Care of Critically Ill Patients for Hyperbaric Oxygen Therapy

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The recompression treatment facilities was commissioned in Stonecutters Island (Ngong Shuen Chau) on 19 March 1994, prepared for the leaving of British Royal Navy.

The RTC was owned by the Hong Kong Government

- Medical use – Occupational Health Division, Labour Department
- Force Training – HK Police Force, Fire Services Department
- Operated by – Fire Services Department
- Maintained by – Electrical & Mechanical Services Department
Location of chamber

- Ngong Shuen Chau
  - Remote
  - Detached from hospital

- Ideally
  - Attached to acute hospital with various specialties
  - Best physically integrated into the ICU of that hospital
    - Minimize transport
    - Share same equipment between ICU and chamber
    - More continuity of care (important for critically-ill patients)
Year of 2010
Multi-place chamber (3 locks)

- Good for Critically-ill patients
  - Various interventions possible
Type of chamber in Ngong Shuen Chau

- >20 year-old
- Cylindrical with a door-step
- Small
  - One stretcher + 2 seats (treatment chamber)
- Lighting
- Temperature control
- Noise level
RTC overhaul or breakdown
RTC overhaul or breakdown
RTC overhaul or breakdown
RTC overhaul or breakdown
Benefits & Risks of HBOT in HK

Benefits
- Depends on indications

Risks
- Its location
- Type of chamber
- Equipment available
- Clinical team’s experience

*Diving and Hyperbaric Medicine 2015;45 March:50-56*
The Hong Kong Society of Critical Care Medicine Position Statement

Protocol of Hyperbaric Oxygen Therapy for critically ill patients in Hong Kong

Dr YAN Wing Wa on behalf of the HKSCCM

This Position Statement was endorsed by the HKSCCM Council in the 14th Council Meeting on 18 May 2010

Introduction

Hyperbaric oxygen (HBO) therapy is the breathing of 100% oxygen inside a treatment chamber at a pressure higher than one atmosphere absolute (1 ATA). In Hong Kong, up to 1994, recompression therapy was provided by the United Kingdom Royal Navy. After the Recompression Treatment Centre (RTC) was open in 1994 in Ngong Shuen Chau, HBO was operated by the Hong Kong Fire Services Department, with maintenance provided by the Electrical and Mechanical Services Department (EMSD), and medical supervision offered by the Occupational Medicine Division (OMD) of the Labour Department. There are some limitations of treating critically ill
Process of transfer to RTC

- An accurate assessment and preparation of patient before transport
- Effective liaison between referring and receiving staff
- Deployment of appropriately trained staff
- Availability of essential equipment and drugs
- Adequate monitoring for patient
- Appropriate infection control measures
- Proper documentation
Indications for HBO – Undersea and Hyperbaric Medical Society (UHMS)

- Air or Gas Embolism
- Carbon Monoxide Poisoning
- Clostridial Myositis and Myonecrosis (Gas Gangrene)
- Crush injury, Compartment Syndrome and Other Traumatic Ischemias
- Decompression Sickness
- Arterial Insufficiencies
- Severe Anemia
- Intracranial Abscess
- Necrotizing Soft Tissue Infections
- Osteomyelitis (Refractory)
- Delayed Radiation Injury (Soft Tissue and Bony Necrosis)
- Compromised Graft and Flaps
- Acute Thermal Burn Injury
- Idiopathic Sudden Sensorineural Hearing Loss (8 October 2011)
An accurate assessment and preparation of patient before transport

- **Indications**
- **Contraindications and potential complications**

  - **Respiratory**
    - Chronic obstructive lung disease (emphysema)
    - Asthma
    - Pneumothorax
  
  - **Otolaryngologic**
    - Chronic sinusitis, or history of ear surgery
  
  - **Ophthalmologic**
    - History of optic neuritis
  
  - **Neurologic**
    - Seizure disorder
  
  - ** Miscellaneous**
    - Pregnancy
  
  - **Drug therapy with**
    - e.g. doxorubicin, disulfiram, bleomycin or cisplatin
  
  - Claustrophobia or emotional unstable
Severe lung dysfunction

- May affect the effectiveness of HBO
  - Because of the high A-a oxygen gradient, adequate arterial O2 tension cannot be built up even with 100%O2 at 2ATA
  - e.g. compromised flaps need to be treated with PaO2 133-187kPa
- May develop desaturation during air break (breathing air inside hyperbaric chamber)
An accurate assessment and preparation of patient before transport to RTC

- Inform consent from patient
- Explain to relatives
- Myringotomy for comatose patients
  - Not routine in some centres
- Tracheal cuff filled with water/saline
- Simplify treatment / monitoring if possible
- Connect all tubes/drains to BSB
  - Chest drain to chest drain box/Hemlich valve with BSB
Effective liaison between referring and receiving staff

- Staff of OMD of Labour Department and Fire Services Department should be notified before transport
- Exact treatment time and duration of HBO
- Police escort is very helpful especially during rush hours (intubated patient)
Deployment of appropriately trained staff

- Experienced (with HBO therapy) doctor should accompany the patient throughout the whole procedure although he/she may not need to enter into the chamber
- Need to know how to operate the ventilator and monitor the tidal volume
Availability of essential equipment and drugs

- Only essential and hyperbaric compatible equipment are allowed to be used inside a chamber.
- Any item potentially inflammable are strictly prohibited.
- Collapsible bag intravenous bags instead of rigid plastic bags be used to avoid inadvertent gas embolism.
- Common drugs for resuscitation is available inside chamber / or prepared by staff outside chamber & pass into chamber via the air-lock.
Equipment available at RTC

- Physiological monitoring
  - Module inside chamber with monitor outside
  - Look through the port hole
  - Parameters
    - ECG, invasive or non-invasive BP, pulse oximetry, temperature
Boyle’s Law

\[ P_1 \times V_1 = P_2 \times V_2 \]

- At constant temperature the volume of a given mass of gas is inversely proportional to the absolute pressure

- Volume changes are greatest near the water surface
Treatment table for CO poisoning (Royal Navy table 60)
Total treatment duration is 90 mins
Type of chamber in Ngong Shuen Chau

- Medical gases (outlets different from HA hospitals)
  - Air
  - O2
  - × Helium
- Suction
  - Hand-grip pump
  - Foot-step pump
  - Venturi-suction unit (same as patient’s breathing gas)
Oxylog 1000 (gas driven, no battery) is to be used for ventilating patient in the hyperbaric chamber.

One may refer to the calibration table provided by the chamber.

Wright’s spirometer should be connected into the ventilator circuit for tidal volume monitor.

Expired gas from patient should be scavenged by attached tubing.

Not dump into the chamber
Ventilator connection diagram

- Dräger Oxylog 1000
- Ventilator tubing
- Air/oxygen outlet hose (inside chamber)
- To patient ET tube
- Wright’s spirometer
- To wall exhaust hose
## Calibration Table for Oxylog 1000 (No air mix)

<table>
<thead>
<tr>
<th>Frequency (breath/min)</th>
<th>MV (L)</th>
<th>Tidal Volume (L)</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>0 meter</td>
</tr>
<tr>
<td>20</td>
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<td></td>
<td>10</td>
<td>0.42</td>
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<tr>
<td></td>
<td>12</td>
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<td>8</td>
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<td>0.94</td>
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</table>

- **Green**: Most commonly used range (0.31L – 0.5L)
- **Yellow**: Less commonly used range (0.25L – 0.30L or 0.51L – 0.7 L)
- **Red**: Cautions range (≤0.24L or ≥0.71L)
Equipment available at RTC

- Fluid/drug infusion
  - Intermittent boluses
  - Drip or micro-drip set (collapsible bags, avoid rigid plastic with venting)
  - ✗ infusion or syringe pumps (not tested to be safely used inside chamber)
Equipment available at RTC

- No urgent blood gases and biochemistry testing available except POC testing under ambient atmospheric pressure

- ☒ Defibrillation
  - Should be done in “doors-open” state
Emergency Trolley at RTC
## Acute Treatment 2009 - 2011

<table>
<thead>
<tr>
<th></th>
<th>DCI</th>
<th>CO Poisoning</th>
<th>Others</th>
<th>Total no. of Patients</th>
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<tr>
<td>2009</td>
<td>7</td>
<td>6</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>2010</td>
<td>13 (1)</td>
<td>8</td>
<td>1</td>
<td>22</td>
</tr>
<tr>
<td>2011</td>
<td>9 (2)</td>
<td>11</td>
<td>2</td>
<td>22</td>
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Note: The figure in ( ) denotes the number of work-related cases.
# Proposed timeline:

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<tbody>
<tr>
<td>Phase 1: PYNEH</td>
<td></td>
<td>Site preparation</td>
<td>First HBOT Centre</td>
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<tr>
<td>Phase 2: KTH</td>
<td></td>
<td></td>
<td></td>
<td>KTH Development and Site Preparation</td>
<td></td>
<td></td>
<td></td>
<td>Second HBOT Centre</td>
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</table>
Year of 2010
Future Chamber

ICU Lock  Entry Lock  Main Lock
Conclusion

- Balance risk & benefit
  - Risk will be different between present state & future hospital based centre
  - Benefit will depend on further evidence on the indications of HBO therapy
Thank you for your attention.