ADVOCATING FOR COMPREHENSIVE POST-RESUSCITATION CARE

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Objectives

- Define Post-Resuscitation Syndrome
- Discuss the American Heart Association (AHA) 2010 Guidelines:
  1. Optimize cardiopulmonary function and vital organ perfusion
  2. Try to identify and treat the precipitating causes of the arrest and prevent recurrent arrest
  3. Identifying and treating acute coronary syndromes
  4. Controlling body temperature to optimize survival and neurological recovery
  5. Optimizing mechanical ventilation to minimize lung injury
  6. Reducing the risk of multi-organ injury and supporting organ function
  7. Assessing prognosis for recovery
- Encourage development of protocols, algorithms & checklists
After the CPR stops...

Post-Resuscitation Syndrome:

“The pathological state with associated organ failure that can occur post cardiac arrest.”
Post Cardiac Arrest Syndrome

Consists of four main clinical considerations:

1. Brain Injury
   • Initial hyperemic blood flow (lasts 10-30 minutes), followed by a more prolonged period of low blood flow
   • Disruption on both a micro- & macro- circulatory levels often results in hyperemia and ischemia
   • Related to:
     o Hypoxia during the arrest
     o Inflammation associated with reperfusion after the arrest “Reperfusion Injury”
2. Myocardial dysfunction
   - Heart initially becomes hyperkinetic
     - Circulating catecholamines
   - Global hypokinesis often follows

3. Systemic Ischemia/Reperfusion Response
   - Response similar to septic shock
     - Activation of the immune system
     - Release of inflammatory cytokines
     - Range of cellular responses

4. Persistent precipitating pathology
   - The cause of the arrest may continue to impact physiological parameters
“A comprehensive, structured, multidisciplinary system of care should be implemented in a consistent manner for the treatment of post–cardiac arrest patients. Programs should include as part of structured interventions: therapeutic hypothermia, optimization of hemodynamics and gas exchange, immediate coronary reperfusion when indicated for restoration of coronary blood flow with percutaneous coronary intervention (PCI), glycemic control and neurological diagnosis, management, and prognostication.”
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

5. Consider induced hypothermia

4. Follow commands?
   - Yes
   - STEMI OR high suspicion of AMI

6. Yes

7. Coronary reperfusion

8. No

Doses/Details

Ventilation/Oxygenation
Avoid excessive ventilation. Start at 10-12 breaths/min and titrate to target PETCO₂ 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

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Why Advocate?

• 5-year study (5,958 patients) published in 2012
  – PCI was performed in 384 of 1,001 (38.4%)
  – TH was performed in 241 of 941 (25.6%) eligible patients

• 2013 study (538 hospitals & 67,498 patients) showed:
  – Post in-hospital cardiac arrest, therapeutic hypothermia was used rarely (12%)
    • Once initiated, the target temperature was commonly not achieved (44.3%)
    • Frequency of use increased over time but remained low (0.7-3.3% over 6 years)
    • Factors associated with therapeutic hypothermia use included patient age (young), time (weekday) & location of occurrence (non-ICU), and type of hospital (teaching)

• Two year study of post arrest care (PACT)
Care Phases

- Immediate: First 20 minutes after return of spontaneous circulation (ROSC).
- Early: 20 minutes to 6-12 hours: early intervention is most effective.
- Intermediate: 6-12 hours to 72 hours: injury pathways still active; aggressive treatment recommended.
- Recovery: Beyond 72 hours: recovery phase; outcomes more predictable.
- Rehabilitation
Cardiopulmonary Function & Vital Organ Perfusion

• Verify/establish IV access
  – CVP
• IV fluids using the CVP as a guide
• Large amounts of volume often required
  – Global hypokinesis & myocardial dysfunction
• Vasoactive drugs
  – Recommended: MAP ≥ 65 mmHg & ScvO₂≥70
• Ensure adequate airway & support breathing (intubation may be required)
  – Avoid using ties that pass around the patient’s neck, potentially obstructing venous return from the brain
• Waveform capnography monitoring
  – To monitor the correct placement of an advanced airway
• Continuous pulse oximetry
• Elevate the head of the bed 30°, if tolerated
  – Reduces the incidence of cerebral edema, aspiration and ventilatory-associated pneumonia
Identify & Prevent

• Identify and treat the precipitating causes & prevent recurrence
• Maintain airway
  ○ CXR
    - Causes/complications of arrest
      - Tension pneumothorax, pneumo/hemothorax, rib fracture
• Continuous ECG and vital sign monitoring
  – Recurrent cardiac dysrhythmias (reperfusion/ischemic)
• Maintain SBP ≥ 90mmHg/MAP ≥ 65mmHg
  – Fluid boluses (cold fluid if TH selected)
  – Vasoactive drugs (dopamine, norepinephrine or epinephrine)
Acute Coronary Syndrome (ACS)

• Identify and treat ACS
  – Most common cause of cardiac arrest is cardiovascular disease & coronary ischemia

• A 12-lead ECG obtained ASAP
  – To detect ST elevation or new left bundle branch block
  – Assess QTI
Acute Myocardial Infarction (AMI)

- High suspicion of AMI?
  - Protocols for treatment of AMI and coronary reperfusion should be activated (PCI, thrombolysis, anticoagulants)
- Concurrent PCI and hypothermia are considered safe
- Good outcomes have been reported for comatose patients post cardiac arrest who undergo PCI
- “Medical or interventional treatments may be considered for treatment of ACS and should not be deferred because of the presence of coma or if hypothermia is indicated.”
• 2013 study showed STEMI patients who suffered a cardiac arrest which resulted in cardiogenic shock had a significantly higher in-hospital mortality rate than those without (62% vs. 30%)
  – IABP or VAD therapy should be considered

Pulmonary Embolism treatment

• Studies indicate that CPR itself does not appear to pose an unacceptable risk of bleeding for post cardiac arrest patients
  – In post–cardiac arrest patients with arrest due to presumed or known pulmonary embolism, fibrinolytics may be considered
• Antiarrhythmic drugs such as amiodarone are often administered during initial resuscitation
  – There is no evidence to support or refute continued or prophylactic administration of these medications

Implantable Cardiac Defibrillator

• A meta-analysis demonstrated that patients with a left ventricular ejection fraction $\leq 35\%$ derived significant benefit from ICD therapy
Targeted Temperature Management

• 2009 International consensus conference sponsored by American Thoracic Society, European Respiratory Society, European Society of Intensive Care Medicine, Society of Critical Care Medicine & Société de Réanimation de Langue Français issued a statement: “recommends strongly for TTM to a target of 32-34°C as preferred treatment (versus unstructured temperature management) of out-of-hospital adult cardiac arrest victims with a first registered rhythm of VF or pulseless VT and still unconscious after [Return of Spontaneous Circulation] ROSC.”
2010 AHA Guidelines: “Brain injury and cardiovascular instability are the major determinants of survival after cardiac arrest. Because therapeutic hypothermia (TH) is the only intervention demonstrated to improve neurological recovery, it should be considered for any patient who is unable to follow verbal commands after ROSC.”

• If TH contraindicated, hyperthermia (T>37.6⁰C), common during the first 24 hours after cardiac arrest, must be avoided

• 3 phases of TH: induction, maintenance & rewarming
**Sunnybrook Health Sciences Centre**

**Physician's Orders**

**Therapeutic Hypothermia**

**Post Cardiac Arrest**

**DATE:** YYYY / MM / DD  **TIME (h):** __________  **PATIENT IDENTIFICATION**

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**Preparation**

1. Communicate with admitting Critical Care Unit regarding induction of hypothermia
2. Elevate head of bed 30 to 45 degrees as tolerated
3. Insert nasogastric/orogastric tube
4. Respiratory therapy to initiate mechanical ventilation protocol without warming humidification.
   - Target PaCO2 40-45 mmHg OR End Tidal CO2 35-40 mmHg
   - Titrated FiO2 towards room air allowing SpO2 no less than 94%.

**Monitoring**

5. Follow assessment guidelines (on back of page 2)
6. Arterial line: Pressurized NS 500 mL for transduced arterial lines
7. Target mean arterial BP of greater than 65 mmHg or as specified _______ mmHg
8. Two peripheral intravenous cannulae. Each maintenance IV line NS at 25 mL/h
9. Foley catheter to urometer
10. Temperature monitoring via:
   - Esophageal temperature probe (preferred)
   - Other

**Investigations**

12. Serial blood work: ABG, lyes, calcium profile q2h until temperature reaches 34°C, then q4h. Reseassess after rewarming is achieved.
13. Other serial blood work:
14. Point-of-care blood glucose testing q4h. Obtain order for intensive insulin Nomogram when BS greater than 8.0 mmol/L
15. 12 lead ECG on admission and pm (for chest pain, hemodynamic instability, ECG changes on monitor)

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**Physician Must Check Off Appropriate Orders**

Refer to Patient Selection Guidelines on back of page 1

**Medications**

16. Administer each of the following prior to intilination of cooling and continue for entire duration of hypothermia
   - Fentanyl:
     - IV loading dose: _______ mcg
     - IV infusion (1000 mcg in 100 mL NS) at _______ mcg/h
   - Midazolam:
     - IV loading dose: _______ mcg
     - IV infusion (50 mg in 50 mL D5W) at _______ mcg/h

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**Physician's Signature:**

**PRINT NAME:**

**Page:**
Induction

- Begin ASAP
- Cool the patient rapidly to 32-34°C
- Recommendation: achieve 32-34°C within 4-6 hours of ROSC
- Recommendation: achieve 32-34°C within 1-3 hours of starting to cool

TIME is BRAIN!
Cooling Methods

• Multiple methods for inducing TH (no single method has been demonstrated to be optimal)
  - Feedback-controlled endovascular catheters
  - Surface cooling devices
  - Cooling blankets and frequent application of ice bags
    - require more labor and closer monitoring
  - Iced (4°C) isotonic fluid can be infused to initiate core cooling
    - must be combined with a follow-up method for maintenance of hypothermia
Trouble-shooting Checklist for the Induction of Therapeutic Hypothermia in Comatose Post Cardiac Arrest Patients

Goal: Core temperature 32-34°C within 6 hours of ED arrival

This checklist is for use as an adjunct to the pre-printed cooling protocols when the rate of cooling is inadequate (less than 0.5 degrees Celsius per hour). Difficulty with cooling may be due to equipment problems or physiologic counter-regulatory mechanisms at work in the patient.

☐ CHECK TEMPERATURE MONITOR.
  - Ensure esophageal probe or bladder probe used for monitoring is in the correct position and functioning properly.
  - If in doubt, change the probe.
  - Switch bladder probe to esophageal probe if urine output low.

☐ CHECK COOLING TECHNIQUE
  - Ice bags: Consider adding more bags to properly cover neck, both axilla and groin. Make sure the ice is replenished q1 hour.
  - Cooling blanket - check temperature setting and ensure device is working properly.
  - Turn ventilator heater off.
  - Remove any external sources of heat or insulation. Keep patient as uncovered/undressed as possible. No blankets!

☐ TREAT SHIVERING AND ENCOURAGE VASODILATION WITH ADDITIONAL NARCOTICS, SEDATIVES AND ADJUNCTIVE MEDICATIONS
  - Refer to your hospital therapeutic hypothermia order sheet for specific drug names and doses.
  - Shivering is a very common problem during the induction phase. Shivering may frequently be subclinical. If in doubt whether subclinical shivering may be contributing to cooling difficulties, treat as if shivering.
  - Additional narcotic or sedative bolus may resolve shivering and also promote vasodilatation.
  - Consider bolus dose of paralytic (NMBA) drug. Most patients will require at least a bolus dose of paralysis to get cold in a timely manner.
  - In addition, magnesium may be given to cause vasodilatation.

☐ Consider bolus of 2 litres of cold normal saline (4 degrees Celsius). This may be repeated if there is no evidence of congestive heart failure.

☐ Recheck temperature in one hour and repeat checklist if needed.
Maintenance

• Optimal duration of TH is at least 12 hours and may be ≥24 hours (from start of cooling)

• Continuous monitoring of the patient’s core temperature
  – Esophageal thermometer
  – Bladder catheter (in nonanuric patients)
  – Pulmonary artery catheter (if one is placed for other indications)
• Analgesia & Sedation should be routinely administered during TH

• Neuromuscular Blocking Agents (NMBA)
  – PRN/infused to PNS/TOF monitoring
Re-warming

- Recommendation: 8-12 hours
- Active/passive not yet studied
Potential Complications

• Coagulopathy
  – Lines/catheters (optimally inserted prior to initiating TH)
  – Control any ongoing bleeding

• Arrhythmias
  – Bradycardia

• Hyperglycemia

• Electrolyte disturbances
  – Hypokalemia/Hyperkalemia

• Prolonged hypothermia impacts immune function
  – Pneumonia and sepsis
Hyperthermia & Normothermia

• Hyperthermia can impair brain recovery
  – Studies suggest that there is an association between poor survival outcomes and fever > 37.6°C
  – May be related to activation of inflammatory cytokines similar to that seen in sepsis

• Hyperthermia after rewarming can also occur
  – Identify & treat
Optimizing Ventilation

• Hyperventilation should be avoided because of potential adverse hemodynamic effects.
  – Increases intrathoracic pressure & inversely lowers cardiac output
  – Decreases PaCO$_2$ which can decrease cerebral blood flow
    o Start at 10 to 12 breaths/minute
    o Titrate to achieve a PETCO$_2$ of 35-40 mmHg or a PaCO$_2$ of 40-45 mmHg ("Normocapnia should be considered the standard")

• Arterial oxyhemoglobin saturation (SaO$_2$) of 100% may correspond to a PaO$_2$ of 80-500 mmHg
  – FiO$_2$ should be titrated to the lowest level required to achieve an SaO$_2$ ≤94%, to avoid hyperoxia
• Positive end-expiratory pressure (PEEP) and titrated FiO$_2$ are strategies that can improve pulmonary function and PaO$_2$

• Essential diagnostic tests in intubated patients:
  o ABGs
  o CXR
    – ETT positioning
    – Pulmonary infiltrates/edema, VAP

• Routinely check PaO$_2$/FiO$_2$ ratio
  o Acute Lung Injury (ALI) <300
  o Acute Respiratory Distress Syndrome (ARDS) < 200

• Terminate ventilation & extubate ASAP
  – If there are no cardiac, pulmonary or other complications
Pain/agitation

- Intermittent or continuous sedation and/or analgesia can be used to achieve specific clinical goals
  - Daily sedation interruption protocols are recommended
Reduce Organ Injury & Improve Perfusion

• Recommended MAP ≥ 65 mmHg & ScvO₂ ≥70

• Vasoactive drugs:
  – Limited data about vasoactive drugs
  – Base therapy on established protocols/orders for ICU
    • Drug actions & interactions with previously and concurrently administered drugs

• Hypotension (recommendations)
  – norepinephrine, dobutamine, dopamine & epinephrine
  – Intra-Aortic Balloon Pump (IABP)

• Hypertension (recommendations)
  – nitroglycerin

• Consider diuretics if evidenced heart failure

• Transfuse red blood cells to maintain targeted ScvO₂
Blood Glucose

• Hyper/hypoglycemia should be avoided
  – Studies have shown increased mortality among post-cardiac arrest patients with hyperglycemia

• A target of moderate glycemic control 8-10 mmol/L may be considered
Acid-Base Balance, Electrolytes

• Acidosis & hyperkalemia are adverse prognostic factors in the post resuscitation phase
  – Prevent severe acidosis, hyper/hypokalemia

• Hypomagnesemia is associated with adverse outcome in critically ill patients
  – Although there is no RCT evaluating magnesium in post resuscitation care, it seems reasonable to avoid

Standard ICU Care

• GI & DVT prophylaxis
Corticosteroids

• Role in the physiological response to severe stress
  – Maintenance of vascular tone & capillary permeability.
  – Several studies report a relative adrenal insufficiency
    (associated with higher rates of mortality in critically ill)
  – No human studies have confirmed the value of routine use
    of these agents post cardiac arrest

CRRT/Hemofiltration

• Treatment for AKI
• Proposed as a method to modify the inflammation
  that occurs with post cardiac arrest syndrome
  – No studies showing improved outcomes yet
  – Future investigations are required
Central Nervous System (CNS)

“Brain injury is a common cause of morbidity and mortality in post–cardiac arrest patients. Brain injury is the cause of death in 68% of patients after out-of-hospital cardiac arrest and in 23% after in-hospital cardiac arrest. The pathophysiology of post–cardiac arrest brain injury involves a complex cascade of molecular events that are triggered by ischemia and reperfusion and then executed over hours to days after ROSC.”

• Clinical manifestations of post–cardiac arrest brain injury include:
  – Coma, seizures, myoclonus, various degrees of neurocognitive dysfunction (ranging from memory deficits to persistent vegetative state) and brain death
Seizure Management

“An EEG for the diagnosis of seizure should be performed with prompt interpretation as soon as possible and should be monitored frequently or continuously in comatose patients after ROSC.”

• Routine prophylactic administration of neuroprotective agents has not been well studied

• If seizures develop, the same anticonvulsant regimens used for status epilepticus caused by other etiologies may be used
“The goal of post–cardiac arrest management is to return patients to their pre-arrest functional level. However, many patients will die, remain permanently unresponsive, or remain permanently unable to perform independent activities. Early prognostication of neurological outcome is an essential component of post–cardiac arrest care.”
Prognostication Algorithm

COMA
POST-CARDIAC ARREST
Pathway for Assessing Neurological Prognosis

ARE THERE ANY MAJOR CLINICAL FACTORS THAT COULD CONFOUND PROGNOSTICATION

CT scan brain
Any intracranial pathology that could alter prognosis?

Metabolic workup - correct sodium, calcium
Exclude drugs - stop sedatives and neuromuscular blockers
Exclude persistent hypothermia
Exclude refractory systemic instability

No brain stem reflexes 24 hours or later after cardiac arrest?

If no brain stem reflexes proceed to formal brain death declaration.
If no brain death present, involve Trillium Gift of Life Network and/or discontinue life support

72 hours or later after cardiac arrest
Absent pupil or corneal reflexes?

If absent pupil or corneal reflexes consider withdrawal of life support or continued observation.
(*false positive rate 0%)
*Caution: false positive rate may be higher after hypothermia

72 hours or later after cardiac arrest
Bilaterally absent N20 SSEP responses?

If bilaterally absent N20 SSEP responses consider withdrawal of life support or continued observation.
(*false positive rate 0.7%)
*Caution: false positive rate may be higher after hypothermia

Day 7 after cardiac arrest
1) Absent pupil or corneal reflexes? OR
2) Extensor or absent motor response? OR
3) Bilaterally absent N20 SSEP response?

If any of 1), 2), or 3) apply consider withdrawal of life support.

None of the above apply?
Indeterminate Outcome
• 24 hours post-cardiac arrest; routine neurological exam, routine/continuous EEG, Somatosensory Evoked Potentials (SSEPs), are the best predictors
  – in the absence of confounders (such as hypotension, seizures, sedatives, or neuromuscular blockers)

• No reliable studies yet on using these tests with TH
  – Recommended that TH should be completed before prognostication

• CT & MRI can also be of benefit

• When to withdraw?
  – No recommendations, however studies have used both 72 & 96 hours
ADVOCATE!!

Find Your Voice

IDEA

PLAN

ACTION

Nurses: What Nurses are Best Known For

HEALTH
NURSING
HOSPITAL
PROVIDING
PATIENTS
CARE

COMPASSION
KNOWLEDGE
NURSES
PROFESSIONALISM

BEST
WORK
QUALITY
SUPPORT
COMPETENT
TEAM
SKILLS
PROVIDE

The Nurse as Change Agent and Advocate
Chapter 8
Advocate!

- AHA Guidelines
- Develop protocols, algorithms & checklists
  - Physician orders
    - Optimization of hemodynamics & gas exchange
    - Glycemic control
    - Neurological diagnosis & management
  - PCI Algorithm
  - TH Algorithm
  - Neuroprognostication Protocols
    - WOLS guidelines/orders, organ donation guidelines/orders
  - Structured rehabilitation plans
    - Discharge planning, links with rehab centers, community
Advocate!

• As laypersons

AHA website has info on post cardiac arrest syndrome:
  – http://www.heart.org/HEARTORG/Conditions/More/CardiacArrest/Post-Cardiac-Arrest-Syndrome-Care_UCM_307981_Article.jsp

& prognosis for survivors:
  – http://www.heart.org/HEARTORG/Conditions/More/CardiacArrest/Prognosis-for-Cardiac-Arrest-Survivors_UCM_307918_Article.jsp

Canada’s Heart & Stroke has similar resources:
Bibliography


Thank you!

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