Hyperbaric Chamber Fires:
Lessons Learnt

Dick Clarke, CHT

Hyperbaric Chamber Fires

Lessons Learnt

Primary Training in Hyperbaric Medicine

Columbia, South Carolina

Factors Precipitating Chamber Fires

Absence of design/manufacturing codes; code non-compliance

Lack of a formal fire safety plan

Inadequate fire safety plan

Apparently adequate fire safety plan not adhered to

Unanticipated factors

Absence of design/manufacturing codes: code non-compliance

Steel monoplace at 2.4 ATA

air compressed; mask O2; inboard dump

no analyzer so unknown O2 concentration

Flash fire

structural integrity maintained

hot gases melted door seal, cut through concrete floor, blew out building windows

Cause of ignition: non-intrinsically safe communication system

Intrinsically safe

keeping level of electrical energy too low to cause ignition
thereby preventing sparks & keeping temperatures low

device designs that exclude oxygen
plus, purging device with inert gas

device strong enough to contain explosion

moving device outside hazardous (chamber) area

No chamber design/construction codes & standards in Peru
some such countries adopt authoritative standards

Lack of adequate operational safety procedures

no overboard O2 dump

unknown chamber O2 concentration

no pt. grounding

oil lubricated air compressor ? filtration

Monoplace Chamber Fire
Lima, Peru, 2006
Incident Report
Glenn J. Butler,
President & CEO §
R.W. "Bill" Hamilton, Ph.D
Hamilton Research
Michael W. Allen,
Senior Vice President – Operations & Safety †‡
* ELIMS Safety Committee Member
† Diving Equipment Manufacturers Committee Member
‡ IMM-PVHO & I Executive Member
Life Support Technologies group
306 White Plains Road, Tarrytown NY 10591
www.LifeSupportUSA.com

Lack of a formal fire safety plan

Lauderdale-by-the-Sea, Florida. May 2009

fire engulfed chamber & 2 occupants at 1.75 ATA O_2

~ 4 yo CP pt., 62 yo grandmother

~ his txs started 7 months earlier!

operator (trainee) didn't know procedure for emergent decompression

~ tried several times to open door while pressurized

both occupants succumbed

Vickers "clam shell" manufactured in 1967

Burn pattern again suggested internal speaker as source

Legal proceedings:

Adult "reached to adjust cushion, static discharge from her clothing jumped to earphone jack"

Adult "banged on chamber for five minutes to attract attention"

"Nobody was monitoring them and when fire started victims were required to scream and bang on glass (sic) dome to get the attention of a bystander who in turn notified staff of the fire, which caused a delay in decompressing the chamber and freeing the victims before the flash fire occurred. When police deputies arrived, the victims were still in the chamber and on fire"

Numerous pages of safety violations

Most damning, set up fictitious inspection company

"Certified Hyperbarics" *for federal facility certification application*

Medical Director & CHT *"exhibited gross lack of competency, gross inattention, criminal indifference to pt. safety"*

Both guilty of *"aggravated manslaughter of a child & manslaughter by reckless disregard of human life & safety of persons exposed to dangerous effects"*

Lack of a formal fire safety plan

Steel oxygen-filled monoplace chamber

single pt. fatality

attempted to smoke cigarette

Hospital admitted responsibility…

"We did not warn pt. that smoking or taking a lighter into the chamber could be dangerous"

Inadequate fire safety plan

Multiplace chamber Milan, Italy

personal clothes; synthetics/pockets

no pt. or IA checks…pockets

hood exhaust system disconnected

"improperly modified hood latex neck seals allowed O_2 to escape into pt. clothes making patients flammable cylinders"

chamber O_2 concentration commonly exceeded permissible limit

" O_2 monitor alarm manipulated"

Fire occurred during compression

"red flame explodes on screen, video goes black"

Water delude system activated...no water emitted

10 pts 1 nurse quickly succumbed

7/8/2021 10 patients and nurse die within seconds in hospital fire

10 patients and nurse die within seconds in hospital fire

Ibid, Nov 1, 1997, 00:00

Eleven people died within seconds yesterday when fire tore through an air-tight, high-pressure treatment chamber at Milan's Rizzoli Galeazzi hospital. The Milan prosecutor, Mr Francesco Saverio Borrelli, said the victims, 10 patients and a nurse, were either burned or asphyxiated.

Of those who died, eight were women. One was an elderly woman who had just checked into the state-subsidised private orthopedic hospital in the Milan suburb of Bruzzano.

The so-called "hyperbaric" chamber is a room where air pressure can be kept higher than normal or where a mix of oxygen and nitrogen can be administered. Such chambers are used to treat patients with deep-wound infections or divers recovering from the "bends".

"It is like a long tunnel that can hold 12 people," explained a member of the hospital staff.

Mr Borelli said a technician outside the chamber spotted a spark inside. "He immediately switched on the decompression and anti-fire systems. The flames were promptly extinguished," he said, but it was too late to save those inside.

The deputy prosecutor in charge of the investigation, Mr Francesco Pelo, said the fire was probably touched off by a metal object taken into the chamber by a patient. They were also looking into the possibility of an oxygen leak from oxygen masks installed in the chamber. An electrical fault was cited as another possible cause.

"The main hypothesis we are working on is that one of the patients had something metallic on him . . . The flames, which only lasted a very short time, took up all the oxygen in less than 30 seconds," he said.

A fire brigade official said the high oxygen content in the chamber would have made the process of combustion unstoppable once fire broke out.

Ten patients who were being treated in an adjoining room were unharmed.

https://www.independent.co.uk/news/10-patients-and-nurse-die-within-seconds-in-hospital-fire-1-1297775 1/2

Several newspaper accounts/Letter to Lancet

Fire lasted ~ 30 seconds

led some to believe it was extinguished vs burning itself out

Fire dept official; "fire unstoppable in high O_2 content"

inconsistent with previous water deluge experience

Initial official report

"Patients going into the chamber were checked by two doctors for flammable objects, but something must have slipped through"

Court proceedings

"A lady enters the hyperbaric chamber where she is to undergo treatment and brings with her an alcohol-based hand warmer, those with flame. From that hand warmer starts the fire that kills, after a slow agony, all the people who were inside."

Initial official report

"Automatic in-chamber fire-fighting system went into immediate action and the fire was put out within less than one minute"

Court proceedings

"The fire extinguishing system was not functioning as the tank that was supposed to contain the water was empty, the propellant compressed air cylinder had the tap closed and the water supply hose valve was closed. The hand shower inside the hyperbaric chamber, foreseen in the design phase, had not been installed."

Inadequate fire safety plan

Chamber operator opened 3-way valve to select BIBS O_2 source

selected >2,000 psig (non-reduced) option

reported hearing 'sizzling bacon' sound

Fire immediately erupted from chamber control panel

flame shot out 3 feet/1 meter, spraying molten stainless steel

penetrated steel filing cabinet igniting contents

chamber tech burned on face, arms, back, as she moved pt.

fire extinguished only when O2 supply secured

Facility sprinkler system & fire alarm activated

News Briefs

Oxygen Fire at Shands Teaching Hospital in Gainesville, FL

By David A. Desautels, MPA, RRT
Stephen D. Robers, PE
Glenn J. Barker

On Friday, June 8, 1990 a high-pressure, oxygen-supported fire occurred in the breathing supply system supplying the hyperbaric chamber at Shands Teaching Hospital in Gainesville, Florida, USA.

The fire did not involve the chamber, but was being prepared for an HBO treatment at the time. Only one technician was slightly injured.

The fire began in the system when a ball valve was activated by the technician in preparation for an upcoming HBO therapy.

The three-way ball valve was designed to select either a 50 pounds per square inch (PSIG) hospital oxygen supply source bounded to a maximum of 60 PSIG or a nominal 2,000 PSIG source from a bank of high-pressure (HP) cylinders through the three-way ball valve and on to a pressure reducing regulator station in the chamber control panel.

The operator high pressure oxygen bank was selected. He was at the time of the incident due to a problem with the primary hospital oxygen supply bounce gauge.

Stainless Steel Ball Valve

The stainless steel ball valve had been factory cleaned, lubricated and recommended for this oxygen service application. Ignition of the valve's Teflon seat material apparently occurred when the operator turned the valve from the "off" 90 degree mid-position to the HP degree "on" position. Ignition occurred at the 45 degree mid-point of the secondary oxygen supply to stream through the valve.

Upon hearing "sizzling bacon" the technician noted a metal like "sizzling bacon" and observed what appeared to be sparks emitting from the valve handle area.

Hearing that normal bacon was sizzling, the technician turned away and while feeling a pattern out of burns's way, unbolted the Fire alarm pull on the valve body.

Jolted, spraying herself and the area with molten Teflon and stainless steel.

The operator then allowed entire flash burns to her face, arms and back from the molten material. Meanwhile, the burning valve acted like a blow torch and burned through an adjacent steel file cabinet setting the paper contents afame.

The fire sprinkler system overstatured the oxygen-fed paper fire to the cabinet area until the oxygen supply was cut off so the sprinkler manifold outside the building a short time later.

Hyperbaric Medicine Center Dedicated to Dr. Jefferson C. Davis

The Hyperbaric Medicine Center at the University of Missouri-Columbia Medical Center was officially dedicated in the memory of Dr. Jefferson C. Davis, who was a member of the first graduating class of the medical school of the University of Missouri, Columbia in 1917.

Dr. Davis died on the 29th recipient of the University of Missouri Medical Alumni Organization Citation of Merit in Medicine.

At the time of his premature death he was a consultant in hyperbaric medicine of this institution, helping with the development of the new facility, which consists of a Sigma 13 chamber.

2nd International Meeting on High Pressure Biology

The Second International Meeting on High Pressure Biology was held in Toulon, France, August 28-31, 1990.

The meeting focused on the following areas: high pressure effects on molecular and cellular levels, high pressure effects on vertebrate and mammalian DPNA, gas effects, hydrostatic pressure, decompression at high pressure, and induction of pressure under pressure.

These well attended meetings were held at the Scripps Institute of Oceanic Service and the Center of Biological Research Station.

Its co-chairs, Drs. Drewes, Rima and Zumalo are to be complimented for bringing together such an interdisciplinary group of basic scientists, for the exciting and stimulating social functions and for the published Proceedings.

Agreement has been reached between the chairmen and Dr. Hugh Van Liew, editor of *Undersea Biomedical Research* (UBR), to publish the meeting's abstracts in an issue of UBR.

Chamber Fire Analyzed

By David A. Desautels, MPA, RRT,
Stephen D. Robers, PE and
Glenn J. Barker

[EDITOR'S NOTE: The initial report of the chamber fire reported in the Nov/Dec issue of PRESSURE, pp 18-19, was prepared to include the following improved information.]

Robers Engineering, Inc., a firm specializing in civil-military hyperbaric systems and fire safety, was called in to investigate the incident and to make recommendations for the Shands Hospital staff to improve fire safety-related improvements. Their investigation concluded that the most likely cause of ignition in the chamber was friction heating of the valve seating material in reaching 400 degrees of the Teflon material in the high pressure oxygen environment. Several fittings in the system showed evidence of significant "sand blasting" damage due to particle impacts. Cylinder manifold valves are known to be contaminated with particles which when entry of contaminants is likely to occur each time a new cylinder is connected to the manifold. Very often, particulates lodged in the oxygen cylinder valve during shipment and storage are the cause of ignition of valve seat material. Particles in the oxygen gas stream cannot contain over the oxygen supply manifold were inspected and the valves found to be contaminated with particles of metal, sand, and a carbonaceous film. Attempts to blow out these contaminants in the manifold valves failed to remove them completely. Not successful and such a procedure should not be considered a solution to valve contamination problems. It is recommended that manifold valves used in oxygen service be complimented for bringing together such an interdisciplinary group of basic scientists, for the exciting and stimulating social functions and for the published Proceedings.

Agreement has been reached between the chairmen and Dr. Hugh Van Liew, editor of *Undersea Biomedical Research* (UBR), to publish the meeting's abstracts in an issue of UBR.

Do not use ball valves for oxygen service at pressures greater than 125 PSIG per OSHA and ASME PVHO

safety guidelines.

Use slow opening type valve designs and large diameter piping to reduce oxygen velocities and to lessen the effects of rapid compression heating in the system.

Use pressure reducing regulators at 125 PSIG PSIG. Rapid oxygen starts at the primary oxygen supply. This will minimize the system contamination normally associated with the "bottom of the tank" high pressure oxygen cylinder manifold systems.

High pressure manifolds remain the best choice for a secondary (warm oxygen supply). However, it is prudent to assume that cylinder valves are contaminated until it is proven that they are not contaminated. Contamination can be expected from the factory with valve connections damage in addition to the steel safety caps to prevent contamination during shipment and storage.

An oxygen service particulate filter should be placed in the system downstream of the primary oxygen supply valve to prevent damage, loss of pressure control, and an accumulation of particulate contaminants in the system downstream.

Misc. Courses

[EDITOR'S NOTE: The courses listed cover topics of possible interest to readers of PRESSURE. Some courses are sponsored by the UHMS Education Committee and are not sponsored by the UHMS.]

Date: Feb 25-Mar. 1, Mar 12-15, Sep. 9-13, Nov. 4-8
Title: Hyperbaric Medicine: An Orientation Course
Director: George B. Hunt, M.D.
Site: Long Beach, California
CME Credits: 36 hours, category 1, 30 CEU contact hours
Contact: Cecilia Lopez, Long Beach Memorial Medical Center, POB 1428, Long Beach, CA 90801-1428; (213) 591-3013.

Date: Apr. 27
Title: Topics in Hyperbaric Medical Research Symposium: Microbial Adaptation to Oxidant Stress
Site: Boston, Massachusetts
CME Credits: 6.5 hours, category 1, AMA, 6.5 CTUs
Contact: Teja Joseph Cassin, Dir. of Ad. and Hyperbaric Physiology, Rm. 0375, AFIP, Washington, DC 20306-6000; (202) 576-2860.

Date: April 29-30, May 1-3
Title: Hyperbaric Orientation
Site: Baton Rouge, Louisiana
CME Credit: Physicians, 40 hours, category 1; Respiratory Therapists, 40 hours
Contact: Suzanne Warner, Hyperbaric Medicine Dept., Our Lady of the Lake RMC, 9777 Bluebonnet Blvd., Suite 114, Baton Rouge, LA 70810; (504) 765-6076.

"Likely cause...high-velocity particle impacts"

ignited valve's Teflon seating & seal material

several fittings significant for "sand blasting" appearance

likely source of particles...HP O_2 cylinder valves & piping

Auto-ignition temperature of valve seating 400-700 F/200-370 C

particle friction heating in HP O_2 exceeds 1,600 F / 870 C

Lessons learned-safety standard failures

protect disconnected oxygen piping

oxygen piping "cleaned for oxygen service"

HP oxygen reduced at source

quarter turn valves contraindicated

filtration at source/prior to reducing regulator

larger diameter piping reduces oxygen velocity/related heating

Apparently adequate fire safety plan not adhered to

Istanbul University Medical Center

Multiplace chamber fire July 1998

3 fatalities: 2 divers, 1 physician

Latter stages extended USN TT 6

Chamber O_2 atmosphere not monitored nor routinely flushed
one diver/pt. using mask with overboard exhaust, second using hood with inboard exhaust

Two "lightsaber-like" oxygen flames seen emitting (via viewport)
spontaneous ignition within regulators

Chamber operator did not/could not activate water deluge
Internal fire extinguisher not activated
Flames only died out when oxygen system exhausted

Relief valves lifted (10 ATA)

Inadequate system maintenance; particularly O_2 delivery system cleanliness

Operational practices inconsistent with recognized standard of care

Physician entered chamber with cigarette lighter

"In all incidents I have encountered in my 30-year hyperbaric practice, the people who accidently put a lighter or mobile phone inside are inside attendants and doctors, because patients are checked before each entrance"

Inadequate/non-existent emergency drills

Apparently adequate fire safety plan not adhered to

Steel oxygen-filled multiplace chamber

animal pt. fatality

chamber operator fatality

Patient treatment #5 underway

horse unsettled; kicking out

dislodged protective padding overlying steel hull

'massive spark' & flames per CCTV

urgent decompression initiated

12004699

REPORT NUMBER

Marion County Sheriff's Office

INCIDENT REPORT

NARRATIVE

REPORTED BY: 4410 HAWKING, JAMES REPORT FILED: 03/10/2012

ON 02/10/12, I RESPONDED TO THE INCIDENT LOCATION AND ARRIVED AT APPROXIMATELY 1217 HOURS. UPON ARRIVAL, I MADE CONTACT WITH LIEUTENANT TRAVIS BLACKBURN, OWENSVILLE VOL. FIRE RESCUE AND HE ADVISED ME OF THE INCIDENT AND WHAT HAD TAKEN PLACE.

I THEN MADE CONTACT WITH THE MANAGER OF THE FACILITY, REPORTEE LEONORA BYRNE, AND I OBTAINED HER PHONE NUMBER. SHE ADVISED ME THE HUSBAND OF ONE OF THE VICTIMS WAS ON SCENE AND HE WAS ALSO A VICTIM. SHE ADVISED HE WAS OUT TO ME AS HE WAS STANDING NEAR THE FENCE LINE. SHE ALSO SUPPLIED ME WITH A NAME OF SORCHA MONELEY, WHO HAD BEEN INJURED IN THE EXPLOSION AND SHE GAVE ME THE NAME OF CHARLOTTE CLAWORTH AND HER PHONE NUMBER, ADVISING SHE WAS GOING TO SHANDS. IN AN ATTEMPT TO MAKE CONTACT WITH SORCHA MONELEY, TO SEE IF HER FAMILY MEMBERS COULD BE REACHED.

I THEN CONTACTED LIEUTENANT OLDBERG, WHO WAS ON SCENE, THE DISTRICT COMMANDER, ALONG WITH SERGEANT MCGUIRE. I WAS ADVISED TO START A CRIME SCENE LOG AND TO ASK THOSE WHO WERE NOT PARTICIPATING IN AN OFFICIAL CAPACITY IN THE AREA OF THE ACCIDENT, TO REMOVE THEMSELVES FROM THE AREA THAT HAD BEEN TAPED OFF.

I INITIATED A CRIME SCENE LOG AT 1038 HOURS. I THEN TOOK ALL PERSONS INFORMATION INSIDE THE AREA AND ASKED THOSE WHO WERE NOT THERE IN AN OFFICIAL CAPACITY TO LEAVE THE AREA. LIEUTENANT OLDBERG AND DETECTIVE SERGEANT SPICKY WAS ON SCENE, ALONG WITH DETECTIVE CLINT SMITH AND DETECTIVE RHONDA STROUP. I WAS ADVISED DETECTIVE STROUP WAS THE LEAD DETECTIVE ON THE INCIDENT AND AT THAT TIME, I TOOK THE POSITION OF MONITORING THE CRIME SCENE AREA AND THE CRIME SCENE LOG.

DURING THAT TIME, AGENTS FROM THE STATE FIRE MARSHAL'S DEPARTMENT ARRIVED ON SCENE, ALONG WITH THE FIRE DEPARTMENT DIVISION CHIEFS.

CRISIS INTERVENTION SPECIALIST (CIS) CINDY TURNER HAD ALSO ARRIVED ON SCENE TO ASSIST. JONATHAN SCOTT WITH THE MEDICAL EXAMINER'S OFFICE ARRIVED ON SCENE TO CONDUCT HIS INVESTIGATION.

A REPRESENTATIVE WITH OSHA ARRIVED ON SCENE TO CONDUCT HIS INVESTIGATION. AN INVESTIGATOR WITH ALCOHOL, TOBACCO AND FIREARMS, JEFF BROWN, ARRIVED ON SCENE, ALONG WITH DWANE KRUEGER FIELD EVIDENCE TECHNICIAN LANCASTER ID 5414, WAS ALSO ON SCENE DURING THE INVESTIGATION AND WAYNE WELLS, WITH THE MEDICAL EXAMINER'S OFFICE, ALSO ARRIVED ON SCENE.

THE INVESTIGATION WAS CONDUCTED THROUGH THE JOINT OPERATION OF ALL AGENCIES. AT THE CONCLUSION OF THE INVESTIGATION, THE BODY OF THE DECEDENT

Assistant ran to alert fire service; heard two explosions

first smaller, followed in ~1 second by massive one, as chamber exploded

sound reported to have been heard several miles away

piece of chamber went through apartment window > 2 miles away

Operator (29 yo) died immediately; blunt force trauma/thermal injuries

remains found buried under chamber debris

Assistant/trainee suffered multi-trauma, including severe head injuries

evacuated to regional trauma center; survived

Horse remained shod (steel)

Not sedated

His coat contained oil-based lotion

not washed with approved soap per FSP

No formal hyperbaric safety training

Authoritative codes re animal chamber construction
guided but not certified per human standards?

Formal training in hyperbaric technology/safety

Water deluge system?

Methane gas detector-chamber flushing issue?
becomes explosive 5-17% range in air...? HBO
loudest explosions >10% in air...? HBO

Year	Type Chamber	Fire/Explosion	Cause	Fire fighting	Severity of the patients (Full body burns)
1967	Monoplace (O_2 compressed)	Fire	Ignition, charcoal pocket warmer	Unknown	1 patient died
1989	Monoplace (O_2 compressed)	Fire	Ignition, Platinum catalysis warmers	Fire extinguisher	1 patient died
1992	Monoplace (O_2 compressed)	Fire	Ignition, Platinum catalysis warmers	Fire extinguisher	1 patient died
1996	Monoplace ($O2$ compressed)	Fire and Explosion	Ignition, Disposable pocket warmer	Non	3 died (1 patient / 2 others)

Apparently adequate fire safety plan not adhered to

THE WORLD AS IT IS

CHAMBER FAILURE

Key Words
Fire, hyperbaric facilities, hyperbaric oxygen, treatment

The Incident

On February 28th 1996 at 1930 (in the first hour of a Saturday night) a fire occurred in a hyperbaric chamber the hyperbaric units of the world. There had been an apparent explosion associated with a monoplace chamber. Three patients died and two other patients had severe, and seriously injured within.

Professor Hideo Takahashi, president of the Japan Hyperbaric Society, and Head of Hyperbaric Medicine at Nagoya University, gave a special presentation on this tragic incident at the Fifth Pacific Hyperbaric Medicine Society Scientific meeting, at Anthrage, Alaska, in June 1996. This is a report of that presentation.

A 76 year old man was undergoing hyperbaric treatment for the chronic results of a brain abscess. He was being treated in a single man chamber pressurised with hyperbaric oxygen with a total treatment duration of 2 hours and had been accepted for hyperbaric oxygen therapy.

Initially, the treatment was uneventful and the patient complained of a bad cold. Medication was given, and the operation of the hyperbaric oxygen chamber was suspended. The patient was 45 minutes into a treatment at 2.5 ATA when the fire started.

Initially, an instrument was ignitured than all environmental and personal clothes. Mr. Kawai, an

References

1 Ignition 2511 and Downdrapper 1. The diabetic question. Acta Chirur 1995; Jan/Feb 12-15
2 Neptune Smith P. Hud Sociogr. SPUMS J 1995; 25(1) 1-3
3 Edwards C, Lowry C and Pontedilice J. Firing and Subsequent Medicine. 3rd edition. Butterworth-Heinemann, 1992.

Dr Cas Taylorsch, who was one of the founders and the first President of SPUMS, is Director of the Diving Medical Centre, 1 Ocean Beach Highway, 31 Leonards, New South Wales 2065, Australia.

There were three metoplace chambers in the unit, a 1980 Gorman, a 1990 Sanshine, and a 1995 Sanshine.

At the time of the successive three were patients at the unit, the staff had been trained in the procedures for moving the chambers, and observing the patients. At the time of the problem nobody was looking at the particular chamber. The patient was being treated by a nurse who was attending to a visiting doctor at the door of the room. The other was caring for a second patient in another monoplace chamber, and was unaware of the problem in the first. The 76 year old male in the chamber was severely burned. A bedside blow off was and and killed his 70 year old wife who was in the chamber. Two other patients died, and three others, from a living and other and two other people were slightly injured.

There were five (and the external fire extinguishers were not activated. There was evidence of an intense fire within the chamber, and the chamber was found to be folded in the way in which it was designed to fold. Both the safety relief valve (instrument) and there was evidence of a blow out of the safety relief valve. Evidence that could not accommodate an explosive force.

The oxygen supply ceased immediately with the explosion and there was no subsequent fire within the unit. The windows of the room were blown out, so were light fittings, and the door of the ceiling was dislodged.

Initial statement released by hospital was that all recommended safety procedures were carried out

Oxer H. SPUMS Journal 1996;26(4)

NBS Monthly Safety Notice

January 2002 National Baromedical Services, Inc.

Importance of Optimizing Chamber Gas Flow

In this notice, attention is focused on the importance of being fully and constantly cognizant of the state of gas flow through the chamber.

Background

The Sechrist 3300B monoplace hyperbaric chamber operates under a state of constant gas (oxygen) flow. Flow can be adjusted via a control valve located within the oxygen exhaust assembly. In the "closed" position the control valve permits approximately 340 lpm of flow. By design, and to avoid a potentially dangerous condition involving CO_2, flow can be completely stopped. In the fully open position, flow peaks at approximately 400 lpm. Adjustment of the control valve between these two extremes provides a corresponding flow volume ranging between 340 and 400 lpm.

This constant flow of gas serves to eliminate metabolic waste gases and provides a useful source of temperature control for the patient. Higher flow rates act as a cooling mechanism, lower flow rates reduce the cooling effect.

However, there are additional aspects to flow control, aspects that have important patient and facility safety implications.

The Issue

The principal source of oxygen for chamber compression, and constant flow, is the hospital's bulk liquid oxygen (LOX) system. This oxygen is stored in a supercooled and liquefied form. As it is withdrawn on demand, it is the hospital's *responsibility* to vaporize back to usable gas, via an associated vaporizing system. Having boiled off from a liquid, this resulting gas is essentially dry. It contains little to no moisture.

While a dry gas has the benefit of minimizing corrosive damage to system valving and piping, it has potentially adverse effects on hyperbaric safety. A dryer atmosphere promotes a greater accumulation of static electricity. A resulting static electrical discharge may generate sufficient energy to cause ignition of volatile substances (hydrocarbon based oils and lotions, alcohol-prepped materials, hydrocarbon contaminated air, etc.).

Key Operational Issues

1) Under routine operations, as the rate of gas flow through the chamber is decreased the chamber atmosphere's relative humidity increases. This effect is the result of a greater accumulation of the patient's evaporative moisture loss within the chamber. This is a good thing.

2) If the patient complains of being cool, slow the rate of oxygen flow. Don't provide additional blankets. This is all too frequently the action taken, yet it represents an increasing safety hazard. Should a fire occur within the chamber, more fuel is available. This could represent the difference between a fire entirely contained within the chamber versus a fire that results in catastrophic failure of the chamber, and potential damage to the entire facility, and its staff.

3) If a patient complains of being too warm:
   i. Cover them with a sheet rather than a blanket.
   ii. Compress the chamber at a slow rate of descent, in order to limit the effect of compression on heat production.
   iii. Titrate chamber flow increases rate for optimal comfort, rather than upping to the highest setting, if t, and is above prove insufficient.
   iv. Maintain the hyperbaric facility temperature within a range of 68-72°F.

4) If a patient complains of being too cold:
   i. Close the exhaust valve.
   ii. If this isn't sufficient, switch the sheet out for a blanket.

5) Get into the habit of observing the oxygen flow setting upon arrival of the ordered treatment pressure. Don't find yourself in a position where a treatment is underway, and you do not know precisely the flow setting.

Bottom Line

Know the flow rate at all times. Optimize it for patient comfort.

Reading Assignment

Wood, Jill. ***Static Electricity.*** *Hyperbaric Facility Safety: A Practical Guide*, ed Workman, T. 1999:323-334

Inadequate fire safety plan

One of several chambers Naval Hospital Central Jakarta, Indonesia

Fire & "explosion" > 4 deaths

3 pts. 1 physician

room filled with smoke > several occupants hospitalized (2 remained so at 7 days)

Operator…

"tried using water deluge system but too late"

"failed to activate deluge system"

"deluge system inoperable"

"deluge system activated but inadequate to extinguish flames"

Hospital declared…

"It had complied with strict operating procedures"

NEWS NATIONAL

Fire kills 4 inside hyperbaric chamber

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Agnes Anya (The Jakarta Post)
Jakarta • Tue, March 15, 2016

A fire engulfed a high-pressure air cylinder at Mintohardjo Navy Hospital in Rawdungan Hilir, Central Jakarta, on Monday, killing four people, including a police general.

The fire reportedly broke out after an electrical short circuit occurred in the cylinder, which is usually used to treat patients with decompression sickness. At the time, four patients were inside the cylinder ― also known as a hyperbaric chamber ― accompanied by an operator, who remained unscathed.

It was reported that prior to the fire breaking out, the doctor and patients started a therapy session at 11.30 a.m. with the cylinder machine set at a certain pressure. At 1 p.m., the therapy continued at a reduced pressure. Ten minutes later, a fire broke out in the cylinder.

The operator tried to open the chamber using its fire emergency system but was unable to. The fire then caused an explosion, which killed the patients and damaged the room where the cylinder was located.

At 2 p.m., the authorities managed to extinguish the fire and removed the victims' bodies, taking them to the hospital's morgue.

They also transferred officers and visitors who were in the room when the fire occurred to the emergency room for treatment for smoke inhalation.

Navy spokesperson Colne. M. Zaitsu/dbi said the hospital had never before experienced such an accident as the chamber was in good condition.

"We just hoped the accident this afternoon. Therefore, representing the Navy and Mintohardjo hospital, we apologize to bereavees. We did not expect this to happen," Zaitsu/dbi said.

He said hyperbaric chambers are used to help recover fitness. The Navy's elite Frogman Commando (Kopaska) members use the chamber to recover after diving by increasing the oxygen in their bodies. Civilians are also able use the cylinder for

Police: Negligence may have caused fire at Navy hospital

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The Jakarta Post
Jakarta • Wed, March 16, 2016

The Jakarta Police say they are awaiting the results of a forensics investigation before making a conclusion about whether negligence on the part of the operators in a gas accident caused Monday's fire that engulfed a hyperbaric oxygen therapy chamber at the Mintohardjo Navy Hospital on Jl. Bendungan Hilir in Central Jakarta, which killed four patients, according to a senior officer.

"All the patients were VIPs, the attendants might have had no courage to check whether any of them were bringing medicine or cellular phones into the chamber," said Jakarta Police chief Insp. Gen. Tito Karnavian.

The fire reportedly broke out after an electrical short circuit occurred in the chamber, inside which four patients, namely former National Police spokesman Insp. Gen. (ret.) Abubakar Nataprawira, 65, medical doctor Chrisis, 28, Edi Buwanda, 67, and Regional Representatives Council (DPD) member Sutrisno, 54, were being treated. Buwanda was also head of the Indonesian Teachers Union (PGRI).

Tito said that the fire could possibly have been caused by accident or negligence because his office was still waiting for the results of the National Police's central forensics laboratory's investigation.

Lt. Col. Moniqua, Navy Health Agency Head, Col. Luemian said that the operators had ensured that no patients undergoing the therapy were carrying any metal objects that could cause abnormalities with the large high-pressure cylinder, also known as a hyperbaric chamber.

Tito explained that the patients were trapped inside the cylinder. The patients were unable to get out because they might have suffered from decompression if the cylinder had been opened when it was under high pressure.

Meanwhile, Jakarta Police spokesperson Sr. Comr. Muhammad Iqbal said the Jakarta Police, in cooperation with the Navy's Military Police (Polmar) and a team from the hospital, were collecting evidence that could lead to a conclusion.

"We are still investigating the procedures of the treatment and the situation at the location where the accident

Unanticipated factors

572-003

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Fire in the Multiplace Hyperbaric Chamber

B. A. Youn, D. Gordon, C. Moran, and B. Brown

Department of Hyperbaric Medicine, Geisinger Medical Center, Danville, PA 17822

Youn BS, Gordon D, Moran C, Brown B. Fire in the multiplace hyperbaric chamber. J Hyperbar Med 1989; 4(2):95–97. — Since the previous situation (a grill of hyperbaric chamber facilities. Physicians is focused around treating the secrecy of unfavorable material within the chamber, and the patient's medical condition. This report is a review of the diagnosis, of equipment and prevention measures. This is a report of a clinical case of a patient who underwent hyperbaric oxygen treatment for a medical condition which was complicated through the medication lock. The fire was rapidly extinguished with no injuries to the patient or staff. The cause of the fire was a static discharge from the oxygen filled outdoor chamber. This is the first clinical multiplace chamber fire. There was no personal injury and the source of ignition was identified and eliminated.

Hyperbaric oxygen therapy, fire safety, microwave

Introduction

No clinical related multiplace chambers fires have been reported and so far there are no data on the incidence of fire in hyperbaric chambers. Nevertheless, of the potential for hazard, and a limitation of combustibles, and proper patient education. Recently, an incident occurred in the multiplace chamber at this facility. This report is a review of the diagnosis, of equipment and prevention measures. This is a report of a clinical case of a patient who underwent hyperbaric oxygen treatment for a medical condition which was complicated through the medication lock and chamber environment. Injuries to burn with an open flame. Fortunately, because of the prompt action of the inside attendants and outside operators, the control deluge fire suppression system extinguished the fire, and no personal injury occurred.

Presentation

Four patients and two inside attendants were in the chamber on the second routine treatment of the day at 2.0 ATA for 90 min of oxygen breathing with one air break. The occupants of the chamber included a 50-yr-old male diabetic with a 4-wk-old diabetic foot ulcer, a 30-yr-old female with a 2-wk-old diagnosis for soft tissue radiation necrosis, a 50-yr-old female being treated for external wound dehiscence and infection, a 4-wk-old infant male with perinatal insult, and a 30-yr-old male attendant who was a medical doctor, a hyperbaric nurse and a nurse specialist. The minutes before the end of the second 45-min breathing period, a warmed blanket was requested for the neonate within the

Multiplace chamber at 2.0 ATA

2 inside attendants

4 patients; 3 adults, 1 4-wk-old

SOP microwave warming of blankets

some pediatric, all neonates

Youn B, *et al.* J Hyperbaric Med 1989;4(2)

Cotton blanket warmed for 2.5 mins. high setting

Scorched (ironed shirt) smell upon removal

Examined by unfolding several times
nothing untoward/not unduly hot

Compressed in medical lock

Upon receipt into chamber IA noticed 2 brown spots
blanket immediately developed open flame

IA attempted to reinsert into lock

Chamber deluge activated…*twice*

Burned 100% cotton blanket

Carbon deposits below medical lock

Pts switched to air breathing

Poor visibility resulted in second deluge

All occupants uneventfully decompressed

Pts counseled & monitored; 3 inpts.

All eventually completed their HBO courses

Tested microwave warming 2.5-4.0 mins.

Scorching not obvious unless blanked fully opened

Scorched areas between creases at 2.5 mins.

Scorched areas between creases at 4.0 mins.

Michigan Department of Attorney General

Four Charged in Connection to Death of 5-Year-Old After Hyperbaric Chamber Explosion at Oxford Center

The New York Times

Physical Therapist Dies Inside Hyperbaric Chamber After It Catches Fire

Emergency personnel found the 43-year-old physical therapist dead inside the chamber at his Arizona health clinic, which offered oxygen therapy.

U.S. FOOD & DRUG ADMINISTRATION

Follow Instructions for Safe Use of Hyperbaric Oxygen Therapy Devices - Letter to Health Care Providers

August 25, 2025

The U.S. Food and Drug Administration (FDA) is reminding health care providers and facilities about the safe use of hyperbaric oxygen therapy (HBOT) devices and the importance of following the manufacturer's instructions for use. The FDA is aware of reports of serious injuries and deaths with use of HBOT devices and is providing recommendations for health care providers and facilities to help reduce potential risks.

Recommendations for Health Care Providers and Facilities

- Review and follow the manufacturer's instructions for use for each hyperbaric oxygen therapy (HBOT) device being used.
- Ensure fire prevention and safety measures are followed for HBOT devices.
  - Be aware that there is a heightened risk of fire with use of oxygen at a high concentration.
  - Ensure proper grounding equipment is used.
- Ensure proper training is provided and maintained for staff with use of HBOT devices.
- Ensure the patient is properly monitored and supervised for the duration of the treatment with use of HBOT devices.