Induced Hypothermia for Neonates
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Stated Learner Objectives
- Compare Selective Head Cooling and Total Body Cooling techniques and nursing interventions.
- List important education for staff from referring hospitals.

Induced Hypothermia
- History of Cooling
- What is HIE?
- What happens when the body is cooled?
- Two ways to cool the neonate
- Issues for Nursing
- What does research show about longer term outcomes?
- Latest research in adjunct treatments
When did cooling start?

• 1722 As early as 300 years ago an essay exists describing the manner of infant immersion from London/Holland
• 1939 Dr. Temple Fay at Temple Univ. School of Medicine as treatment for metastatic disease and to achieve pain control
• 1941 Used to treat schizophrenic symptoms
• 1940s and 1950s Dr. Wilfred Bigelow deep hypothermia for cardiopulmonary bypass

History Continued

• 1954 to 1959 Dr. Hubert Rosomoff adjunct treatment for traumatic brain injury and cerebral vascular lesions at the Neurologic Institute of New York
• Deep hypothermia was associated with lethal arrhythmias and increased infections which resulted in a decline in popularity
• 1990 to 1995 decreased ICP, reduced mortality, and increased survival rates
Neonatal Cooling

- First reported in the therapy of infants after perinatal asphyxia in 1959
  - No control group
  - Initiated after failed resuscitation
  - No consistency on how it was applied (temp and timing)
- Safety and Efficacy could not be proven

Neonatal Cooling

- Gunn and Gluckman (2007) describe the uncontrolled case series in the 1950s and 1960s. Reported outcomes were better than historical controls. (short term)
- Preceded active resuscitation

Picture
Hypoxic-Ischemic Encephalopathy

- Results from decreased oxygen levels during the birth process
- The decreased oxygen before or during birth can destroy cells in the infant’s brain
- Damage continues for some time after initial insult
- Picture - cells deprived of oxygen

HIE: Incidence

- Peripartum asphyxia affects 2-5 per 1000 live births in technically-developed countries
- 0.5-1 per 1000 live births have subsequent moderate to severe HIE
- Worldwide HIE results in death for 10-60% of affected infants
- 25% of survivors have long term neurodevelopmental sequelae

HIE: Mechanism of Injury

- Neuronal death occurs in two phases after a reversible hypoxic-ischemic global insult
- What are these insults?
  - Cord prolapse
  - Placental Abruption
  - Maternal hypotension
  - Asphyxia due to shoulder dystocia
HIE: Two Phases of Injury

“Primary neuronal death”
- Immediate
- Related to cellular hypoxia with exhaustion of the cell’s energy stores if insult is severe

HIE: Second Phase

• “Delayed neuronal death”
  - Secondary phase believed to begin after a latent period of approximately 6 hours as originally identified in animal studies
  - Mechanisms causing the delayed death
    • Hyperemia
    • Cytotoxic edema and mitochondrial failure
    • Accumulation of excitotoxins
    • Active cell death
    • Nitric Oxide synthesis
    • Free radicals

HIE: MRI Studies Support 2-Phase Model

• MRI of term infants supports 2 phase model of neuronal death
• Imaging demonstrated normal cerebral oxidative metabolism shortly after birth
• In Later MRIs, the degree of energy failure was predictive of outcome.
Researchers HIE Conclusions

- "A Therapeutic Window"
- Uniform initiation time of < 6 hours for cooling
- *Time is Brain*

What happens when the body is cooled?

- Peripheral constriction and shunting of blood to the core organs
- Decreased inflammatory response
- The brain is protected by inhibiting depolarization and therefore by-products
- Decreased Cerebral Metabolic Rate
- Decreased Cerebral Edema
- Decreased Intracranial Pressure

Neuroprotection for the Neonate

- Precise Mechanisms?

- Programmed cell death (Apoptosis)
- Inflammatory Second Messengers
- Excitotoxicity after Hypoxic-Ischemia
2 Ways to Cool

**Head Cooling**
- May allow better cooling of the cortex
- One study demonstrated reduction of cortical lesions by MRI
- Beware of temperature gradient created between body and head

**Whole Body Cooling**
- Allow for cooling to commence at institutions without protocol and on transport
- Whole body as well as head cooling - decrease in basal ganglia and thalamic lesions (MRI)

Criteria for Induced Hypothermia

**One Indicator of hypoxic ischemic event**
- Apgar < 5 at 10 minutes
- Continued need for resuscitation at 10 minutes
- Acidemia ph < 7.0, Base deficit > 16

Are there differences between head & body?

Criteria for Induced Hypothermia

**Two Indicators of encephalopathy by physical examination**
- Level of consciousness
- Spontaneous activity
- Posture
- Tone
- Primitive Reflexes
- Autonomic System
  - Pupils
  - Heart rate
  - Respiration
Criteria for Head Cooling

• In addition to previous criteria also require an abnormal aEEG (a= amplitude integrated).

• Problems related to aEEG
  – Another piece of equipment
  – Time frame constraints
  – Ability to set up and read

Adverse Effects of Hypothermia

• Suppression of Immune Function
• Prolongation of Clotting Times
• Metabolic Effects
• Cardiovascular Adaptation during cooling
• Skin disturbances
Pharmacology

- Metabolism effected by hypothermia
- Pain medication?
- Seizure treatment

Zaneli et al., 2011

Issues for Nursing

- Impact on the rest of child’s needs
- Parents needs
- Consents?
- Adverse effects- system by system
- Long term outcomes
- Transport of infants
Research and Long Term Outcomes

NICHD trial
• Body Cooling
• Milder degrees of encephalopathy may be cooled
• Earlier Initiation of treatment

Cool Cap trial
• Head Cooling
• Moderate versus Severe Encephalopathy

Current Research on Adjunct Treatments

• Stem Cell Treatment
• Xenon

When else is hypothermia used in the Pediatric population

• Post cardiac arrest
  – Survival to hospital discharge 2%-28% out of hospital CA
  – 14-42% after in-hospital CA
  – Many survivors have severe neurological disability
• Traumatic brain injury
Our trip to Nemours

- Picture

Cardiac Arrest and Brain Injury

- Period of increased sensitivity of the brain to secondary injury
- Pediatric cardiac arrest is usually related to asphyxia instead of VF/VT as in adults
- Brain injury is different based on cause of arrest

Post Cardiac Arrest Treatment in Children

- Avoid hypotension
- Maintain normoxia
- Maintain euglycemia
- Avoid hyperventilation
- Avoid hyperthermia
- Avoid rewarming
- Consider induced hypothermia

» Hickey & Painter (2006)
Protocol in Children

Fink et al. (2010) Children's Hospital of Pittsburgh
– After 2002 publications of adult randomized controlled trials began cooling children who were comatose after CA
– Cooling blanket, ice packs, fan, lowering room temp., gastric lavage with iced saline. One case iced IV saline.
– Target- 34 (33.5-34.8)
– Reached in 7 hours (5-8)
– Maintained for 24 hrs (16- 48hrs)
– Rewarming for 6 hrs (5-8hrs)

Conclusions for Hypothermia as Treatment Post Cardiac Arrest

• Hypothermia was not associated with survival
• Hypothermia needed more electrolyte replacement
• Hypothermia overcooled had greater mortality
• Current American Heart Assoc. guidelines recommend consideration of use of HT for comatose survivors of pediatric CA

Current CA Research

National Institutes of Health (NIH) is supporting multicenter, randomized, controlled trials investigating therapeutic HT after pediatric CA

Enrollment began September 2009
Traumatic Brain Injury

• Potential understanding of protective mechanisms of hypothermia
• Different goal temperature ranges
• Oxidative Stress

» Bayir et al., 2009

Beginning a Cooling Program

• Start by including all the stakeholders.
• Write your list of questions.
• Answer your list of questions.
• Clearly define responsibilities of any participants
• Choose one person to oversee time frames for education, initiation, follow up, etc…

List of Questions

• Who will we be cooling?
• Where will they come from?
• How will we transport?
• How will we use the aEEG?
• Who will be responsible?
• How will we monitor temperature?
• Which lab values will be measured?
• Equipment, time frames, follow up??????
Recommendations

- Identifying the best candidates
- Rigorous protocol
- Systematic patient follow up
- Look for PI opportunities

References


References cont.


