Sudden Cardiac Arrest

Suddenly, a Person Becomes a Patient
... Now What?

Update on Treatment Guidelines for SCA

James R. Boogaerts, Ph.D., MD, FACC
CardioVascular Associates of the Southeast
"I came in with Halley's Comet in 1835. It is coming again next year, and I expect to go out with it."

Mark Twain

Mark Twain passed away on April 21, 1910, one day after Halley's return
Hello Halley's Comet.

Hello again, Halley's Comet.
Chorus
Did you perhaps go farther than you have told us?

Prometheus
Yes, I stopped mortals from foreseeing doom.

Chorus
What cure did you discover for that sickness?

Prometheus
I sowed in them blind hopes.

(Re: our perception of the mortal state)
“patient”

from Latin verb: *patior, patire, passio* : to suffer

“one who suffers”
Bystanders who witness the sudden collapse of an adult should activate the emergency medical services (EMS) system and provide high-quality chest compressions by pushing hard and fast in the middle of the victim’s chest, with minimal interruptions. This recommendation is based on evaluation of recent scientific studies and consensus of the American Heart Association Emergency Cardiovascular Care (ECC) Committee. This science advisory is published to amend and clarify the “2005 American Heart Association (AHA) Guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiovascular Care (ECC)” for bystanders the provision of chest compressions alone during bystander resuscitation (LOE 4*). Although these studies were not deemed sufficient to justify the elimination of ventilations from the bystander CPR sequence, the 1997 statement strongly encouraged further research that would focus on “…the timing, rate, and depth [of ventilations] as well as conditions under which respiratory assistance should be used.” The statement also recommended “…more research on real-world obstacles to learning, remembering, and actually performing CPR…” In addition, the statement contained a secondary conclusion that “…provision of chest compression
What is cardiac arrest?
Sudden cardiac arrest occurs suddenly and often without warning. It is triggered by an electrical malfunction in the heart that causes an irregular heartbeat (arrhythmia). With its pumping action disrupted, the heart cannot pump blood to the brain, lungs and other organs. Seconds later, a person loses consciousness and has no pulse. Death occurs within minutes if the victim does not receive treatment.
WHAT IS A HEART ATTACK?

A HEART ATTACK occurs when blood flow to the heart is blocked.

A blocked artery prevents oxygen-rich blood from reaching a section of the heart. If the blocked artery is not reopened quickly, the part of the heart normally nourished by that artery begins to die.

WHAT HAPPENS

Symptoms of a heart attack may be immediate and may include intense discomfort in the chest or other areas of the upper body, shortness of breath, cold sweats, and/or nausea/vomiting. More often, though, symptoms start slowly and persist for hours, days or weeks before a heart attack. Unlike with cardiac arrest, the heart usually does not stop beating during a heart attack. The longer the person goes without treatment, the greater the damage.

The heart attack symptoms in women can be different than men (shortness of breath, nausea/vomiting, and back or jaw pain).

American Heart Association®
Learn and Live
CARDIAC ARREST is a LEADING CAUSE OF DEATH.

Nearly 360,000 out-of-hospital cardiac arrests occur annually in the United States.

**Fast action can save lives.**

**WHAT IS THE LINK?**

Most heart attacks do not lead to cardiac arrest. But when cardiac arrest occurs, heart attack is a common cause. Other conditions may also disrupt the heart’s rhythm and lead to cardiac arrest.

**American Heart Association**

CALL 9-1-1
We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.

T.S. Eliot   --- "Little Gidding"   ... Four Quartets
To arrive at a great destination ...
... you need a roadmap:
Chain of Survival

image retrieved from http://towermedical.co.uk/2012/10/therapeutic-hypothermia/
This talk is about raising consciousness (in this case, literally) regarding a straightforward protocol of great value in treatment of patients who are comatose after ACLS has successfully resulted in ROSC.
Therapeutic Hypothermia is now recommended treatment for selected patients following Sudden Cardiac Arrest.

More consistent, routine utilization is now indicated, so that more patients might benefit.
Special thanks to:

Lance Becker, M.D.
Ben Abella, M.D.

U. Penn. Center for Resuscitation Science
for information and PowerPoint material

Lance B. Becker, MD, is Professor of Emergency Medicine at the University of Pennsylvania. Previously Dr. Becker was a Professor at the University of Chicago's Department of Medicine, Section of Emergency Medicine. He was the founder and Director of the Emergency Resuscitation Center at the University of Chicago in Chicago and Argonne National Laboratory. He has been a past Chair of the Cardiopulmonary, Perioperative, and Critical Care Council of the American Heart Association and is a past Chairman of the Basic Life Support Committee.
Automatic External Defibrillators for Public Access Defibrillation:

Recommendations for Specifying and Reporting Arrhythmia Analysis Algorithm Performance, Incorporating New Waveforms, and Enhancing Safety

A Statement for Health Professionals From the American Heart Association Task Force on Automatic External Defibrillation, Subcommittee on AED Safety and Efficacy

1. Richard E. Kerber, MD, Chair; Lance B. Becker, MD; Joseph D. Bourland, EE, PhD; Richard O. Cummins, MD, MPH; Alfred P. Hallstrom, PhD; Mary B. Michos, RN; Graham Nichol, MD; Joseph P. Ornato, MD; William H. Thies, PhD; Roger D. White, MD; Bram D. Zuckerman, MD,; Members Endorsed by the Board of Trustees of the American College of Cardiology
Cardiac Arrest, Hypothermia, and Resuscitation Science

Benjamin Abella

This course will explore new breakthroughs in the treatment of patients during cardiac arrest and after successful resuscitation, including new approaches to cardiopulmonary resuscitation (CPR) and post-arrest care.

Sessions:
May 20th 2013 (6 weeks long)
Sudden Cardiac Arrest
Abnormal Rhythms

VT

VF

nSR

Abnormal Rhythms
VT

VF
Two bad things about Sudden Death:

1. It’s sudden.

2. It’s death.
... and one good thing:

1. It’s not death after all.
It’s sudden ...
Ventricular Fibrillation →

Electric Shock

Sinus Rhythm
... but it’s not death:

[EKG following ROSC]
What is Death?
For a human, here's the relevant tracing:
The Checklist Manifesto begins on familiar ground, with his experiences as a surgeon.

But before long it becomes clear that he is really interested in a problem that afflicts virtually every aspect of the modern world—and that is how professionals deal with the increasing complexity of their responsibilities.
Gawande begins by making a distinction between errors of ignorance (mistakes we make because we don’t know enough), and errors of ineptitude (mistakes we made because we don’t make proper use of what we know).

Failure in the modern world, he writes, is really about the second of these errors.

... it’s just too easy for an otherwise competent doctor to miss a step, or forget to ask a key question or, in the stress and pressure of the moment, to fail to plan properly for every eventuality.
High-Quality
BLS
Minimize interruptions to 10 seconds or less
normal flow
normal conduction
normal valves
Sudden Cardiac Arrest
Nihilism in cardiac arrest

Culture of hopelessness common in healthcare providers regarding cardiac arrest
Part 1 - Review, When Is a Patient Dead

The question still remains

When is a person really dead?
Sudden Cardiac Arrest
Sudden Cardiac Arrests in U.S. ... every day:

( n = 1,000 )
Sudden Cardiac Arrests in U.S. ... every ten days:

- [image: imagessays.com] -> acasta [million dot project] 
  (n = 10,000)
[ annual U.S. mortality 2,500,000 ( . ) ] [ annual U.S. births 4,100,000 . ]

( n = 1,050 )

[ U.S. population ... 315,000,000 ] Each dot = 300,000 individuals
• Sudden cardiac arrest is a leading cause of death in the US.

• Approximately **330,000** of all adult coronary heart disease deaths in US are due to sudden cardiac arrest.

• About **900** Americans die every day due to sudden cardiac arrest.
Sudden cardiac death (SCD), which is responsible for approximately 300,000 deaths in the United States, refers to an unexpected death from a cardiovascular cause in a person with or without preexisting heart disease.

Ilkhanoff and Goldberger; Circulation 2012; 126: 793-796
Sudden Cardiac Arrests annually in U.S.: (n = 300,000)

Bryant - Denny Stadium - capacity 101,821

Jordan - Hare Stadium - capacity 87,451

Tiger Stadium - capacity 92,542
< 6% of EMS-treated cardiac arrest patients survive to discharge from the hospital.

In Alabama, survival to hospital discharge after out-of-hospital cardiac arrest is < 3%.
3 \% \text{ survival with good neuro status} ( . ) :

( n = 1,000 )
Sudden Cardiac Arrest

Survival to hospital discharge with good neurological outcome is < 3 %

Optimist would conclude that there is great opportunity for improvement here.
The most common sequence of events leading to arrhythmic SCD is the degeneration of ventricular tachycardia (VT) into ventricular fibrillation (VF), often followed by asystole or pulseless electric activity.

Ilkhanoff and Goldberger; Circulation 2012; 126: 793-796
### Characteristics of populations at risk for sudden cardiac arrest

<table>
<thead>
<tr>
<th>Population</th>
<th>% SC deaths</th>
<th>Predictability</th>
</tr>
</thead>
<tbody>
<tr>
<td>No history of cardiac disease</td>
<td>45%</td>
<td>poor</td>
</tr>
<tr>
<td>Low-medium risk post MI</td>
<td>40%</td>
<td>limited</td>
</tr>
<tr>
<td>High risk heart disease (LVEF &lt; 35%)</td>
<td>13%</td>
<td>possible</td>
</tr>
<tr>
<td>Monogenic arrhythmic disease</td>
<td>2%</td>
<td>limited</td>
</tr>
</tbody>
</table>

H.J. Wellens ; Applied Cardiopulmonary Pathophysiology 16: 127-132, 2012
~30% survival with good neuro status (\( n = 1,000 \) )
myth of the

Massive Heart Attack
A New Orleans high school classmate:

5/29/12

Tragic death of TV producer who helped found TMZ and revived Ellen DeGeneres' career after she came out as gay

By DAILY MAIL REPORTER

PUBLISHED: 00:02 EST, 30 May 2012 | UPDATED: 00:07 EST, 30 May 2012

A prolific TV producer who helped found the celebrity-stalking website TMZ and revived Ellen DeGeneres' career after she publicly came out as a lesbian has died tragically.

Jim Paratore, 58, was cycling in France with his family when he suffered a massive heart attack.

He was responsible for numerous famous TV shows, including 'The Ellen DeGeneres Show,' 'The Rosie O'Donnell Show,' 'The Bachelor' and 'The People's Court.'

Mr Paratore teamed up with Harvey Levin to found and produce TMZ.com, which is now one of the biggest names in celebrity and entertainment news.

TMZ reports Mr Paratore was the one who pitched the idea for the website to executives at Time-Warner in 2006. He also produced the website's successful TV show.

However, one of his greatest feats was launching the 'The Ellen DeGeneres Show.'
BIRMINGHAM, Ala. - Dale Benos, Ph.D., noted scientist and chairman of the University of Alabama at Birmingham Department of Physiology and Biophysics, died suddenly of natural causes Oct. 7, 2010. He was 60.

Benos held professorships in Cell Biology and Neurobiology and was a senior scientist with UAB's Gregory Fleming James Cystic Fibrosis Research Center, the Nephrology Research and Training Center, UAB Center for AIDS Research, UAB Comprehensive Cancer Center, Arthritis and Musculoskeletal Center, Center for Computational and Structural Biology, Center for Biophysical Sciences and Engineering and Vision Science Research Center.

He was internationally recognized for his contributions to the field of physiology and biophysics and he received many accolades, at UAB and beyond. In 2006 he received the UAB President's Award for Excellence in Teaching. In 2008, he was named UAB's first holder of the University of Alabama Health Services Foundation Endowed Chair in Biomedical Research.
UAB cardiologist Vijay Misra dead at age 51

Vijay Misra, M.D., noted cardiologist and director of the University of Alabama at Birmingham Heart and Vascular Center Cardiac Catheterization Laboratory, died suddenly June 4, 2011. He was 51.

..........

Misra distinguished himself in clinical interventional cardiovascular research. In addition to active collaborations in numerous multi-center projects, Misra was a leader in single-center clinical studies. He made significant contributions to the development of several novel procedures and devices in interventional cardiovascular/endovascular therapy, including the first to use the Tandem Heart LV support device to perform high-risk aortic valvuloplasty for aortic stenosis on a human and development of the cone crush bifurcation stenting technique.
Dean Parks, a bartender who taught hundreds of children to fish, dies at 50

By Andrew Meacham, Times Staff Writer In Print:

Saturday, January 19, 2013

CRYSTAL BEACH — We live on the edge of a bountiful Gulf of Mexico, which on calmer days approximates to paradise, the donor said. Many young people have never held a fishing pole. What if the Centre of Palm Harbor could sponsor a summer fishing camp, pairing local kids with professional fishing guides?

In recent years, Mr. Parks worked as a fishing guide and was a stay-at-home dad to his two children with Amanda Baty: Marlee, 6; and Fisher, 4.

Mr. Parks suffered a massive heart attack Jan. 10 and died at Helen Ellis Memorial Hospital. He was 50.

Mr. Parks ran the fishing camps like mass baptisms, and won over hundreds of young converts.

A Dunedin native, Mr. Parks lived in Crystal Beach. An already wide circle of friends expanded with bartending jobs at the El Jalapeno bar and Neptune’s Lounge in Tarpon Springs.

“He was the best bartender in the world,” said Eddie Mullally, who owns Neptune’s Lounge and a bicycle shop next door. “If he knew you and you drank Miller Lite, the minute you walked in you’d have a Miller Lite up there for you.”
JAMES GANDOLFINI DIES IN ITALY

6/19/2013 6:00 PM PDT BY TMZ STAFF

BREAKING NEWS

James Gandolfini -- who famously played Tony Soprano on "The Sopranos" -- died earlier today in Italy ... TMZ has learned.

Gandolfini is believed to have suffered a heart attack. He was 51.

Gandolfini was in Italy to attend the 59th Taormina Film Festival in Sicily -- and he was scheduled to participate in a festival event this weekend with Italian director Gabriele Muccino.

Gandolfini shot to fame playing a hitman in the 1993 hit "True Romance" ... and quickly became a Hollywood legend when he was cast as Tony Soprano in 1999. He won 3 Emmy awards for the role during the show's 6 season run.
Sample coronary angiograms of survivors of Sudden Cardiac Arrest:

- Normal coronaries
- Treatable lesions

vascular substrates for potential “massive heart attack”
Save-J: Preliminary Results

• Control group patients:
  – Continued conventional CPR
  – TH if they have ROSC
  – Hemodynamic Optimization Strategy

• Start date: 10/08

• Neurologically-intact survival:
  – 12.3% in ECPB group
  – 1.8% in “conventional CPR” group
Therapeutic Hypothermia after Sudden Cardiac Arrest: 90° Turn Toward Recovery
Cardiac arrest:
Modern era of hypothermia use

The New England Journal of Medicine

INDUCED HYPOTHERMIA AFTER OUT-OF-HOSPITAL CARDIAC ARREST

TREATMENT OF COMATOSE SURVIVORS OF OUT-OF-HOSPITAL CARDIAC ARREST

Mild hypothermia induced by a helmet device: a clinical feasibility study

Said Hachimi-Idrissi *, Luc Corne, Guy Ebinger, Yvette Michotte, Luc Huyghens

Department of Critical Care Medicine and Cerebral Resuscitation Research Group, AZ-VUB, Free University of Brussels, Laarbeeklaan, 101, B-1090, Brussels, Belgium
My Favorite Save ...
My Favorite Save

( *click on next slide to see 6 min. video* )

Penn Medicine Center for Resuscitation Science:
Video: http://youtu.be/ujfvGyKimhE
human myocardium
myocardial cell: 50% engine (contractile elements), 33% powerhouse (mitochondria) ... by volume
isolated myocardial cells
myocardial cells in tissue culture
\( n = 100,000,000,000 \) neurons in brain ... 6 acres membrane area
In the care provided for SCA patients who remain comatose following ROSC, it is important to suspend clinical judgment, to delay decision making, to avoid neuroprognostication on these patients for 72 hours (3 days!) after the event:

[SCA -> CPR -> ACLS -> ROSC -> TH -> rewarm -> DAWN of DAY 4 -> then it's time to make clinical decisions.]

So different from old-school thinking.

Welcome to the future that has now arrived.

The brief video clip below is from Lecture of Week 6, Part 2 of this course:

Cardiac Arrest, Hypothermia, and Resuscitation Science

Here is a link to a 3 minute video clip by Dr. Ben Abella, U.Penn Center for Resuscitation Science (<click) - a powerhouse for research into best approach to handling this critically ill group of patients:

How Do We Know Whether a Patient Will Recover?
Clinical examination is not very helpful to determine brain recovery

American Academy of Neurology

Scientific advisory statement from 2006:

Within three days of cardiac arrest, very hard to tell who will wake up and who will remain in coma

AND:

“Current indicators of poor prognosis in comatose survivors are derived from patients not treated with induced moderate hypothermia. If this treatment becomes standard care, these indicators may need revision.”
Cellular injury

cell necrosis

apoptosis (cell death)

membrane dysfunction

dysfunction of ATP dependent ion pumps
Post-Cardiac Arrest Syndrome

- Brain injury
- Myocardial dysfunction
- Systemic ischemia and reperfusion response
Free radical generation
release of oxygen free radicals by ischemia, amplified by reperfusion, produce oxidation, irreversible injury to cell membranes, mitochondria, endothelium

Blood brain barrier
ischemia/reperfusion increases permeability

Vasoactive mediators –
ischemia → thromboxane A2, local vasoconstriction, hypoperfusion, microthrombi
All of these processes are temperature dependent

A period of mild hypothermia - reduced core body temperature to 90°F (32°C) can blunt, reverse or prevent these destructive processes
- Tachycardia $\leq 97^\circ F$
- Bradycardia when temp $< 95^\circ F$
- More susceptible to atrial fibrillation
- Prolonged PR, QT intervals when temp $\leq 92^\circ F$

- $\leq 90^\circ F$ (32°C) mild arrhythmias
- Ventricular arrhythmias at lower temps ($< 82 - 86^\circ F$)
Mechanisms of action of therapeutic hypothermia:

Reduces extracellular levels of excitatory neurotransmitters
Decreases brain glycine levels after ischemia
Increases levels of BDNF and other neurotrophins after ischemic injury
Avoids the proliferation, migration, transformation, and activation of astroglial cells
Decreases p53 protein levels in the brain and apoptotic neuronal death
Affects the levels of proteins Bcl-2 and cytochrome C
Blocks the TNF pathway of apoptosis
Affects stress-activated signaling pathways avoiding cell apoptosis
Prevents apoptosis by inhibiting the caspase pathway
Blocks the proteins responsible for mediating the caspase-independent apoptosis
Induces the formation cold shock proteins
Lowers lactate levels from anaerobic metabolism decreasing cellular acidosis
Improves brain glucose metabolism and preserves glucose reserves in the brain
Reduces free radical levels after neuronal damage
Blocks delta-PKC and preserves function of Epsilon-PKC after ischemia
Reinforces Akt pathway and carries out structural alterations in PTEN
Decreases production of inflammatory cytokines and leukotrienes
Decreases inflammatory cells function such as macrophages
Suppresses epileptogenic electrical activity
Reduces disruption of the blood–brain barrier
Decreases damage of the endothelial vasculature
Decreases the concentrations of thromboxane A2

Mechanisms of action of Therapeutic Hypothermia:

**TH** provides beneficial effects at many levels.
Hypothermia mechanisms

- ischemia
- reperfusion

- reactive oxygen species (ROS)
- inflammatory cascades
- mitochondrial dysfunction

- vascular dysfunction/hypotension
- apoptosis – organ dysfunction
- cerebral edema

<<< hypothermia
Comatose out-of-hospital VF: 
Class I recommendation

In-hospital arrest, other rhythms:
Class IIb recommendation
Adult Cardiac Arrest
Shout for Help/Activate Emergency Response

Start CPR
- Give oxygen
- Attach monitor/defibrillator

2 minutes

Check Rhythm
If VF/VT Shock

Drug Therapy
IV/IO access
Epinephrine every 3-5 minutes
Amiodarone for refractory VF/VT

Consider Advanced Airway
Quantitative waveform capnography

Treat Reversible Causes

Return of Spontaneous Circulation (ROSC)

Post-Cardiac Arrest Care

Continuous CPR
Monitor CPR Quality

© 2010 American Heart Association

2010 ACLS Guidelines
Post–cardiac arrest care algorithm

2010 ACLS Guidelines

Adult Immediate Post–Cardiac Arrest Care

1. Return of Spontaneous Circulation (ROSC)

2. Optimize ventilation and oxygenation
   - Maintain oxygen saturation ≥94%
   - Consider advanced airway and waveform capnography
   - Do not hyperventilate

3. Treat hypotension (SBP <90 mm Hg)
   - IV/IO bolus
   - Vasopressor infusion
   - Consider treatable causes
   - 12-Lead ECG

4. Follow commands?
   - No
   - Yes

5. Consider induced hypothermia
   - No
   - Yes

6. STEMI or high suspicion of AMI
   - No
   - Yes

7. Coronary reperfusion
   - No
   - Yes

8. Advanced critical care

Doses/Details

Ventilation/Oxygenation
Avoid excessive ventilation. Start at 10-12 breaths/min and titrate to target PTCO₂ of 35-40 mm Hg. When feasible, titrate FiO₂ to minimum necessary to achieve Spo₂ ≥94%.

IV Bolus
1-2 L normal saline or lactated Ringer's. If inducing hypothermia, may use 4°C fluid.

Epinephrine IV Infusion:
0.1-0.5 mcg/kg per minute (in 70-kg adult: 7-35 mcg per minute)

Dopamine IV Infusion:
5-10 mcg/kg per minute

Norepinephrine IV Infusion:
0.1-0.5 mcg/kg per minute (in 70-kg adult: 7-35 mcg per minute)

Reversible Causes
- Hypovolemia
- Hypoxia
- Hydrogen ion (acidosis)
- Hypo-/hyperkalemia
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis, pulmonary
- Thrombosis, coronary

Peberdy M A et al. Circulation 2010; 122:S768-S786

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### Therapeutic Hypothermia Post Cardiac Arrest Orders

**Therapeutic Hypothermia Post Cardiac Arrest**

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check eligibility for Therapeutic Hypothermia (ALL boxes must be checked)</td>
<td></td>
</tr>
<tr>
<td>Cardiac arrest (any initial rhythm, any patient location)</td>
<td></td>
</tr>
<tr>
<td>Coma/ - not alert, does not follow commands</td>
<td></td>
</tr>
<tr>
<td>Age 18 or older</td>
<td></td>
</tr>
<tr>
<td>Intubated, mechanically ventilated patient</td>
<td></td>
</tr>
<tr>
<td>Check for complications due to cooling</td>
<td></td>
</tr>
<tr>
<td>Refractory shock – SBP less than 90 mmHg despite fluids and pressors – reconsider initiation once SBP greater than 90</td>
<td></td>
</tr>
<tr>
<td>Other, more likely causes for coma such as: overdose, intoxication, stroke, hypoglycemia, infection, seizure, head trauma, or asynchrony in neurologic clinical exam</td>
<td></td>
</tr>
<tr>
<td>Coma or severe neurologic dysfunction prior to arrest</td>
<td></td>
</tr>
<tr>
<td>Traumatic full arrest</td>
<td></td>
</tr>
<tr>
<td>Intracerebral hemorrhage</td>
<td></td>
</tr>
<tr>
<td>Patient requiring mechanical ventilation</td>
<td></td>
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<tr>
<td>Coagulopathy or uncontrollable bleeding: Disseminated intravascular coagulation, severe thrombocytopenia, liver failure, vasculitis, clostridial disease (e.g., Gas Bacter)</td>
<td></td>
</tr>
</tbody>
</table>

**Baseline Rapid Neurologic Assessment** (to be documented before giving sedatives/paralytics)

1. **Glasgow Coma Scale**
2. Purposeful movements: Yes No (must be NO to initiate hypothermia)
3. **Ocular Response Intact** (by head positioning unless collared): Yes No
4. **Gag Reflex**
5. **Muscle Tone**
6. **Myoclonus**
7. **Plantar Reflex**
8. Cough: Yes No
9. CONV: Yes No
10. Pupil S大小: Left Right
11. Symmetric: Yes No
12. Pupil Reactivity: Blink Sluggish Fixed

**Physician's Orders**

Therapeutic Hypothermia Post Cardiac Arrest

**Physician's Initials**
THERAPEUTIC HYPOTHERMIA POST CARDIAC ARREST ORDERS

LAB/TESTS:
1. Baseline Labs: Basic Metabolic Profile, CBC with platelet count, PT/INR/PTT, CPK, Troponin, Myoglobin, Magnesium, BNP, Ionized Calcium, Phosphorous, LFT's, Lipase, Lactate, Cortisol level, Sputum, blood and urine cultures, toxicology screen if appropriate.
2. ABG's now and every 6 hours and PRN until patient rewarmed.
3. Blood HCG for women less than or equal to 50 unless history of hysterecomy.
4. 12 Lead ECG, repeat every 6 hours x 4.
5. CT scan of the head without contrast to rule out intracerebral or subarachnoid hemorrhage.
6. CXR AP portable, repeat CXR in AM and after 72 hours to rule out aspiration pneumonia.
7. Repeat myoglobin in 2 hours.
8. Repeat K+ in 2 hours using POC device.
9. Repeat Troponin every 6 hours x 3.
10. Serial Labs: CBC, PT/INR, PTT, Basic Metabolic Profile, Magnesium, Ionized Calcium and Phosphorous every 6 hours for 48 hours.
11. Fasting Lipid Profile within 24 hours of admission.
12. EEG during initiation of hypothermia, next day and after rewarming if patient does not follow commands.
13. Echocardiogram with color flow doppler within 24 hours post ROSC.
14. Repeat Lactate 24 hours after initial level.
15. Check all stools for occult blood.

Ventilator Management: GOAL PaO2: 100 mmHg, PCO2: 35-45 mmHg.

Initial Ventilator settings:
- Mode:
- RR:
- FIO2:
- PEEP:

BP Management: Goal MAP greater than 80 mmHg and less than 120 mmHg.
1. Norepinephrine (Levophed): 8 mg/250 ml DSW at 2.5-20 mcg/min to maintain above parameters.
2. Dobutamine (Dobutrex): 500 mcg/500 ml DSW at 2.5-20 mcg/kg/min to maintain above parameters.
3. Dopamine (Intropin): 600 mg/DSW 250 ml at 2.5-20 mcg/kg/min to maintain above parameters.
4. Additional pressor support: Physician's Order.

PHYSICIAN ORDERS
Therapeutic Hypothermia Post Cardiac Arrest
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Physician's Initials

PHYSICIAN ORDERS
Therapeutic Hypothermia Post Cardiac Arrest
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Physician's Initials
THERAPEUTIC HYPOTHERMIA POST CARDIAC ARREST ORDERS

Other Meds
1. Acetaminophen 650 mg PO or rectally every 6 hours x 48 hours
2. Protegrin 40 mg IV every day.
3. ASA 325 mg per NG tube or 300 mg suppository per rectum 1 dose unless contraindicated (allergy or active bleeding)

Hypothermia Induction (Goal is 32°C-34°C within 1-2 hours of resuscitation)
1. Ice packs on groin, axilla and neck areas, change frequently, cushion with towels. Remove once patient reaches 33°C. Decrease room thermostat to 55°F
2. Iced 0.9% NS Administration (choose one) Available in CCU Medication refrigerator
   - Infuse 1500 ml cooled NS (4°C) IV over 30 minutes using pressure infuser
   - If temperature remains greater than 34.5°C after initial NS bolus, may repeat 500 ml cooled NS over 10 minutes. May repeat cooled NS infusions, 500 mL, over 30 minutes until temperature less than or equal to 34.5°C.
   - Do not infuse more than 30 mL/kg total volume ___ Maximum total volume

Cardiac Shock/Left Ventricular Failure/Low Ejection Fraction
   - Infuse 1500 ml cooled NS (4°C) IV over 30 minutes using pressure infuser
   - If temperature remains greater than 34.5°C after initial NS bolus, may repeat 500 ml cooled NS over 30 minutes. May repeat cooled NS infusions, 500 mL, over 30 minutes until temperature less than or equal to 34.5°C.
   - Do not infuse more than 30 mL/kg total volume ___ Maximum total volume

Chilled Gastric Lavage (preferred method in ESRD and fluid overload, advanced CHF)
   - Suction stomach contents via gastric tube
   - Rapidly instill 250-500 ml bolus of 4°C 0.9% NS or iced-tap water via gastric tube
   - After 5 minutes (for 250 ml) or 10 minutes (for 500 ml) suction fluid from stomach.
   - Repeat above for target volume (30 mL/kg to 3 liters maximum): ___ liters
   - Document lavage input/output volumes

3. Connect Quadro Catheter to Thermocap, set at 33°C and initiate cooling
4. If unable to use Quadro Catheter - Apply Cool Kit cooling blanket and attach to Blanketrol III. Assess skin carefully and document hypothermia with skin integrity while applying cooling blanket. Set Blanketrol III to Automatic Mode at 33°C

PHYSICIAN ORDERS
Therapeutic Hypothermia Post Cardiac Arrest
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[Physician's Initials]

DVT Prophylaxis
1. Place compression foot pumps on patient
2. [Blank] Heparin 5000 units subcutaneously every 8 hours OR
3. [Blank] Enoxaparin 40 mg subcutaneously every 24 hours

Electrolyte Management
1. D/C other pre-existing electrolyte replacement orders
2. D/C Potassium Protocol. DO NOT replace potassium unless serum potassium is less than 3.2 mmol/L during cooling phase
3. If Potassium less than or equal to 3.2 give KCL 40 mmol in 100 mL SW IV over 4 hours
4. If Magnesium less than or equal to 1.8, give Magnesium Sulfate 2 grams in 50 mL SW IV over 2 hours
5. If Ionized Calcium less than or equal to 1.1, give Calcium gluconate 1 gram IV slow push (10 min)
6. If Phosphorus 2.5-3.0, give Na Phos 10 mmol in 250 mL NS IV over 4 hours
7. If Phosphorus less than or equal to 2.4 give Na Phos 15 mmol in 250 mL NS IV over 4 hours

Glucose Control
1. Discontinue previous insulin orders
2. Goal is to maintain blood glucose less than or equal to 200
3. Do not obtain blood glucose sample by finger stick, obtain venous or arterial blood sample
4. If blood glucose is greater than 200, initiate Continuous Insulin Infusion Intensive Care Unit Order Set

Volume Management: Discontinue after rewarming achieved
1. [Blank] Replace urine output every hour with
   - 0.9% NS
   - 0.45% NS
   - Lactated Ringers
   - 0.5 mL/1 mL IV fluid replacement to urine output
   - 1 mL/1 mL IV fluid replacement to urine output
2. Additional IV fluids:

PHYSICIAN ORDERS
Therapeutic Hypothermia Post Cardiac Arrest
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Physician's Initials

[Patient Label]
**THERAPEUTIC HYPOTHERMIA POST CARDIAC ARREST ORDERS**

**Hypothermia Maintenance** – Once temperature of 33°C is achieved

1. Maintain patient temperature at 33°C for 24 hours
2. Monitor and document temp every 4 hours while hypothermic.
3. Monitor vital signs every 1 hour and PRN

**Rewarming Phase** – Begin rewarming after 24 hours at 32-34°C

1. Check K+ results prior to re-warming, if greater than 4 hours since drawn, collect K+ STAT.
2. Do not give K+ replacement from 1 hour before rewarming begins until patient temp reaches 36.5
3. Notify MD for K+ less than 3.0 or greater than 5.2 pg/kg to re-warming.
4. Discontinue Magnesium, Phosphorous and I onized Calcium replacement orders prior to rewarming.
5. Perform POC blood glucose every 2 hours while re-warming if receiving insulin therapy
6. Program **Thermoguard** to re-warm patient at 0.25° C per hour (Goal is 37°C in 16 hours)
7. If using **Kool Kit** - Program **Blanketrol III** to start SLOWLY rewarming the patient at a rate no faster than 0.25-0.5° C per hour (Goal is 37°C in 6 hours)
8. Assess VS, ECG and presence of shivering every 30 minutes during rewarming
9. Document temperature every 30 minutes during re-warming phase.

**Once Temp reaches 36.1°C**

1. Continue sedation and neuro muscular blockade (if being used) until temp reaches 36.1°C. **Once temperature reaches 36.1°C, discontinue neuromuscular blockade.**
2. Continue with sedation only as needed to maintain a RASS score of 0 to -2 utilizing the ICU Sedation/ Analgesia Orders.
3. Continue to monitor temperature continuously for 72 hrs post rewarming if patient remains in ICU
4. Use cooling blanket if temp > 38.0° C
5. Discontinue every 6 hour labs. BMP every 12 hours x 48 hours. CBC every day x 2 days
6. Place Potassium protocol orders on chart and follow for potassium replacement.
7. Discontinue Quattro Catheter 96 hours post insertion

**Physician Orders**

Therapeutic Hypothermia Post Cardiac Arrest

Physician Signature: ____________________________ Date: ____________ Time: ____________

**Physician Label**

Therapeutic Hypothermia Post Cardiac Arrest
Zoll IVTM - intravenous cooling catheter

standard triple-lumen IV central line (for comparison):
The IVTM™ from ZOLL tackles the heart of the temperature problem. Cold or warm saline solution is fed in a circulatory system around the balloons of the catheter, so that the patient is cooled or warmed by the venous blood flowing over the individual balloons.
Temperature-controlled saline solution to the Thermogard XP

Standard catheter infusion lumen

Temperature-controlled saline solution from the Thermogard XP

*Internal jugular site (JI)

*Subclavial site (S)

*Femoral site (F)
Zoll IVTM cooling catheter - inserted into femoral vein in similar fashion as triple-lumen IV central line

(click on image to view brief video)
FIGURE 1 | Primary and secondary brain injuries following neurologic events.
Even a small rise in temperature can lead to further neurological damage which can then lead to even larger areas being damaged, and to an additional loss of nerve cells.⁶

With a temperature rise of one degree, the risk of a poor result is increased by the factor 2.2.⁷ Reports show that mild fever almost leads to a doubling of patient mortality, whereas high fever can even triple the mortality rate.⁶

The IVTM device continuously monitors the patient and reacts automatically to every change in the Core Body Temperature. IVTM regulates the temperature of the saline solution circulating in the catheter, and hence attains and maintains the Core Body Temperature selected.
Time and Temperature in Patient #9

Temperature (°C)

Cooling Phase

Hypothermia Phase

Re-warming Phase

Time (hours)
Therapeutic Hypothermia

Outcomes: Cerebral Performance Categories

1. **Good recovery** – conscious, alert, able to work and lead a normal life, may have minor psychological or neurological deficits (mild dysphasia, non-incapacitating hemiparesis)

2. **Moderate disability** – conscious, sufficient cerebral function for part-time work in sheltered environment or independent activities of daily life. May have hemiplegia, seizures, ataxia, dysarthria, dysphasia or permanent memory or mental changes

3. **Severe disability** – conscious, dependent on others for daily support, limited cognition, wide range of cerebral abnormalities from ambulatory with severe memory disturbance to paralytic and able to communicate only with eyes
Retrospective study at one hospital in Switzerland
Cooling intervention with historical controls
Survivors of out-of-hospital arrest (n=109)
Cooling initially via ice bags, then cooling mattress
Target temperature $91^\circ F$, maintained for 24 hrs
All post-arrest ST elevations received cardiac cath

Mauro Oddo, MD; Marie-Denise Schaller, MD; François Feihl, MD; Vincent Ribordy, MD; Lucas Liaudet, MD

Critical Care Medicine, 2006
Cerebral Performance Category Scale

**Good outcome**

1. Conscious and alert with normal function or only slight disability.

2. Conscious and alert with moderate disability.

**Bad outcome**

3. Conscious with severe disability.

4. Comatose or persistent vegetative state.

5. Brain dead or death from other causes.
Real world usage: Switzerland

Outcome at discharge for out-of-hospital VF arrest

Baseline
- CPC5: 56%
- CPC3: 19%
- CPC2: 12%
- CPC1: 14%

Cooling
- CPC5: 40%
- CPC3: 5%
- CPC2: 14%
- CPC1: 42%
Real world usage: Switzerland

Outcome at discharge for out-of-hospital asystole arrest

<table>
<thead>
<tr>
<th></th>
<th>CPC5</th>
<th>CPC3</th>
</tr>
</thead>
<tbody>
<tr>
<td>baseline</td>
<td>89%</td>
<td>11%</td>
</tr>
<tr>
<td>cooling</td>
<td>83%</td>
<td>17%</td>
</tr>
</tbody>
</table>
Real world usage: Switzerland

Outcome at discharge for all rhythms with post-arrest hypotension and shock

<table>
<thead>
<tr>
<th>Baseline</th>
<th>CPC5 79%</th>
<th>CPC3 21%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling</td>
<td>CPC5 71%</td>
<td>CPC2 11%</td>
</tr>
</tbody>
</table>
~30% survival with good neuro status (\( n = 1,000 \)):
2010 ACLS Guidelines

1. Return of Spontaneous Circulation (ROSC)
   - Optimize ventilation and oxygenation
     • Maintain oxygen saturation ≥94%
     • Consider advanced airway and waveform capnography
     • Do not hyperventilate

2. Treat hypotension (SBP < 90 mm Hg)
   • IV/IO bolus
   • Vasopressor infusion
   • Consider treatable causes
   • 12-Lead ECG

3. Consider induced hypothermia
4. Follow commands?
   - Yes
     - STEMI OR high suspicion of AMI
   - No
     - Coronary reperfusion

7. Coronary reperfusion
6. STEMI OR high suspicion of AMI
5. Advanced critical care
Regarding debate about recommendation for TH use: This train has left the station ...
My Favorite Save

Penn Medicine Center for Resuscitation Science:

Video: http://youtu.be/ujfvGyKimhE
Pride ... 3/6/05 0830 h - Colorado River - elev. 2,400 ft.
Humility - 3/6/05 1930h - South Rim Grand Canyon - elev. 6,860 ft.
57 y/o cardiologist, previously healthy, chairman of ad hoc committee to establish TH protocol at Trinity M.C. (available 2/2/11), collapsed on entering hospital - afternoon 8/2/11...

... security video showed downtime 5 minutes
... spotted on floor by medical records personnel:

Code Blue → CPR / ACLS → VF → shock → VF →
ETT intubation → shock → VF → intraosseous amio L tibia →
VF → shock -> NSR -> ROSC -> unresponsive →

TH protocol (TH #5 at Trinity) →
head CT(OK) → LH cath (OK) → TEE(OK) →
90ºF X 24 hrs. → rewarming X 12 hrs. →
extubated day 4 → ICD day 10 → d/c home day 14 →
delivered CV Update Therapeutic Hypothermia talk 2/4/12 and 2/9/13 →
Therapeutic Hypothermia talks to BREMSS 2/28/13, Trinity EMS Workshop 5/23/13

Birmingham AHA Heart Ball - Honored Heart Survivor talk 3/1/14
5th Annual Louis S. Pappas Education Seminar 2/28/15
4th Annual Ed Waits Respiratory Care Conference 6/24/15