In-hospital Care of the Post-Cardiac Arrest Patient

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Disclosures

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

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

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

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

HEART-LUNG RESUSCITATION

I. FIRST AID: OXYGENATE THE BRAIN IMMEDIATELY

- **Airway** - Tilt head back
- **Breathe** - Inflate lungs 3-5 times, maintain head tilt
- **Circulate** - Compress heart once a second

II. SUPPORT RECOVERY

- **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**

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
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?

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
Post-Cardiac Arrest Syndrome

☐ Brain injury

☐ Myocardial dysfunction

☐ Systemic ischemia/reperfusion

☐ Persistent precipitating pathology
Anticipate hypotension & shock
Hemodynamic Instability

![Comparison of VF Duration](image)

- **MEAN SYSTOLIC BLOOD PRESSURE**
- **TIME (minutes)**
- **COMPARISON OF VF DURATION**
- **Blue line**: < 3MIN VF
- **Red line**: > 3MIN VF

Norepinephrine
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
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

![Graph showing mortality rates for different types of hypotension]
Dopamine vs Norepinephrine

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

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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

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Pulmonary Embolus

- 1246 cardiac arrests
- 5% etiology – pulmonary embolus

Initial rhythm:
- Pulseless electrical activity – 63%
- Asystole - 32%
- Ventricular fibrillation - 5%

Kurkiyan, Arc Int Med, 2000
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

Cardiac Arrest & STEMI: Who Survives?

Time to first responder (min.)

Time to return of spontaneous circulation (min.)

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
Code STEMI & Code Cool
Time is Muscle

6 RCTs of Primary PCI by Zwolle Group 1994 – 2001
N = 1791

$P < 0.0001$

$RR = 1.08 [1.01 – 1.16]$ for each 30 min delay
$(P = 0.04)$
Time is Brain?

- 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 1/2 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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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

Janz et al. *Crit Care Med* 2012
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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