Bayfront Health
Seven Rivers

Therapeutic Hypothermia (TH) Education Components:

- **ALC Course: "Therapeutic Hypothermia After Cardiac Arrest"**
- **This PowerPoint: "Nuts & Bolts of Post-Resusc. TH"**
- **Live Presentation by Drs. Bennett / Villarreal**
- **Live "Hands-On" Practical Session with ICU RN TH Educator / Preceptor**
- **Documentation of Competencies**

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"The Nuts & Bolts of Post-Resuscitation Hypothermia"

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ACCREDITED
AMERICAN COLLEGE OF CARDIOLOGY
CHEST PAIN CENTER
PRIMARY PCI

Objectives

- Identify goals associated with induced hypothermia
- List equipment needs to initiate and maintain induce hypothermia
- Discuss steps performed during pre-induction, induction, maintenance and re-warming phases
- Describe possible complications associated with induced hypothermia
- Discuss documentation associated with induced hypothermia

Statistics

- Approximately 5-30% of patients resuscitated from cardiac arrest survive to leave the hospital
- The majority of these patient suffered ischemic brain injury which resulted in severe disability or ultimately leads to their death
- Research indicates that the induction of mild hypothermia in patients following cardiac arrest may achieve significant reduction of the incidence of severity of brain injury in arrest survivors

Statistics

- Of those who survive to hospital admission but do not survive to discharge
  - 10% die due to recurrent dysrhythmias
  - 30% die due to cardiovascular collapse
  - 40% die due to neurologic impairment
  - 20% die due to other causes (sepsis, etc.)

Pathophysiology of Anoxic Brain Injury – Phase 1: No Flow

- Cardiac arrest causes immediate cessation of blood flow
- This leads to a rapid depletion of cerebral oxygen and ATP stores and depressed cerebral function
  - ATP is stored as energy in the body and the body can not function without adenosine triphosphate
- Damage occurs to neurons in the CNS during cardiac arrest

Pathophysiology of Anoxic Brain Injury – Phase 2: Low Flow

- Return of spontaneous circulation
- The viability of neurons depends on type, location and duration of global anoxia
- Neurons in the cerebral cortex, hippocampus and basal ganglia are the most vulnerable

Pathophysiology of Anoxic Brain Injury

- After return to spontaneous circulation, initially there are supra-normal levels of cerebral blood flow which drops below normal after several hours
- Cerebral vasospasm occurs and there is a reduction in cerebral perfusion pressure
- Cerebral blood flow is compromised due to coagulation issues
- There is also a deterioration of the blood brain barrier

How Does Induced Hypothermia Diminish Anoxic Brain Injury?

- Decreases energy utilization and oxygen consumption
- Decreases nitric oxide production and lessens the release of other neurotoxins
- Diminishes the loss of brain cells
- Stabilizes the blood brain barrier and decrease cerebral edema

Initial Screening

- The ***physician*** will determine if the patient meets criteria for the hypothermia protocol which is to be completed on patient's arrival to the ED
- The goal is to transfer the patient from ED to ICU as quickly as possible
- As soon as possible, initiate calls to the hospitalist (or appropriate attending physician) and AHS to contact ICU for bed preparation
- Rapid cooling will only be performed in ED or ICU

Inclusion Criteria

- Non-traumatic cardiac arrest with ROSC
- Core temperature >34ºC at presentation
- Time to initiation of hypothermia <6 hours
- Comatose after ROSC with a GCS <8 and no purposeful movements to pain
- Over 18 years of age
- Patient is intubated and mechanically ventilated

Exclusion Criteria

- Advanced Direction (DNR/DNI)
- Uncontrolled GI bleeding
- Known terminal illness or pre-arrest impaired cognitive status
- Cardiovascular instability as evidenced by uncontrolled arrhythmias
- Refractory hypotension (unable to achieve target MAP 75 mmHg despite intervention)
- Sepsis as suspected cause of cardiac arrest
- Suspected intracranial hemorrhage
- Major intracranial, intra-thoracic and intra-abdominal surgery within 14 days
- Pregnancy

Remember

- Initiating paralysis in a patient that is already hypothermic should be avoided because it can result in a precipitous drop in core body temperature
- Elderly patients will cool more quickly than younger or obese patients

Temperature Conversions

Celsius	Fahrenheit
32.0	89.6
33.0	91.4
34.0	93.2
35.0	95.0
36.0	96.8
36.5	97.7
37.0	98.6
37.5	99.5
38.0	100.4

4 Phase Approach

- Pre-Induction
- Induction
- Maintenance
- Re-warming
- If cooling not possible, prevent hyperthermia
  - Risk is highest 48 hours after resuscitation
  - Poorer neurologic outcome each 1ºC > 37ºC

Pre-Induction

- Vital Signs
  - BP, MAP, HR, O2 Sat, temperature and cardiac rhythm
  - MAP goal >75 and <120 mmHg
  - CVP goal of 6-10 mmHg
- Chest x-ray
- 12-Lead EKG

Pre-Induction

- Line placement
  - Arterial line (***Must*** have arterial line placed)
    - Use saline flush only for pressure lines
  - CVP/Central line catheter
  - Temperature-sensing foley to monitor temperature
  - A bladder probe is only accurate when there is adequate urine output
    - If urine output < 4ml/hr, switch to an esophageal probe placed by a physician
  - Protect indwelling bladder catheter and temperature probe from coming in contact with cooling blanket wraps
  - Orogastric tube

*Remember VAP and CL bundles

Pre-Induction

- 0.9% sodium choride will be started
- If possible, fluids should be dextrose-free with the exception of standard infusion or RX for hypoglycemia

Pre-Induction

- Baseline assessment
- Thorough skin assessment before applying cooling system wraps
- All clothes must be removed

Pre-Induction

- Labs
  - CMP
  - Troponin
  - UA
  - Lactate
  - CBC
  - PT/PTT
  - Serum & Urine Toxicity
  - Serum Albumin
  - Magnesium
  - Phosphorus
- Type & Screen
  - Notify MD is Hgb <10
- Females <55 yrs should have urine or serum HCG unless otherwise confirmed not pregnant
- Replace electrolytes if ordered prior to induction

Equipment

- Cardiac monitor
- Gaymar Hypothermia Machine with chest and leg wraps and tubing (or ice packs)
- Distilled water for Gaymar cooling device
- Gaymar temperature probe (rectal or esophageal)
- Temperature sensing Foley
- Sedation
- Neuromuscular blockade agent
- 2-1L bags of cold 0.9% saline
- Arterial catheter and tubing set up
- Peripheral nerve stimulator with Train of Four monitoring

Gaymar Medi-Therm III

Gaymar Wraps

- Torso wrap
- Two thigh leg wraps
- Small-medium or large wraps depending on size of patient
- Weight of wraps when filled
  - Large torso – 3.0 lbs
  - Medium/Small torso – 2.5 lbs
  - Each leg – 2.0 lbs

Analgesia & Sedation

- Sedation and analgesia will be given for comfort
  - Fentanyl or Morphine
  - Propofol
  - Ativan or Versed may be given in ED if Propofol is delayed
- Use RASS to assess levels of sedation with a goal of -4

Richmond Agitation Sedation Scale

- **+4** - Combative Overtly combative or violent, immediate danger to staff
- **+3** - Very agitated Pulls on or removes tubes or catheters or has aggressive behavior toward staff
- **+2** - Agitated Frequent non-purposeful movement or patient ventilator dyssynchrony
- **+1** - Restless Anxious or apprehensive but movements not aggressive or vigorous
- **0** - Alert and calm
- **-1** - Drowsy Not fully alert, but has sustained (more than 10 seconds) awakening, with eye contact/eye opening to voice
- **-2** - Light sedation Briefly (less than 10 seconds) awakens with eye contact to voice
- **-3** - Moderate sedation Any movement (but no eye contact) to voice
- **-4** - Deep sedation No response to voice, but any movement to physical stimulation
- **-5** - Unarousable No response to voice or physical stimulation

How to Assess RASS?

1. Observe patient. Is patient alert and calm (score 0)?
   Does patient have behavior that is consistent with restlessness or agitation (score 1 to 4 using the criteria)
2. If patient is not alert, in a loud speaking voice state patient's name and direct patient to open eyes and look at speaker. Repeat once if necessary. Can prompt patient to continue looking at speaker.
   Patient has eye opening and eye contact, which is sustained for more than 10 seconds (score −1).
   Patient has eye opening and eye contact, but this is not sustained for 10 seconds (score −2).
   Patient has any movement in response to voice, excluding eye contact (score −3).
3. If patient does not respond to voice, physically stimulate patient by shaking shoulder and then rubbing sternum if patient has not response to shaking.
   Patient has any movement to physical stimulation (score −4).
   Patient has no response to voice or physical stimulation (score −5).

Neuromuscular Blockers

- Before starting a neuromuscular blocker, patient ***MUST*** be adequately medicated with analgesic and sedation to goal.
- Patient ***MUST*** receive artificial respirations via mechanical ventilation
- Obtain baseline Train of Four and then every hour
- Adjust neuromuscular blocker to achieve 2/4 and prevent shivering
- Vecuronium (Avoid with significant renal or hepatic impairment) or rocuronium

*Do ***NOT*** initiate sedation while patient is receiving neuromuscular blocker

Shivering

- Hypothermia activates the sympathetic nervous system causing vasoconstriction and shivering
- Shivering increases O2 consumption by 40-100%
- Sedatives, opiates and neuromuscular blockers can counteract these responses and enhance the effectiveness of active cooling

Induction

- Core temperature goal is 32º-34ºC within 6 hours of arrest
- Document time cooling is started on protocol

Gaymar Cooling Device

- Keep device plugged in at all times during use
- Lift cover and fill tank with distilled water until green band on float is visible
- Apply torso pad and connect to first cooling hose
- Apply thigh wrap to each, connect leg wraps together and then connect free ends to second cooling hose
- Connect temperature monitoring indwelling bladder catheter to temperature monitoring port on the cooling device
- Place machine on auto to control patient temperature
- Adjust “Set Point” to desired temperature

Gaymar Cooling Device, cont

- Ensure that tracts are unobstructed and fluid is filling wraps when machine is turned on
- Wrap patient's hands and feet in dry towels to prevent frost bite and decrease shivering stimulus

Cooling with blankets and ice

- Sandwich the patient with 2 cooling blankets
- Place a sheet between the patient's skin and cooling blankets
- Pack patient in ice (groin, chest, axilla, side of neck)
- Avoid packing ice on top of chest (may impair chest wall movement)
- May bolus with refrigerated 0.9% NaCl until patient's core temperature is 34ºC
- Gastric lavage with ice water via OGT.

Maintenance

- Cooling may be continued for 12 or 24 hours
- Cooling should continue for no longer than 24 hours from the initiation of therapy
- The benefits of any off-unit procedures or tests should be carefully weighed against the interruption of cooling
- Do not cool <32ºC
- Cool until 32º-34ºC

Maintenance

- BP, MAP, HR, O2 Sat and cardiac rhythm every 15 minutes, then every 30 minutes x4, then hourly and as needed
- CVP every hour – Goal 6-10 mmHg
- Temperature every15 minutes until desired temp (32º-34ºC) is achieved and then every 30 minutes until re-warming is completed

Maintenance

- Every 6 hours for 24 hours
  - CMP
  - PT/PTT
  - Magnesium
  - Phosphorus
  - CBC
- Daily
  - Chest x-ray
  - CBC, CMP, Magnesium, Phosphorus and ABG
- Other studies may be ordered as needed

Prophylaxis

- DVT Prophylaxis
  - Sequential compression devices
  - Enoxaparin (adjusted dose if renal insufficiency)
- Stress Ulcer Prophylaxis
  - Famotidine IV or per OGT
- Lacrilube to both eyes every 4 hours and prn while on neuromuscular blockers
- HOB elevated 30º
- OGT to low intermittent wall suction

Respiratory Concerns

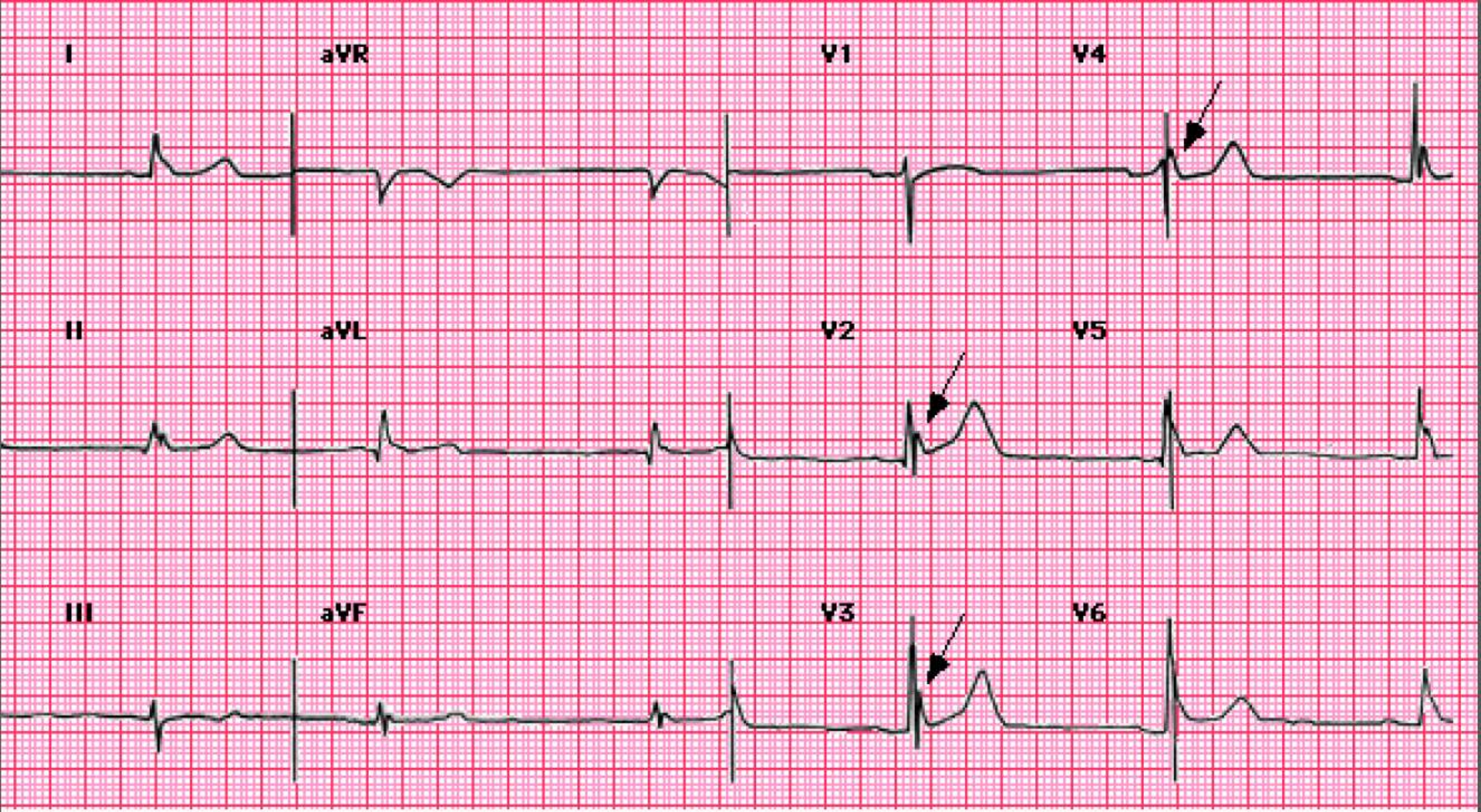
- Hypothermia shifts the oxyhemoglobin curve to the left, which may result in decreased O2 delivery
- The metabolic rate is also lowered, decreasing O2 consumption/CO2 production, cardiac output and cerebral blood flow
- Ventilator settings may need to be adjusted due to decreased CO2 production using temperature-corrected blood gases
- ABG measurements must be analyzed at the patient's actual body temperature
- CO2 should be maintained in the normal range (35-45)

Cardiac Concerns

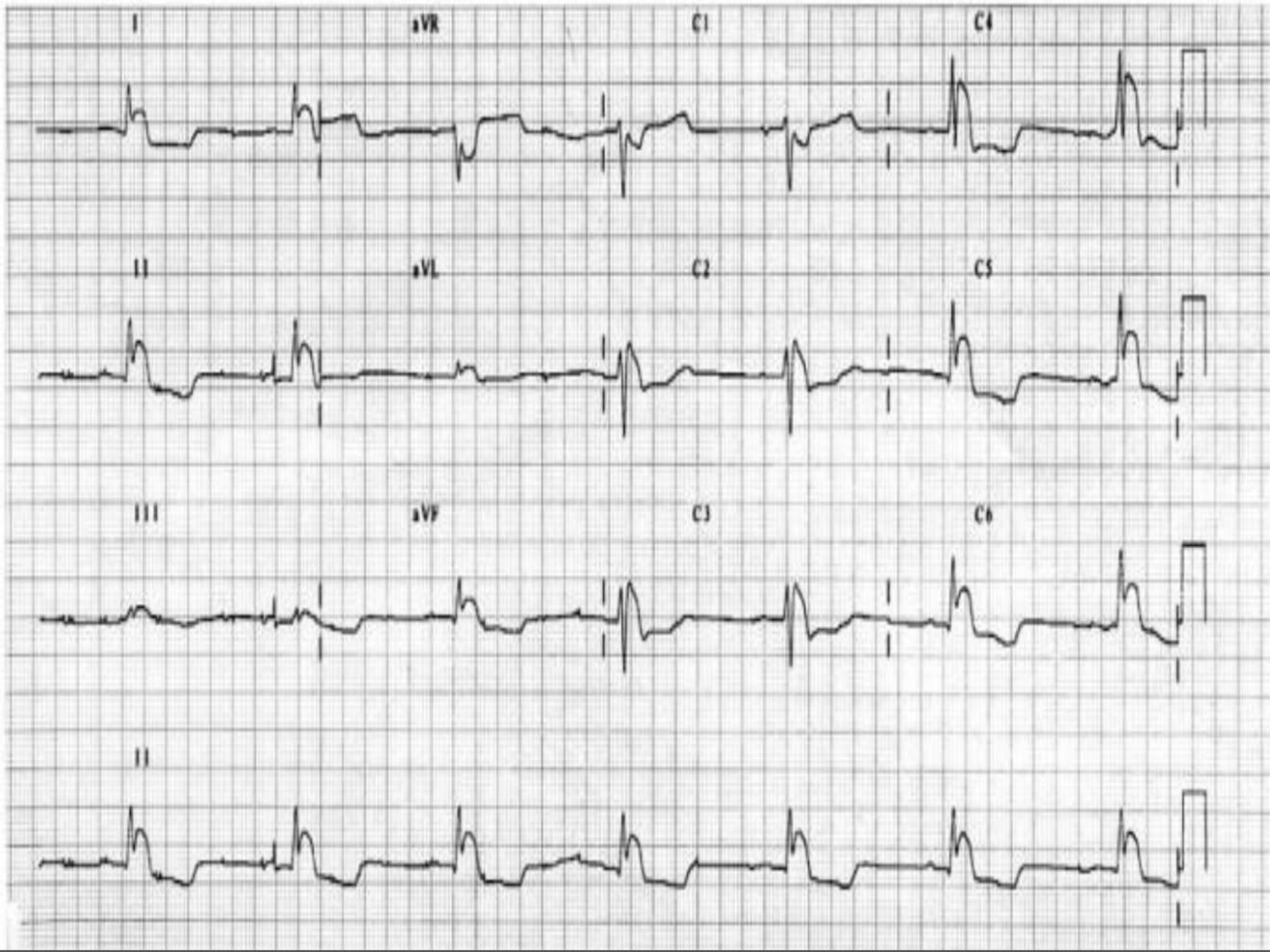
- Monitor the patient for arrhythmias associated with hypothermia (the most common is bradycardia)
- Hypothermia initially causes sinus tachycardia, then bradycardia
- Temperature <30ºC has increase risk for arrhythmias
- Temperature <28ºC has increased risk for ventricular fibrillation
- The severely hypothermic myocardium (<30ºC) is less responsive to defibrillation and medications

Cardiac Concerns

- Osborn waves may be present
- Osborn waves, also known as J waves, camel-hump waves, or hypothermic waves, are best seen in the inferior and lateral precordial leads
- They become more prominent as the body temperature decreases, and they resolve gradually with rewarming



Electrocardiogram in hypothermia The ECG reveals marked sinus bradycardia (about 40 beats/min) with first degree atrioventricular block (PR interval = 0.23 sec). The slow heart rate in this patient is due to hypothermia (90°F, 32.2°C), which also produces prominent convex deflections at the J point (junction of QRS and ST segments) that are best seen in the precordial leads. The J waves or Osborn waves (arrows) are characteristic of severe hypothermia and resolve with rewarming; how they occur is not known. Courtesy of Ary Goldberger, MD.

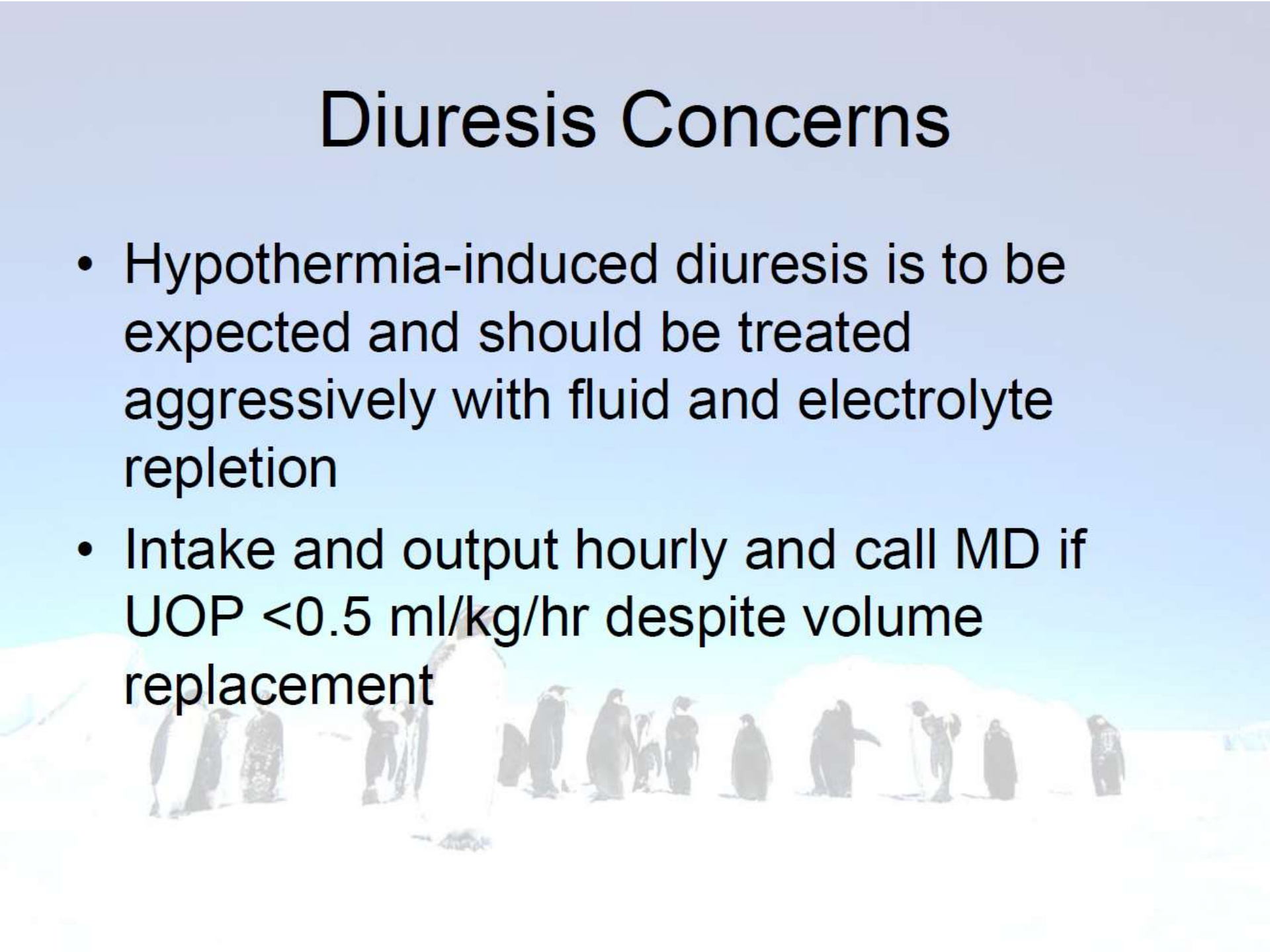

I
aVR
C1
C4
II
aVL
C2
C5
III
aVF
C3
C6
II

Glucose Concerns

- Decreased insulin secretion and decreased insulin sensitivity leads to hyperglycemia, which should be treated aggressively
- Vasoconstriction may cause finger-stick accu-checks to be inaccurate

Diuresis Concerns

- Hypothermia-induced diuresis is to be expected and should be treated aggressively with fluid and electrolyte repletion
- Intake and output hourly and call MD if UOP <0.5 ml/kg/hr despite volume replacement



Potential Labs Associated With Hypothermia

Potential Lab Findings	Treatment
↑ Amylase	No intervention unless persist after warm
↑ LFTs	No intervention unless persist after warm
↑ Serum Glucose	Follow insulin protocol
↓ K+, Mg, Phos, Ca	Correct as needed
↑ Lactate	Optimize oxygen delivery
Metabolic acidosis	Optimize oxygen delivery
Thrombocytopenia	Correct if active bleeding
Leukopenia	No intervention unless persist after warm
↑ PT or PTT	Correct if active bleeding

Laboratory Concerns

- Hypokalemia due both to intracellular shift and cold diuresis
- Hypokalemia may be exacerbated by insulin administration
- Will at least partially correct during rewarming due to ion shift
- Do not aggressively replace potassium during cooling
- When patients are re-warmed, potassium exits cells and hyperkalemia may occur
- Magnesium, calcium and phosphate may also need replacement due to cold diuresis
- May alter clotting cascade and platelet function
- Unexplained increases in serum amylase and lipase have been observed during hypothermia therapy
- Neutropenia and increased incidence of pneumonia has been associated with exposure to prolonged hypothermia

Electrolyte Replacement

- Do not replace potassium unless serum potassium is <3 mEq/L during cooling phase
- Call MD for specific replacement dose

DO NOT USE ELECTROLYTE REPLACEMENT ORDERS

Blood Pressure Concerns

- A MAP goal of >75 mmHg is preferred from a cerebral perfusion standpoint
- Hypertension is additive to the neuroprotection of hypothermia
- May need inotropes/pressors to maintain BP
  - Norepinephrine or epinephrine
  - If MAP >120 MAP mmHg, Nitroglycerin infusion may be started
- Often BP remains elevated during hypothermia as a result of peripheral vasoconstriction
- Hypotension is a concern during the warming phase

Medication Concerns

- Do not administer any medication labeled “Do Not Refrigerate” to patient
- This include Mannitol, which may precipitate if cooled

Skin Concerns

- Skin care should be checked every two hours for burns caused from the cooling packs/blankets
- Do not cool <32ºC
- Do not bath patient during hypothermic or re-warming phase
- Turn patient every two hours and assess for skin breakdown

Fluid Concerns

- Cooling causes diuresis
- Warming causes hypovolemia
- May replace urine output every 1 hour with fluid if hypovolemia is a concern

Remember

For significant dysrhythmias, hemodynamic instability or bleeding, actively rewarm the patient and call the MD immediately

Re-Warming

- Target temperature is 36º-37ºC
- Target temperature to be obtained in 18 hours
- Stop re-warming at 36ºC
- May use warm blankets if needed
- Do not use Bair Hugger
- Goal of 0.17ºC/hr
- Call MD if warming >0.5ºC/hr
- Document time re-warming is started and is finished

Re-Warming

- The rewarming phase may be the most critical as peripheral beds, which were once constricted, start to dilate
- This shift sometimes causes hypotension
- Monitor Temperature, VS and rhythm every 30 minutes until target temperature is reached and then every hour
- Continue sedation/analgesia and neuromuscular blocker until target temp is reached (after warm follow physician orders)
- Empty foley at start of re-warming and maintain strict I&O

Re-Warming

- Do not permit temperature >37ºC in the first 24 hours (may need to administer acetaminophen)
- Continue labs and I&O
- Anticipate increase in potassium
- Anticipate hypovolemia
- Document time re-warming is started and is finished

Re-Warming

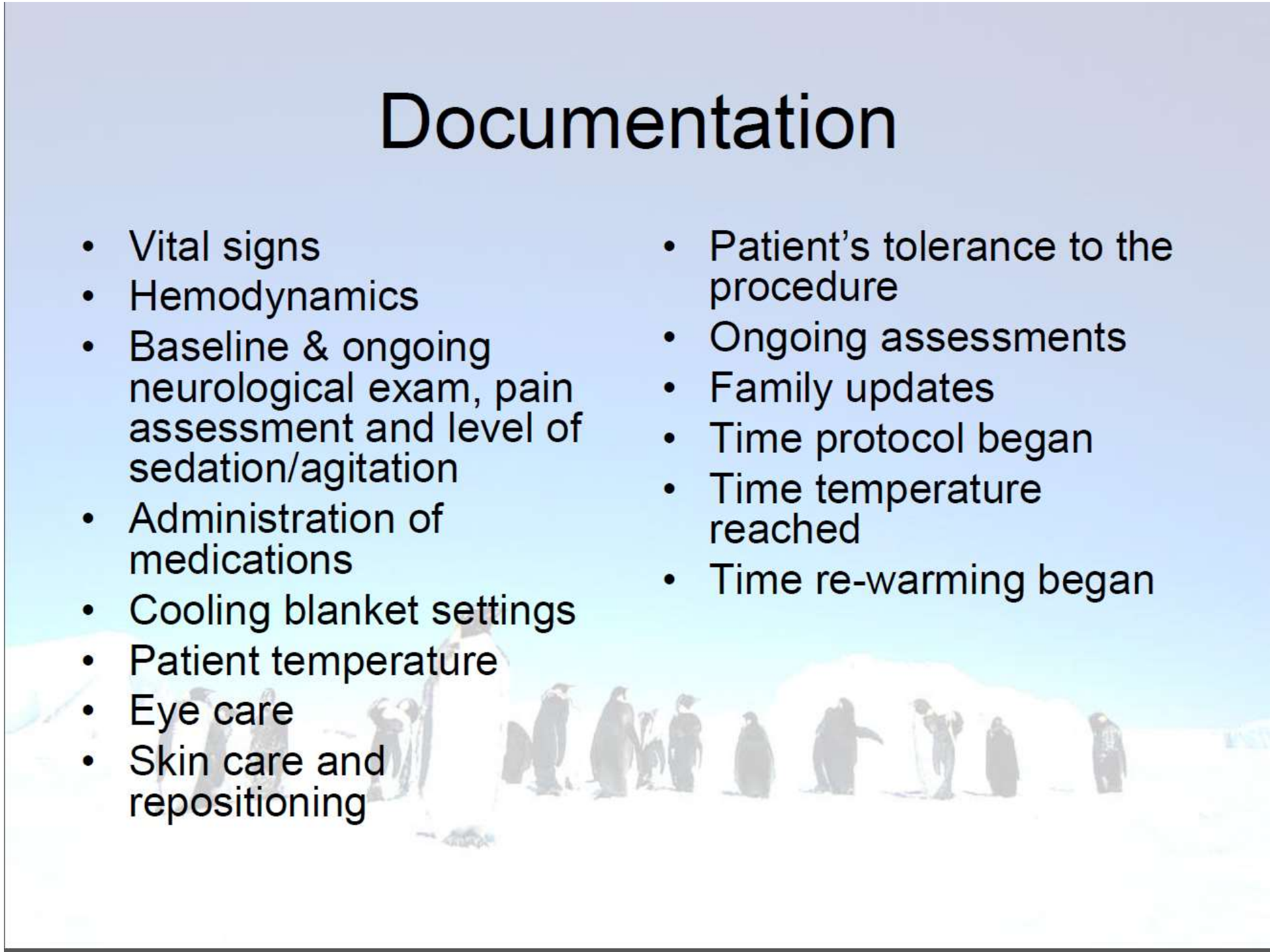
- Observe for shivering every hour
- If off neuromuscular blockers and shivering occurs in re-warming phase, apply warm blankets
- May have order for Demerol or Toradol for shivering during this phase

Patient & Family Education Support

- Explain the purpose of hypothermia and the need for pharmacologic paralysis
- Encourage the family to continue to talk to the patient
- Provide emotional support and answer questions
- Offer pastoral care support to the family
- Facilitate communication between the family and the physician

Documentation

- Vital signs
- Hemodynamics
- Baseline & ongoing neurological exam, pain assessment and level of sedation/agitation
- Administration of medications
- Cooling blanket settings
- Patient temperature
- Eye care
- Skin care and repositioning
- Patient's tolerance to the procedure
- Ongoing assessments
- Family updates
- Time protocol began
- Time temperature reached
- Time re-warming began



Prognosis

- Determination of neurological prognosis is unreliable before 72 hours after ROSC
- Recommended criteria for initiating DNR status and/or withdrawal of care

Additional Training:

- Physician TH Presentation by: Drs Bennett / Villarreal
- Practical Skills Education with ICU TH Mentor
- Review of BHSR Physician Orders (CERNER), and TH Policy /Procedures / Protocols
- Documentation of Competencies

For additional Information:

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