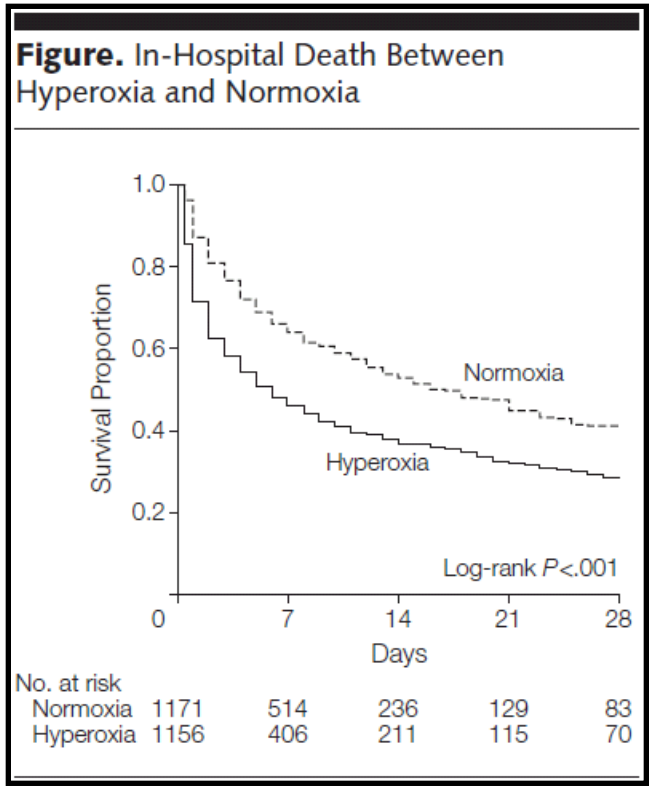
Too much oxygen kills

Avoidance of Hyperoxia

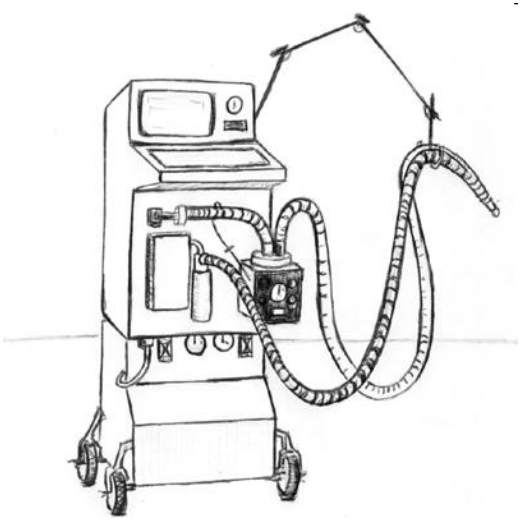
- Kilgannon 2010:
  - PaO2 at ICU admission
  - Hyperoxia (> 300mmHg)
  - Odds ratio for death 1.8
- Janz 2012:
  - PaO2 within first 24 hours
  - Higher PaO2 harmful
  - Odds ratio for death 1.4



Kilgannon JH, et al. *JAMA*, 2010

Oxygen Management

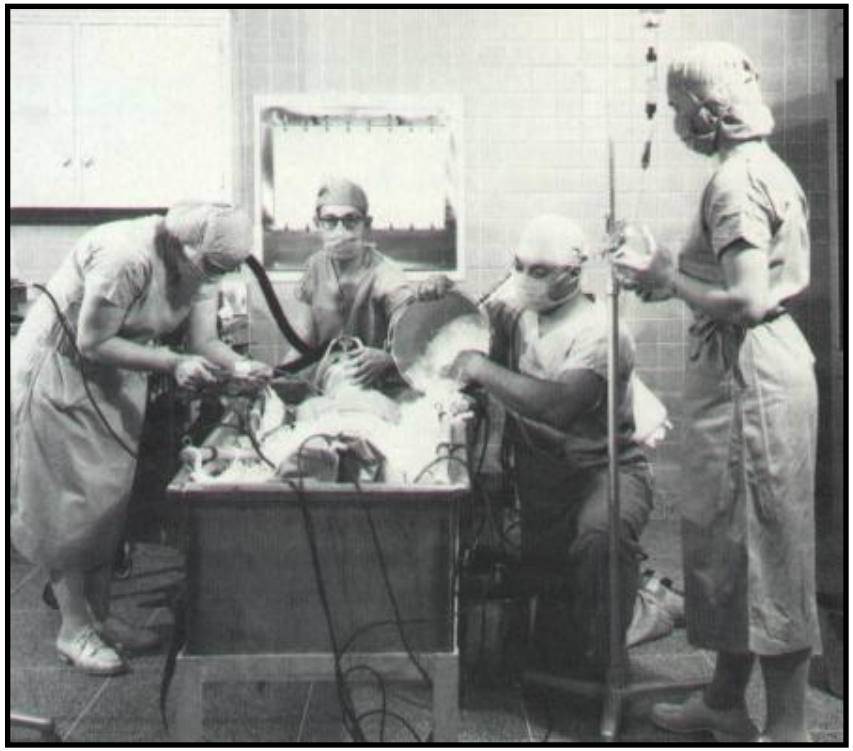
- Avoid hypoxia & hyperoxia
- Aim for normoxia
- Titrate FIO2 rapidly to maintain O_2 sats > 94%



Take Home

1. Do *not* prematurely prognosticate
2. Aggressively resuscitate post-arrest patients
3. Utilize a post-arrest clinical pathway

Questions?



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