Hyperbaric Oxygen for the Non-Hyperbaric Practitioner

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OBJECTIVES

- Be able to distinguish advantages and disadvantages of types of HBO chambers
- Possible mechanism of HBO
- Awareness of the possible risks/complications of HBO
- How to help to prevent possible oxygen toxicity with HBO treatment

Multiplace Chamber Class A

ADVANTAGES OF MULTIPLACE CHAMBER

- Direct Access to the patient
  - Extension of the ICU
  - Emergencies such as pneumothorax doesn't require rapid decompression
- All equipment is in the chamber so there is no pressure differential

Access to Patient and Equipment

Disadvantages of Multiplace Chamber

- Large physical plant footprint
- High capitalization and operating costs
- High support requirements
- Care attendants are subject to pressurization

Monoplace Class B

Advantages of Monoplace Chamber

- Small physical space imprint
- Chamber can be adjacent to ICU
- Less technology and support requirements
- Critical patients can be safely treated
- Lower capitalization and operating costs
- No risk to support staff

Disadvantages of Monoplace Chamber

- No direct access to the patient
  - Would have to immediately decompress if pneumothorax for example
- Equipment is outside of the chamber
  - Have to regulate fluids during compression/decompression, etc

No direct access to the patient

Equipment Outside of Chamber

Mechanism of HBO

More than 90% of the oxygen consumed by the brain is used by the mitochondria to generate energy to maintain complicated synaptic functions (50%), ionic balance (25%), and protein synthesis (25%)

Mechanism of HBO

The first step in the cellular metabolism of glucose is the process of glycolysis, which occurs in cellular cytoplasm and generates two moles of adenosine triphosphate (ATP) and pyruvate per mole of glucose

Mechanism of HBO

With an adequate amount of oxygen present, pyruvate enters the mitochondria and is metabolized by the Krebs cycle and the electron transport chain producing a net of 38 ATP per mole of glucose

Mechanism of HBO

- The immediate reaction of the brain to injury is to actually increase its metabolic demands in response to the stress
- At the same time, there is a decrease in oxygen delivery to the brain due to decreased blood flow and swelling in the brain, i.e., a flow/metabolic mismatch

Mechanism of HBO

Effect of Pressure

Diffusion Gradient

Ambient Air

↓

Alveolar Air

↓

Arterial Blood

↓

Cerebral Capillaries

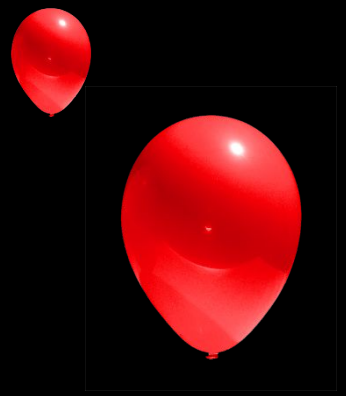
↓

Brain Cell Mitochondria

What is happening during the ascent/descent of HBO

- Boyle's Law: volume inverse to pressure
  - Increase pressure/compression = decrease in volume
  - Decrease pressure/decompression = increase in volume

- Example
  - During compression a balloon will shrink
  - During decompression a balloon will expand



Risks Associated With the HBO Dive

Barotrauma

- Ear
  - Pain or ruptured TM on compression
    - ✓ Circumvented by myringotomy
- Sinus cavities
  - Pain
    - ✓ Circumvented by slow compression/decompression and sedation

Risks Associated With the HBO Dive

Barotrauma

- Potential pneumothorax, especially during decompression
  - HBO_2 treatment has to be aborted and treatment rendered
- Lung volume (tidal volume) changes
  - Decreased during compression (descent)
  - Increased during decompression (ascent)
  - Particularly close attention to and adjustment of tidal volumes, peak inspiratory pressures, and respiratory rate is required during descent and ascent

Risks Associated With the HBO Dive

IV Fluids

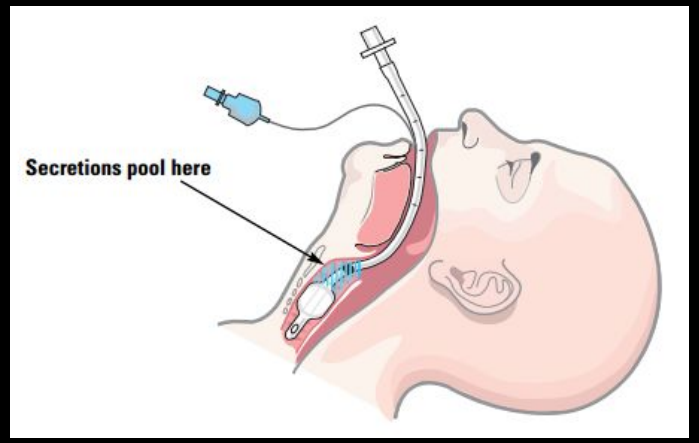
- Increase fluids/medications during compression
- Decrease fluids/medications during decompression
  - Need stiff tubing, bolus during compression, slow drips during decompression etc

Possible Oxygen Toxicity

- Cerebral: seizures, possible neurologic deterioration
- Prevention: initial intravenous loading of anticonvulsants and maintaining therapeutic blood levels for 7 days
- Pulmonary: Important issue because of the large surface area in the lung that is exposed to O_2
- Prevention: pulmonary monitoring of PaO_2/FiO_2 levels, PEEP requirements, chest x-ray

Procedure for Replacing cuff air with water / NS

1. Prepare both syringes: water & air
2. Suction patient
3. Suction above the cuff
4. On positive breath evacuate cuff and fill immediately with water/NS
5. Use minimal leak technique
6. Suction as needed and check breath sounds



Critical Issues Prior to HBO_2 Treatment (Particularly important before first treatment)

- P/F ratio $\geq$ 200
- PEEP $\leq$ 10 cm H_2O
- ICP controlled < 20 mmHg
- CPP > 60 mmHg
- SBP > 100 mmHg and relatively stable
- Spine fractures stabilized/treated
- Anticonvulsant level therapeutic
- Ventriculostomy functioning
- Licox $P_{bt}O_2$ monitor functioning
- **The HBO_2 environment must become an extension of the ICU environment**

CONCLUSIONS

- There are advantages and disadvantages to both types of HBO chambers
- HBO_2 appears to be working at the mitochondrial level to improve cerebral oxidative metabolism
- There are risks during compression and decompression especially with monoplace chamber
- There are potential oxygen toxicity with HBO treatments that can be prevented with good awareness