



Care of Critically Ill Patients for Hyperbaric Oxygen Therapy

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Recompression Treatment Centre (RTC)

- 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)



九龍半島
KOWLOON PENINSULA

Year of 2010









Type of chamber in Ngong Shuen Chau

- 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



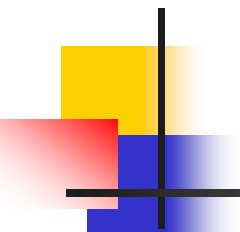
Benefits & Risks of HBOT in HK

- Benefits

- Depends on indications

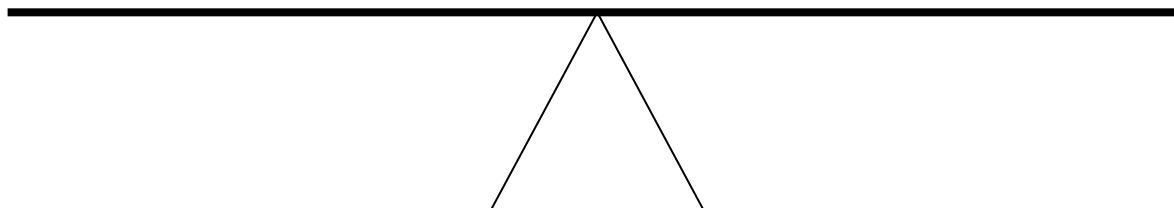
- Risks

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



Risk

Benefit





www.hkscm.org

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

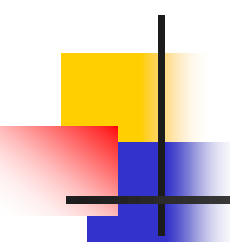
Introduction

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





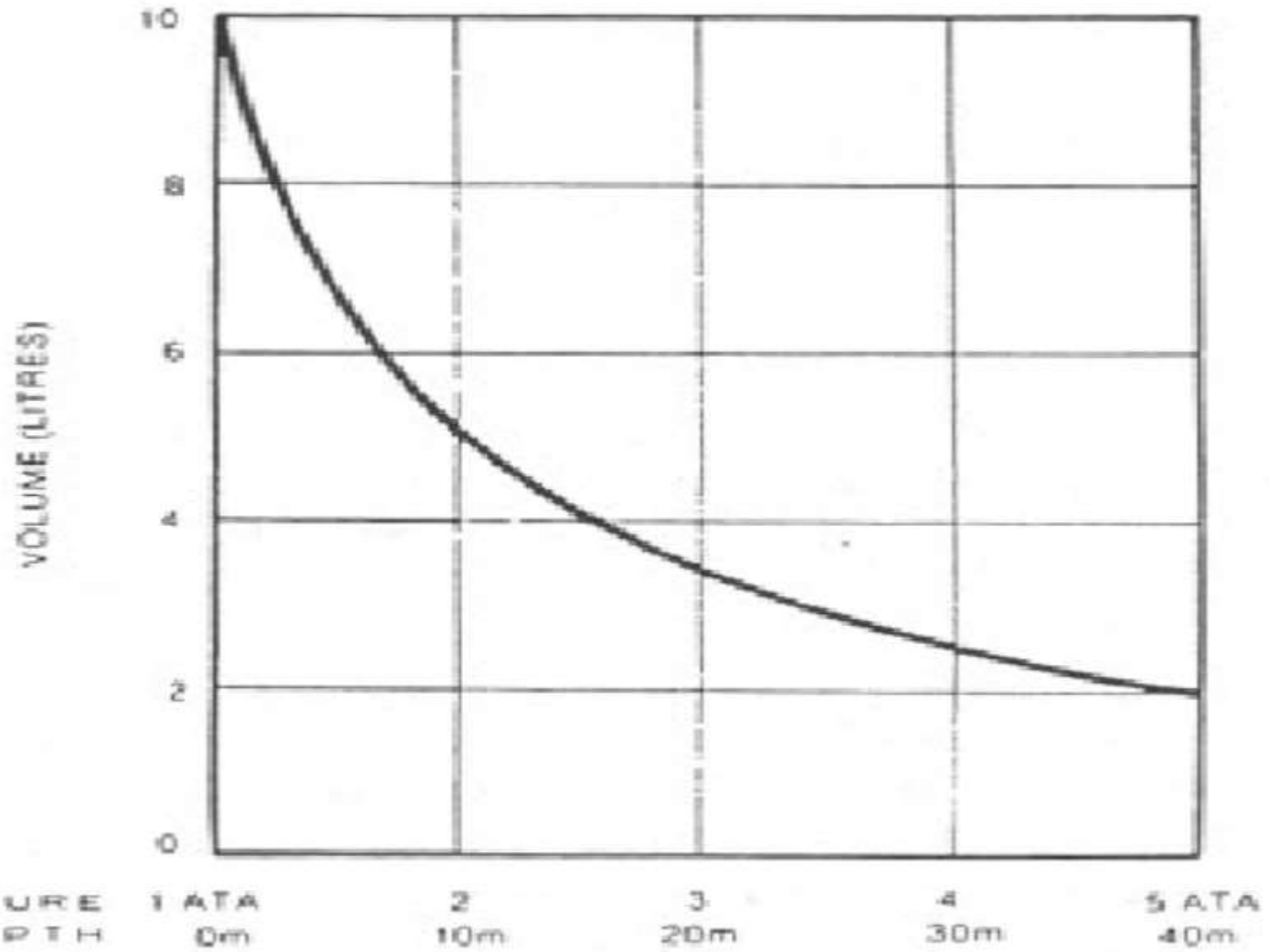




Boyle's Law

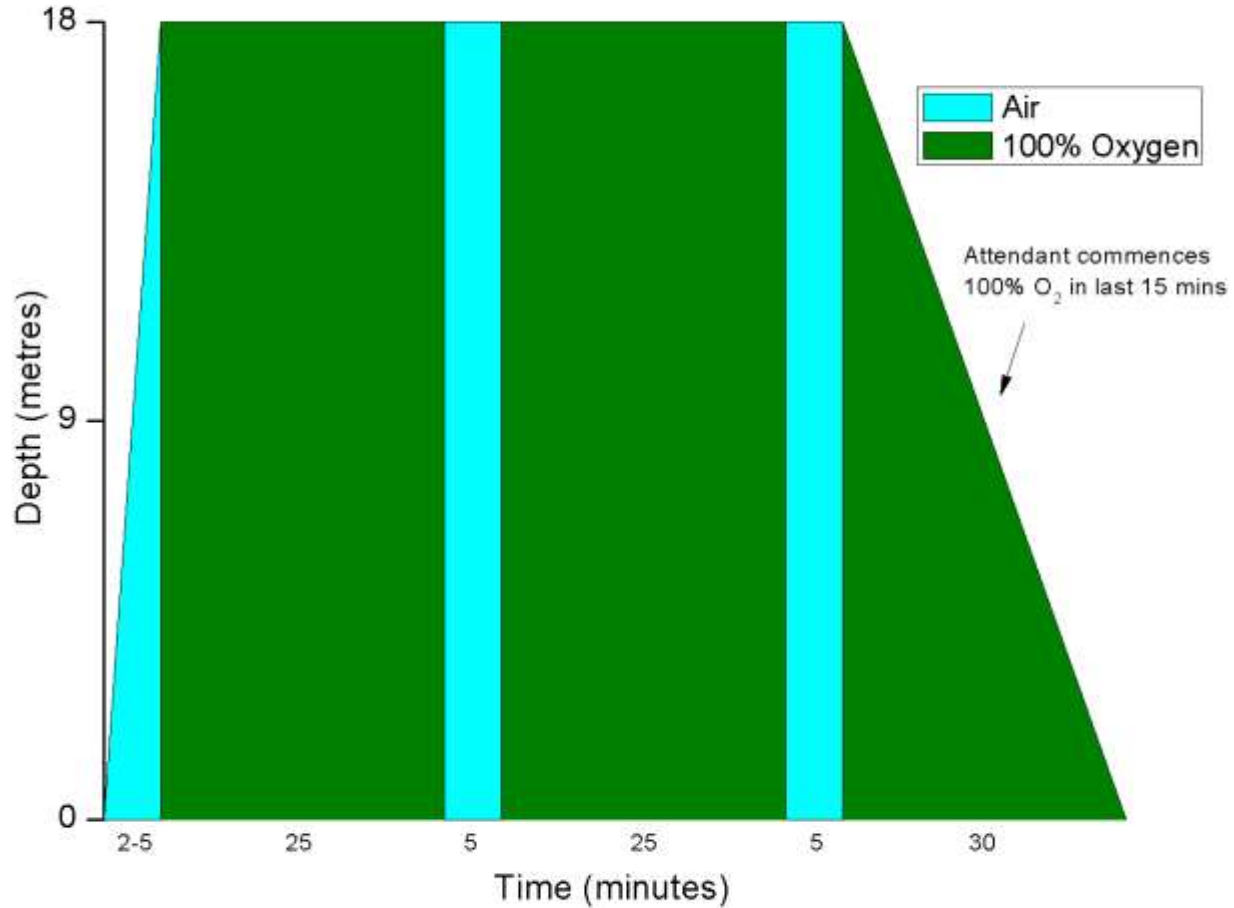
$$P_1 \times V_1 = P_2 \times V_2$$

- 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

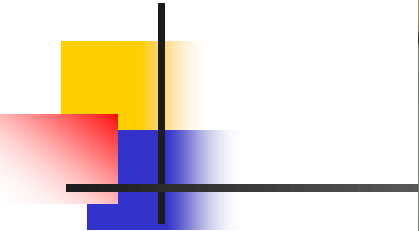




Type of chamber in Ngong Shuen Chau

- 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)







Ventilator

- 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

Dräger

Oxylog 1000



Control panel with two pairs of BNC connectors. The left pair is labeled with a lightning bolt symbol and a crossed-out lightning bolt symbol. The right pair is labeled 'Paw' with a downward arrow and an upward arrow symbol.

Psupply

Air Mix

Air Mix

Pmax knob with a scale from 25 to 55 mbar. A red heart icon is located below the knob.

Freq knob with a scale from 5 to 35 1/min. A red heart icon is located to the left of the knob.

MV knob with a scale from 3 to 20 L/min.

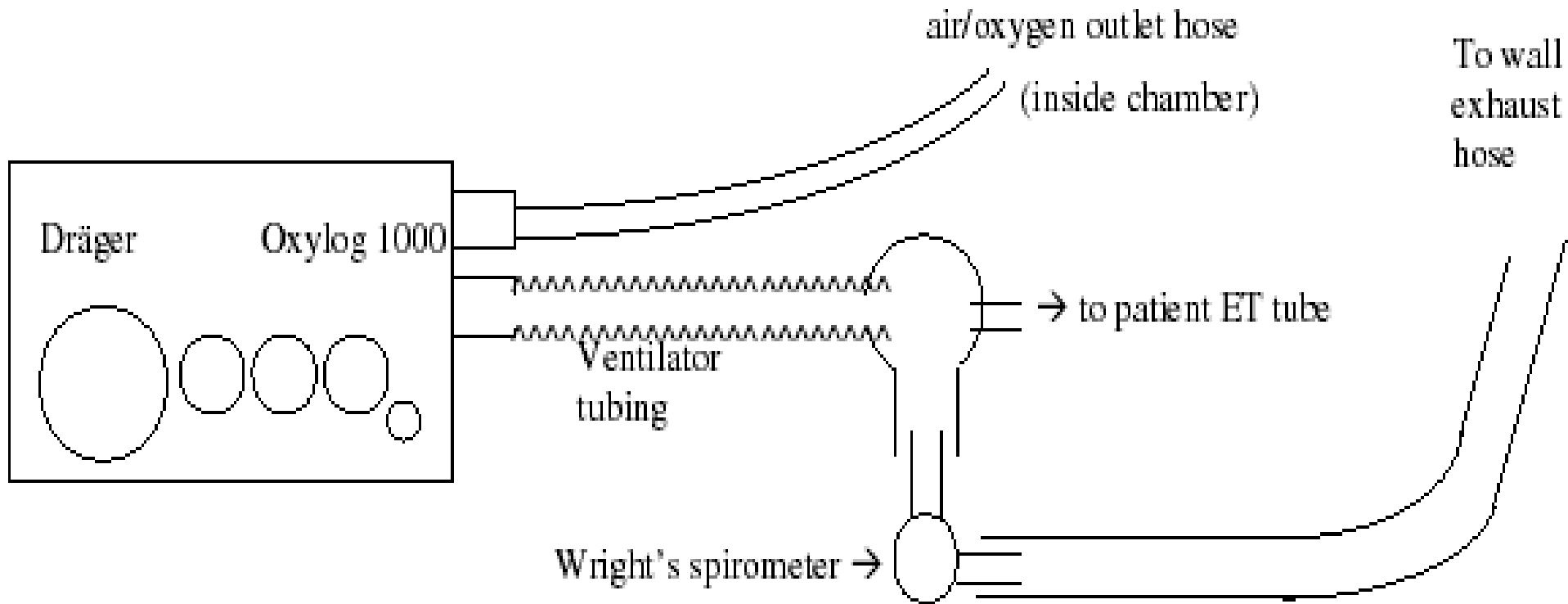
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Abridged instructions for use of the Oxylog 1000

1. Check that the device is operating correctly. If it is not, check the power supply and the battery level.
2. Connect the device to the patient's airway.
3. Set the flow rate to 20 L/min.
4. Set the pressure to 55 mbar.
5. Set the frequency to 10 1/min.
6. Set the MV to 3 L/min.
7. Check the device's output and the patient's response.
8. Record the data and the patient's response.


Ventilator Circuit


Ventilator connection diagram




Calibration Table for Oxylog 1000 (No air mix)

Frequency (breath/min)	MV (L)	Tidal Volume (L)			
		0 meter	6 meter	12 meter	18 meter
20	8	0.33	0.23	0.17	0.15
	10	0.42	0.28	0.21	0.17
	12	0.52	0.36	0.26	0.21
15	8	0.45	0.30	0.23	0.18
	10	0.58	0.37	0.29	0.23
	12	0.74	0.47	0.36	0.28
	15	0.98	0.62	0.46	0.35
	20		0.83	0.62	0.46
10	8	0.64	0.40	0.30	0.24
	10	0.80	0.50	0.37	0.30
	12	0.97	0.62	0.45	0.37
	15		0.81	0.59	0.47
	20			0.78	0.62
5	8	0.93	0.60	0.45	0.35
	10		0.77	0.56	0.45
	12		0.94	0.70	0.55
	15			0.90	0.71

 Most commonly used range (0.31L – 0.5L)

 Less commonly used range (0.25L – 0.30L or 0.51L – 0.7 L)

 Cautions range ($\leq 0.24L$ or $\geq 0.71L$)





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



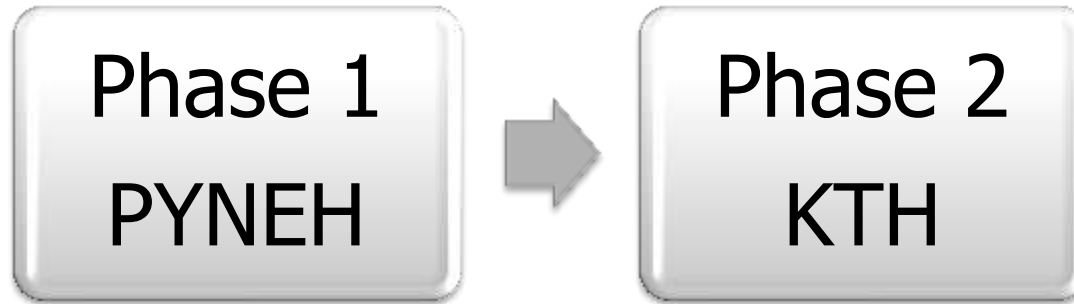


Acute Treatment 2009 -2011

	DCI	CO Poisoning	Others	Total no. of Patients
2009	7	6	1	14
2010	13 (1)	8	1	22
2011	9 (2)	11	2	22

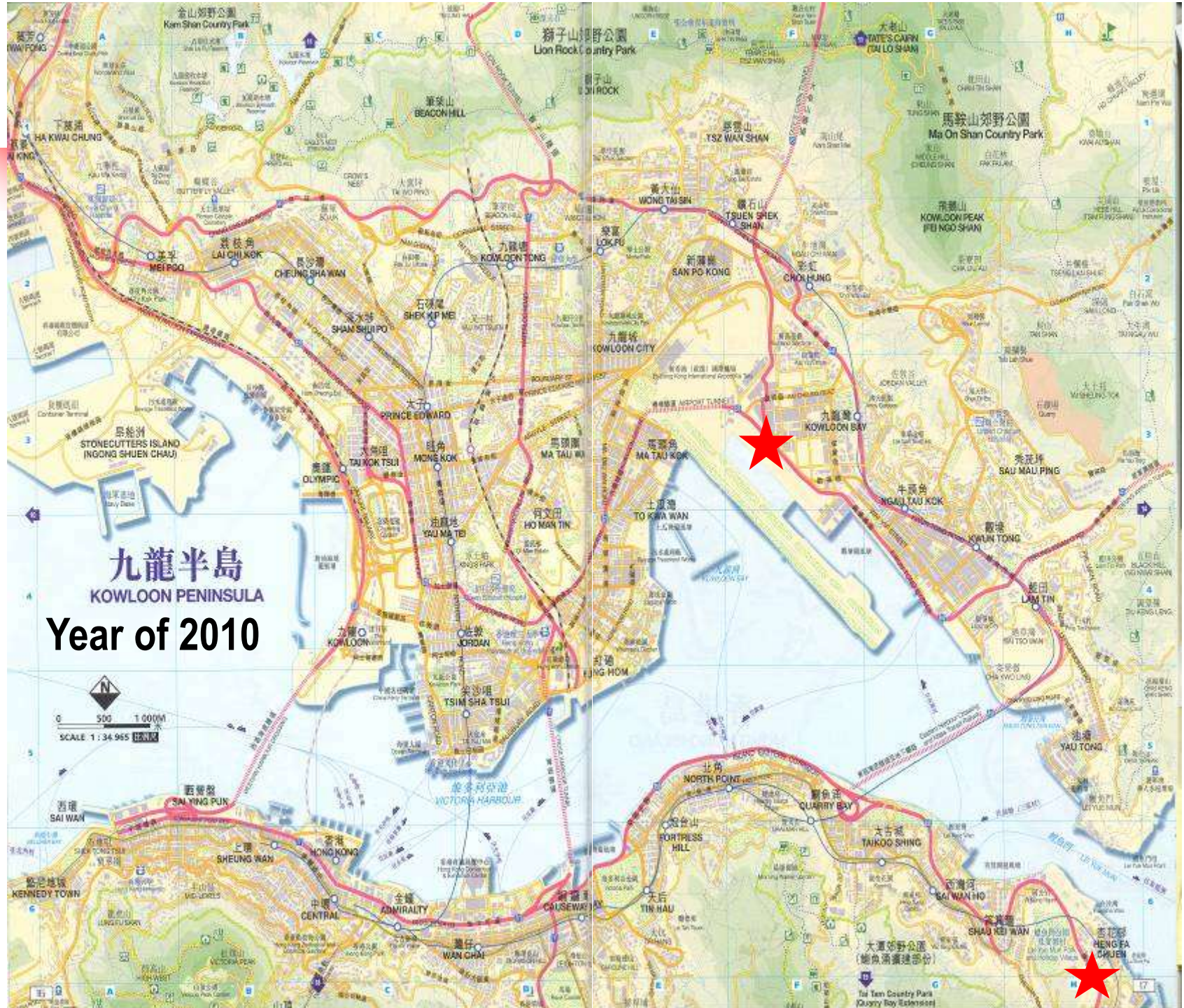
Note: The figure in () denotes the number of work-related case

Phased approach



Proposed timeline:

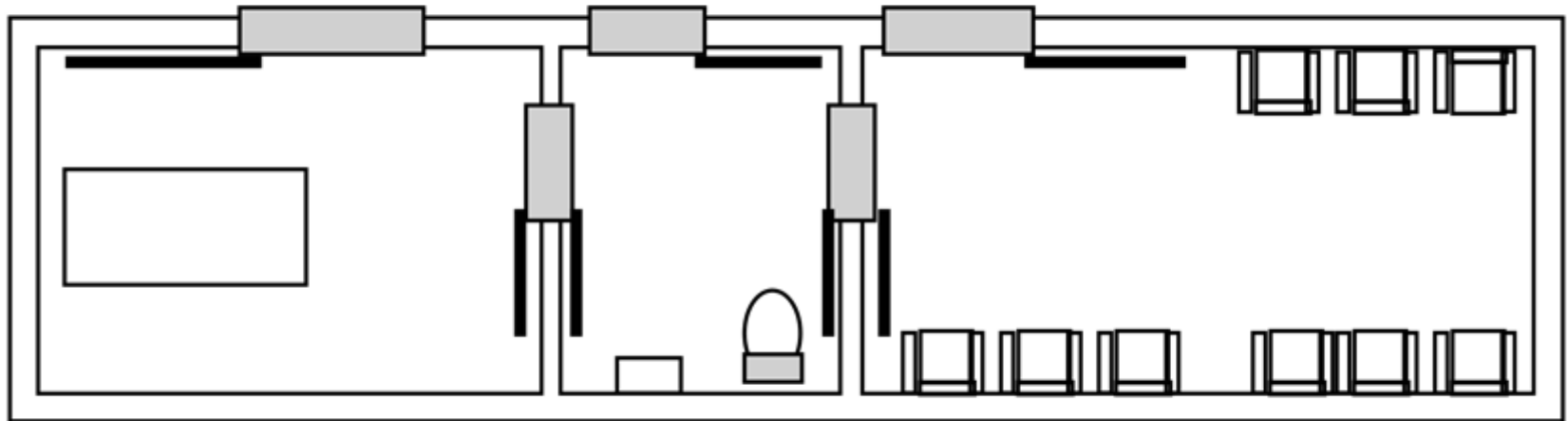
Year	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Phase 1: PYNEH		Site preparation	First HBOT Centre					
Phase 2: KTH				KTH Development and Site Preparation			Second HBOT Centre	



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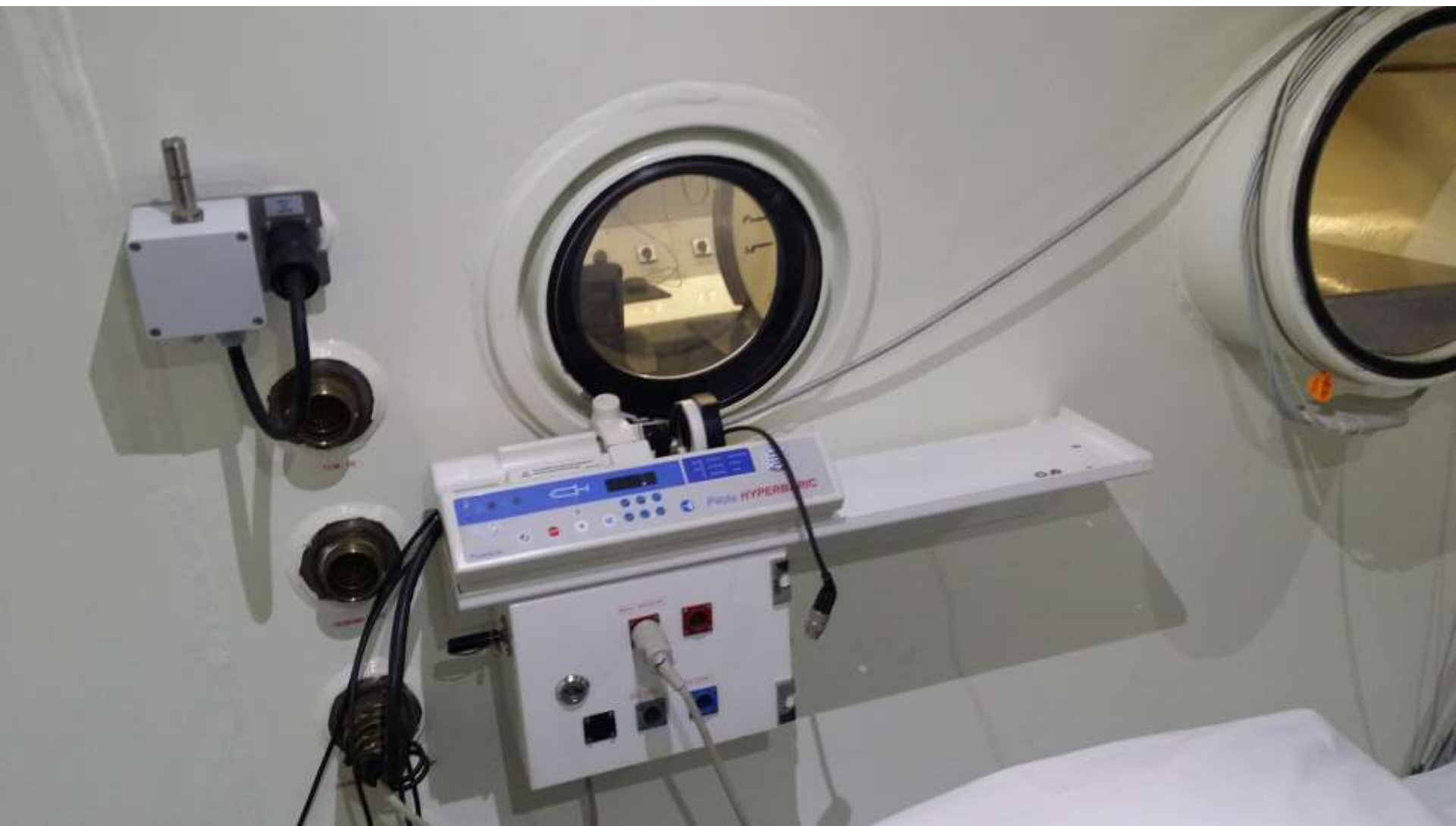
Future Chamber



ICU Lock

Entry Lock

Main Lock

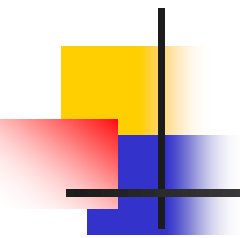






Conclusion

- 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.