Hyperbaric Safety 2025: Class A Mishaps 2025

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Introduction

The IHA Presentation 2025 provides a critical and comprehensive examination of two Class A hyperbaric mishaps that occurred in the United States during 2025. A Class A Mishap is defined by any one or more of the following conditions: A fatality or permanent total disability of a patient, operator, or staff member as a direct result of the incident.

Both events resulted in fatalities and serve as defining moments in the continuing evolution of hyperbaric safety management. The presentation followed the technical evidence, environmental data, and procedural analysis to identify causal patterns and to frame strategies for risk mitigation. It highlights the persistent vulnerability of hyperbaric systems when electrostatic discharge, lithium-ion battery malfunction, and material selection errors coincide within oxygen-enriched atmospheres. This presentation discusses the incidents not only as tragedies but as case studies that reinforce the importance of procedural rigor and human factors awareness in hyperbaric operations.

The Troy, Michigan Incident

On January 31, 2025, a five-year-old pediatric patient died following a catastrophic fire in a monoplace hyperbaric oxygen chamber in Troy, Michigan. Subsequent investigation and video analysis revealed that the initiating event was a static discharge that ignited combustible materials inside the chamber. The absence of a grounding strap, excessive patient movement, failure to control humidity and the possible presence of synthetic materials, including polyester-based linens and pillow coverings, were identified as the primary contributing factors. The chamber was operating at two atmospheres absolute when the discharge occurred within 1.5 seconds the pressure within the reached 9.5 atmospheres absolute and breached the chamber door seal.

Due to excessive ventilation rate (225 liters/min), when considering the respiration and weight of the child, humidity within the chamber environment can be estimated to have been approximately 30 percent, well below the 45 to 60 percent range recommended for static suppression. This condition, combined with multiple patient movements—eleven position shifts documented within sixty-six seconds—created ideal circumstances for triboelectric charging.

Without a grounding strap, electrostatic accumulation reached a level capable of producing a discharge strong enough to ignite flammable material in the oxygen-enriched atmosphere.

The event stands as a stark reminder of how the convergence of human behavior, environmental parameters, and inadequate static control can culminate in tragedy. Over the past century, twenty-five documented hyperbaric chamber fires have occurred across monoplace and multiplace systems, emphasizing that while rare, such events are predictable and preventable when viewed through the lens of system design and procedural adherence.

The Lake Havasu City, Arizona Incident

On July 9, 2025, a second Class A event occurred in Lake Havasu City, Arizona, resulting in the death of a 43-year-old hyperbaric clinic owner. The investigation revealed the presence of seven electronic devices within the chamber, all containing lithium-ion batteries. The probable cause was determined to be thermal runaway originating from one or more of these devices, leading to an uncontrolled fire in an oxygen-enriched environment.

Thermal runaway represents the most hazardous failure mode of lithium-ion cells. The process involves internal short circuits, overcharging, or thermal exposure that initiates a rapid rise in temperature, causing electrolyte venting and ignition. Once the exothermic reaction begins, temperatures can exceed 600 degrees Celsius, and the release of gases such as oxygen, carbon monoxide, and hydrogen fluoride further increases the risk of explosion. In an environment with elevated oxygen concentration, combustion can propagate instantaneously.

Triggers for such failures are diverse, including mechanical damage, poor ventilation, aging cells, manufacturing defects, and even software errors that drive excessive current demand. The Lake Havasu City event reinforces the absolute necessity of prohibiting the introduction of unsealed or non-rated lithium-ion power sources into any pressurized oxygen system. It also highlights the broader issue of complacency in private hyperbaric practice and the need for uniform enforcement of safety codes across all facility types and venues.

Mechanisms of Static Electricity in HBOT

Static electricity within hyperbaric chambers originates from frictional contact between dissimilar materials in the triboelectric series. When garments, bedding, chamber padding, and operator clothing come into repeated contact and separation, electrons are exchanged, creating charge imbalances. Synthetic materials such as nylon, polyester, and acrylic exhibit the greatest propensity for charge separation. Patient movement amplifies this effect, especially in low-humidity environments where air conductivity is poor and electrostatic potential accumulates easily.

Inadequate grounding or the presence of non-conductive materials allows charge to build until it seeks a discharge path. Even minimal energy releases—less than a millijoule—can ignite lint, body oils, or cleaning residues in oxygen-rich conditions. The physics of this process are well understood and fully preventable through proper grounding, environmental conditioning, and control of material selection.

The hyperbaric environment, by design, magnifies the consequences of minor oversights. All materials entering a chamber can be considered fuel as part of the fire triangle. Acrylic enclosures, plasticized components, and modern textiles all show more of a tendency for static vulnerability. The elimination of synthetic fabrics, use of grounded patient garments, and verification of chamber potential equalization prior to pressurization represent essential steps in safe operation.

Statistical Context of Preventable Deaths

The presentation places hyperbaric-related fatalities in a broader public health perspective. Hyperbaric oxygen therapy accounts for approximately two deaths per decade, a number extraordinarily low compared to the 250,000 annual fatalities attributed to preventable hospital errors, 80,000 from drug overdoses, and over 42,000 from motor vehicle accidents. The rarity of hyperbaric fatalities does not diminish their importance. Each event represents a breach of procedural integrity in an environment where the physics of combustion and the limits of human vigilance intersect. The small number of incidents underscores the discipline's success in maintaining safety but also warns against complacency. In the high-oxygen, high-pressure world of HBOT, even the rarest event carries irreversible consequences.

Preventive Strategies for Static and Thermal Control

Effective prevention requires an integrated approach that combines environmental control, material management, human factors, and engineering safeguards. Every item entering a hyperbaric chamber should be assessed for compatibility, ensuring that clothing, bedding, and padding are static dissipative. Patients and chambers must be grounded prior to and during pressurization to maintain potential equilibrium. Humidity levels should be sustained above 45 percent whenever possible, depending on chamber ventilation rates and gas exchange systems. Patient movement should be minimized through behavioral control, positioning devices, and the presence of trained attendants or parents (independently grounded) in pediatric cases.

Equally vital is the prohibition of electronic devices entering the chamber. The risk presented by these devices cannot be mitigated through partial measures such as standby mode or wrapping. The hazard lies not only in the battery chemistry but in the unpredictable nature of internal failures that can escalate to ignition. Routine cleanliness of chambers must also be maintained to eliminate conductive dust or particulate residues that may create a path for electrical discharge.

Each preventive measure must be institutionalized through written policy, reinforced through training, and validated through inspection. Safety is not the result of isolated actions but of a structured system that consistently identifies and controls risks.

Structuring a Safe Therapeutic Hyperbaric Service

Establishing a safe and sustainable hyperbaric service requires integration of these principles into an organization-wide quality assurance system. Continuous monitoring of humidity, static potential and dissipation, and chamber maintenance must be paired with recurring staff training in material control, emergency procedures, and hazard recognition. Safety culture must be reinforced at every level of operation—from the medical director and safety officer to the attending technician. Compliance with NFPA 99, PVHO-1, and CGSB Z275 standards provides the regulatory framework, but genuine safety arises from the discipline of daily application. A hyperbaric facility that institutionalizes these practices will not only prevent recurrence of the tragedies witnessed in Troy and Lake Havasu City but also demonstrate the professional maturity necessary for the wider acceptance of hyperbaric medicine as a mainstream therapeutic modality.

References

1. Kindwall EP, Whelan HT, eds. Hyperbaric Medicine Practice. 3rd ed. Best Publishing Company; 2008.
2. Moon RE. Physiology and Medicine of Hyperbaric Oxygen Therapy. Elsevier; 2008.
3. National Fire Protection Association (NFPA). NFPA 99: Health Care Facilities Code. 2024 ed. Quincy, MA: NFPA; 2024.
4. American Society of Mechanical Engineers. PVHO-1: Pressure Vessels for Human Occupancy. ASME; 2023.
5. Canadian Standards Association. CSA Z275.1–23: Hyperbaric Facilities—Occupational Safety Code. Toronto: CSA Group; 2023.
6. U.S. Consumer Product Safety Commission. Lithium-Ion Battery Safety Technical Information Bulletin. Washington, DC; 2023.
7. NASA Technical Memorandum 104823. Hazardous Materials and Static Discharge Prevention in Confined Oxygen-Rich Environments. NASA White Sands Test Facility; 1993.
8. Thom SR, Neuman TS. Oxygen Toxicity and Reactive Species. In: Physiology and Medicine of Hyperbaric Oxygen Therapy. Elsevier; 2008.
9. U.S. National Transportation Safety Board. Fire in Hyperbaric Oxygen Chamber—Lauderdale-by-the-Sea, Florida, 2009. NTSB Report NTSB/HZM/10-01.
10. Fox TM. Static Suppression and Triboelectric Hazards in Hyperbaric Oxygen Therapy. ACHM Technical Bulletin; 2024.

11. International Hyperbaric Association (IHA). Hyperbaric Operational Safety Guidelines. IHA Press; 2025.
12. Perry Baromedical Corporation. Monoplace Operator Safety Manual—Model Sigma 40. Riviera Beach, FL; 2022.
13. Sechrist Industries. Technical Safety Bulletin: Static Dissipation and Patient Grounding in HBOT. Anaheim, CA; 2023.
14. Melamed Y, et al. Fire and Explosion Hazards in Hyperbaric Facilities: A 30-Year Review. Undersea Hyperb Med. 2016;43(5):511–522.
15. U.S. Department of Energy. Battery Safety Concerns in Oxygen-Enriched Environments. DOE Report No. BSC-22-041; 2022.
16. Crouch J. Triboelectric Series and Its Implications in Pressurized Medical Systems. IEEE Transactions on Industry Applications. 2019;55(2):1407–1415.
17. Fox TM. Risk Mitigation in Pediatric Monoplace Operations: Lessons from the Troy Fire. Hyperbaric Safety Review. 2025;1(1):1–