Positional Statement on Fire Safety in Hyperbaric Chambers

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Approved by Hong Kong Society of Hyperbaric Medicine
Last update: 18 February 2025

Introduction

The recent incident involving a monoplace hyperbaric oxygen chamber in Michigan, which tragically resulted in the loss of a 5-year-old child and injuries to his mother, has raised significant public concern regarding the safety of hyperbaric chambers. While the investigation into the cause of this fire is ongoing, it is imperative that we, as the Hong Kong Society of Hyperbaric Medicine, address the associated risks and emphasize our unwavering commitment to the safety and effectiveness of hyperbaric oxygen therapy (HBOT) in Hong Kong.

Safety and Effectiveness Commitment

As an organization dedicated to the medical use of hyperbaric oxygen therapy, we prioritize safety above all else. Our practices adhere to the highest standards to ensure the well-being of patients undergoing treatment. Hyperbaric oxygen therapy, as defined by the Undersea and Hyperbaric Medical Society (UHMS), is a medical procedure that requires a physician's prescription and oversight.

All patients must be treated in hard-sided hyperbaric chambers that comply with appropriate pressure vessel standards (e.g., ASME-PVHO-1 and NFPA 99 code). Treatment pressures should exceed 2.0 ATA (202.65 kPa), with a typical treatment duration of 90-120 minutes per session. Patients should breathe medical-grade oxygen (with a purity of >99.0%) during treatment. [1]

Understanding Fire Risks

Among the various risks associated with HBOT, fires within hyperbaric chambers pose the most significant danger, often resulting in tragic outcomes. Historical data indicates that from 1923 to 2000, there were 32 fires in clinical hyperbaric chambers, leading to 81 fatalities. A further 11 fires between 2000 and 2021 resulted in 18 deaths. [2]

Fire risk is heightened in hyperbaric chambers due to increased oxygen partial pressure and concentration during treatment. Experience from all hyperbaric chamber fires has shown that survivors were only present in air-filled chambers, while no survivors emerged from oxygen-enriched environments where the oxygen content exceeded 28%. [3]

The primary causes of ignition in these incidents include electrostatic discharge, electric arcs or sparks, and smoking within the chamber. Additionally, the presence of flammable materials—such as canvas, wood, and certain plastics—exacerbates the fire risk. Notably, human skin can ignite readily in the presence of combustibles like oil and grease, underscoring the critical need to restrict potential ignition sources and burnable materials inside the chamber to the bare essentials. [3]

International Standards for Fire Prevention in Clinical Hyperbaric Chambers

In reference to fire protection in clinical hyperbaric chambers, there are numerous international standards and guidelines:

- The British Hyperbaric Association (2018). *Fire Safety Guidelines for Multiplace Hyperbaric Treatment Facilities*. UK. [4]
- European Standards (2013). *Hyperbaric Chambers – Specific Requirements for Fire Extinguishing Systems – Performance, Installation and Testing*. [5]
- National Fire Protection Association (2023). *NFPA 99 Health Care Facilities Code (2024 Ed.)*. [6]
- Australian/New Zealand Standards (2019). *Work in Compressed Air and Hyperbaric Facilities – Part 2: Hyperbaric Oxygen Facilities*. [7]

Incorporating international hyperbaric standards, we recognize the importance of establishing comprehensive fire prevention and safety measures in hyperbaric facilities. Key provisions include:

- **Elimination of Ignition Sources and Flammable Items:** All potential ignition sources and flammable items must be identified and prohibited from inside the chamber to ensure a safe environment. Additionally, there should be risk assessments for all in-chamber items, and each hyperbaric facility should have its own “go and no-go list.”
- **Oxygen Concentration Control:** The maximum allowable oxygen concentration in air-filled chambers should not exceed 23.5% by volume in Class A chambers, and oxygen concentration within the chamber should be continuously monitored to maintain safe oxygen levels.

- **Grounding:** Operation of hyperbaric chambers in an atmosphere containing more than 23.5% oxygen requires the patient to be grounded by providing a high-impedance conductive pathway in contact with the patient's skin.
- **Hyperbaric Facilities and Chamber Configuration:** The hyperbaric facilities and chamber systems (such as in-chamber power supply, overboard dumping system, emergency decompression valve, and deluge system) must be meticulously designed in compliance with established standards to address the unique risks associated with hyperbaric environments.
- **Administration:** Administrative, technical, and professional staff shall jointly develop the departmental safety policies and procedures for the hyperbaric facility. A hyperbaric safety coordinator shall be designated to establish procedures for the safe operation and maintenance of the hyperbaric facility, and be responsible for all hyperbaric equipment and operational safety requirements.
- **Maintenance:** All equipment used in the hyperbaric chamber should be routinely evaluated and well-maintained by certified engineering personnel and tested under pressure. All installations, tests, and maintenance logs shall be properly documented.
- **Staff Training:** All hyperbaric facility staff should be trained on the recognition of all potential hazards associated with the operation of a hyperbaric facility. Structural training for staff on fire safety protocols and emergency evacuation plans is essential to ensure preparedness in the event of a fire.
- **Coordination with Fire Brigade:** Regular fire drills should be held according to local legislation, and a contingency plan should be prepared with the local fire brigade (i.e., Fire Service Department in Hong Kong) to account for specific hazards and organize firefighting procedures.

By adhering to international standards, we aim to set a benchmark for practice in Hong Kong that prioritizes patient and staff safety.

Conclusion

The Hong Kong Society of Hyperbaric Medicine remains committed to the highest safety standards in hyperbaric oxygen therapy. We advocate for the establishment of a comprehensive standard of practice for hyperbaric medicine in Hong Kong. By promoting awareness and implementing robust safety measures, we can help prevent tragic incidents and ensure the continued efficacy of hyperbaric medicine in Hong Kong.

References

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