“Any man’s death diminishes me, because I am involved in mankind...”

- John Donne
Cardiac Arrest in 2011...
Where are we?
Or where should we be?

Michael W. Dailey, MD FACEP
Associate Professor of Emergency Medicine
Albany Medical College
Disclaimers:

I have no conflicts to disclose.
BOSTON (AP) — A 64-year-old man running in the Boston Marathon had a heart attack and was revived along the side of the course.

Race officials say he is in stable condition at the Beth Israel Deaconess Medical Center in Boston. Authorities would not identify him, but they said he was from out of state.

James Hooley, with the Boston EMS, said the man had a heart attack less than two miles from the end of the race. He staggered to the ground, and bystanders helped resuscitate him with chest compressions until first aid workers arrived with a defibrillator.

A total of 1,324 runners in the field of more than 26,000 received first aid of some sort along the route or at the finish. Thirty-three were taken to hospitals for treatment.

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Introduction

• Historical outcomes of comatose cardiac arrest survivors is terrible

• Cardiac Arrest causes the release of toxic compounds directly linked to brain injury

• Therapeutic Hypothermia (TH) reduces the release of toxic compounds, thus reduces brain injury
“Hey, Lori! Take a look at Mr. Geckler’s EKG!”
Most important point!

• ROSC comes first!
• Good CPR, early defibrillation, controlled ventilations all contribute to increased ROSC
• No breaks in compressions if possible
• Cardiac arrest is won at the scene of the arrest, not in the ambulance or at the hospital—achieve ROSC, then transport*

*When safe to do so
Case 1
Case 1

- 64 male found down at a fire scene
- CPR in progress
- EMS CPR and multiple shocks
Name: 86298281956
ID: 23 Aug 88
HR 72 bpm
QRS 0.132s
ST elevation consider inferior infarct
**Acute MI Suspected**
Abnormal ECG **Unconfirmed**
Normal sinus rhythm with sinus arrhythmia
Right axis deviation
Nonspecific intraventricular block
x1.0 0.85-40Hz 25mm/sec
25mm/sec

CLIFTONPARKEMS 3811371-130 266498013667R LP1213876172
MOTHER GOOSE GRIMM

WAIT A MINUTE... THEY'RE PERFORMING CPR ON YOU.
Incidence – ROC Study

• 10 sites; catchment population was 21.4 million
• 20,520 cardiac arrests, 11,898 (58.0%) had resuscitation attempted;
• 954 (4.6% of total) were discharged alive
• 2,729 (22.9% of treated) had initial rhythm of ventricular fibrillation or ventricular tachycardia
• Survival ranged from 3.0% to 16.3%
• VF Survival ranged from 7.7% to 39.9%, with a median of 22.0%
• Significant differences across sites for incidence and survival (P<.001)

Total Results

• 7.9% of all cardiac arrest patients survived
• 21% of all patients in ventricular fibrillation survived
• Take home message:
  – Have your arrest in Seattle or Colonie
    ...not Alabama!
Termination Rules

• ALS rules with 100% sens and spec
• Event not witnessed by EMS
• No defibrillation in EMS setting
• No ROSC in EMS setting
• Arrest not witnessed
• No bystander CPR

(For cardiac etiology arrest only)


Take Home Message

• Cardiac arrest is won on the scene
• Transporting a non-viable patient is a waste of resources and very dangerous for EMS providers
Post-Cardiac Arrest Syndrome

ROSC 20 min 6-12 hrs 72 hrs Disposition

Cardiac Arrest Care Immediate Early Intermediate Recovery Rehabilitation

Prehospital Care

Hospital Care

Prevent Recurrence

Limit Ongoing Injury / Organ Support

Prognostication

Rehabilitation
Cardiac Arrest Care

- Compressions
  - Bystander/Prearrival
- Compressions
  - EMS
- Defibrillation
- Access
  - Quick large IV or IO
- Meds
- Airway management
  - King or ETT
Progress of an Arrest

- **Prearrival Compressions**
- **EMS Arrival**
  - Confirm CA
  - Access when available
- **200 Compressions**
- **200 Compressions**
- **Airway with NRB and OPA**
- **Eval and rhythm check**
- **200 Compressions**
- **200 Compressions**
- **Advanced airway when convenient**
- **Begin to discuss transport**
Interventions that Changed Outcomes

• Bystander CPR – compression only
  – Increases participation
  – Increases early perfusion
• Initial CPR by providers with blow-by oxygen and delayed intubation
• Compressions following defibrillation prior to pulse check or rhythm analysis
Interventions that Do Not Help

• Early intubation
• Excessive ventilation
• CPR in ambulances and moving patients in arrest
• Bad CPR
TH Background
What are we really talking about here?
Where did this idea come from?

Did we just cook it up?
Post-Cardiac Arrest Syndrome

ROSC
20 min
6-12 hrs
72 hrs
Disposition

Cardiac Arrest Care
Immediate
Early
Intermediate
Recovery
Rehabilitation

Prehospital Care

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Prognostication

Rehabilitation
What does the literature show?
Look back...

- 1878 – Boehm, closed chest massage on cats
- 1892 – Maass, closed chest massage on a human, with meaningful recovery after 10 days of coma
- 1900 – Prevost and Batelli defibrillate
- 1947 – Beck, open-chest defibrillation “hearts too good to die…”
- 1958-1962 – Kouwenhoven, Safar, CPR!
HEART-LUNG RESUSCITATION

FIRST AID: OXYGENATE THE BRAIN IMMEDIATELY

1 or 2 operators

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

IF PRESENT - CONTINUE LUNG INFLATIONS'
IF ABSENT -

Circulate - COMPRESS HEART ONCE A SECOND.
ALTERNATE 2-3 LUNG INFLATIONS WITH
15 STERNAL COMPRESSIONS UNTIL
SPONTANEOUS PULSE RETURNS.
HEART-LUNG RESUSCITATION

First Aid: Oxygenate the brain immediately
1 or 2 operators

Airway - Tilt Head
If Not Breathing
Breathe - Inflate
Maintain
Mouth-to-mouth

Heart - Look
Circulate - Compress

For physicians only

Start Spontaneous Circulation

Drugs - Epinephrine: 1.0 mg (1.0 cc of 1:1000) i.v. or 0.5 mg intracardiac. Repeat larger dose if necessary.
Sodium Bicarbonate: Approximately 3.75 g/50 cc (1/2 dose in children) i.v. Repeat every 5 minutes if necessary.

E.K.G. - Fibrillation: External electric defibrillation. Repeat 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

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
First formal TH study...1959!

What happened then?

• What temperature?
  – Mild? 34-36
  – Moderate? 30-32
  – Profound? 10

• How to induce?

• How to maintain?

• What about complications?
What causes brain injury?

• Duration and severity of ischemia (primary)
• Direct injury during reperfusion (secondary)
  – Oxygen free-radicals
  – Lipid cell membrane damage
  – Decreased effectiveness of Na/K+ cellular pump
  – Lactate production
What causes brain injury?

• Release of toxic compounds caused by the reperfusion of brain cells (tertiary)
  – Increased neurotransmitters
  – Hyper-excited receptors

• Hyperthermia from primary brain response
Why does TH work?

• TH decreases brain metabolism by:
  – Retarding the initial rate of ATP depletion at membrane
  – Reducing neurotransmitter release
  – Altering intracellular messenger activity

• TH may prevent cellular damage by:
  – Limiting breakdown of the blood–brain barrier
  – Reducing inflammatory responses
  – Reducing intracellular calcium
  – Maybe even altering gene expression and protein synthesis
What has been tried?

- Barbiturates
- Calcium channel blockers
- Escalating epinephrine
- Steroids
- Etc...
Statistics from the literature

Australian Study
- 21/43 (49%) have "returned to a normal life."

Normothermic Group Pts

European Study
- 75/136 (55%) have "returned to a normal life."

TH Group Pts
- 9/34 (26%) have "returned to a normal life."

Normothermic Group Pts
- 54/137 (39%) have "returned to a normal life."
• ALS Task Force of International Liaison Committee on Resuscitation

• “Unconscious adult patients with spontaneous circulation after out-of-hospital cardiac arrest should be cooled to 32C-34C for 12 to 24 hours when the initial rhythm was V Fib.”

• “Such Cooling may also be beneficial for other rhythms or in hospital cardiac arrest”
Number needed to treat?

- ASA in MI? 42
- STATINS? 364
- Therapeutic hypothermia? 6!

McAlister FA. The "number needed to treat" turns 20 — and continues to be used and misused. CMAJ 2008;179:549-53

Why did it take so long?

- 1999, ARREST Trial
  - Improved ROSC, but no improved discharge to home with Amiodarone

- Rapid shift to Amiodarone from Lidocaine...

- Amiodarone $1.00/mg, with dose of 300 mg

- 2002, HACA Trial
  - Significantly improved outcomes for discharge after cardiac arrest

- Ice? $00.00/Kg, with a variable dose...
Therapeutic Hypothermia
A Case Report
Case

• 48 year old male asleep next to his wife starts to “breath funny”
• Unable to arouse him – call 911
• Pre-arrival instructions
Case

- CPR and defib by EMS
- BVM
- IV epi and amiodarone
- Intubation following ROSC
- GCS 4 upon arrival
- CT head shows cerebral edema...
Mr. Phillips,

\[ G = 6.67 \times 10^{-11} \text{N} \cdot \text{m}^2/\text{kg}^2 \] \( (mc^2) \left( \frac{\Delta v}{a} \right) (F_d) (mc^2) (\sigma \Delta T^4) (\delta \Delta T^4) \left( \frac{1}{5} \right) (\cos(10)) (\sin(180)) N \]
Regional statistics from 2009

- Albany Medical Center Hospital
  - Program 2009 data
  - 42 EMS ROSC Pts
  - 22 (>50%) have “returned to a normal life”
  - <10 (<24%) historically would have
- Ellis Hospital
  - 4/7 have “returned to a normal life”
So how are we doing it?
EMS Goals

• Prevent recurrence
• Prevent ongoing injury and organ support
• What does this mean?
  – Arrhythmia control
  – Airway management
  – BP control
  – Glucose control
  – Seizure control
Inclusion Criteria

• ROSC Patient has a GCS < 8
• Patient age > Puberty
  – Males = arm pit hair (AHA)
  – Females = breast development (AHA)
• Airway
  – ALS: ALS/BLS airway w/ EtCO2
  – BLS: Patient BLS airway w/ adequate ventilations
Exclusion criteria

• Known or suspected to be pregnant
• Trauma patients
• Suspected sepsis
• Other causes of coma (such as drug intoxication or status epilepticus)
• Recent major surgery within 14 days

* Contact receiving facility for clarification if ?
Transport of the ROSC Pt

- ROSC patients receiving TH must be transported to a TH receiving facility if less than 60 minute transport time:
  - AMC, CMH, Ellis, Glens Falls, St. Peters, Sam, so far...
  - If the ROSC Pt degrades to recurrent cardiac arrest transport to closest hospital
  - If the patient has a STEMI call Medical Consultation to discuss appropriate destination
Documentation of the ROSC Pt

• A complete post ROSC patient assessment
  – GCS must include specific elements
  – Pupil exam
• Interpretation of post ROSC EKG & 12 lead EKG
• TH inclusion criteria
• Cooling methods administered
• Completion of the CARES registry entry
Big question...what about intra-arrest cooling?
What about intra-arrest cooling?

- Minimal data from outcomes studies
- Significant suggestive data:
  - Dogs: Improved resuscitation in hypothermic dogs
  - Swine: Improved resuscitation with hypothermic fluid infusion
- Human examples:
  - Approved for NYC
  - Ongoing in Richmond
  - Cases in NC, Pgh, others
## Post-Cardiac Arrest Syndrome

<table>
<thead>
<tr>
<th>ROSC</th>
<th>20 min</th>
<th>6-12 hrs</th>
<th>72 hrs</th>
<th>Disposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac Arrest Care</td>
<td>Immediate</td>
<td>Early</td>
<td>Intermediate</td>
<td>Recovery</td>
</tr>
</tbody>
</table>

### Prehospital Care
- Prevent Recurrence
- Limit Ongoing Injury / Organ Support

### Hospital Care

### Prognostication

### Rehabilitation
Hospital Care

- Therapeutic hypothermia
  - 32-34 C for 24 hours
- Glycemic control
- Oxygen management
- Ventilatory management
- NO EARLY prognostication!
  - Can not evaluate for ultimate outcomes for at least the first 48 hours
Bottom line

• Cardiac arrest should be a terminal event in many cases...
• When it should not be, we must optimize the probability of meaningful recovery
• Doctors need prompting to bring new therapies to our patients...
• Therapeutic hypothermia is not new
Remember...

- Get ‘em back, then chill ‘em
- No therapeutic hypothermia program is successful without good initial EMS care
- More than 30 people in the area are alive today because EMS saved them, and gave them a chance for therapeutic hypothermia
- The success of the hospital TH programs is a testament to good EMS care
“The physician’s choice between prolonged resuscitative efforts and a dignified and peaceful death in patients with incurable disease is part of the art of resuscitation.”

- P. Safar, 1964
QUESTIONS?
Questions?