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ATRIUM Clinical Update

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Chest Drainage and Hyperbaric Medicine

Today, hyperbaric medicine is a recognized specialty and hyperbaric oxygen therapy (HBOT) has seen tremendous growth, particularly in treating complex nonhealing and at-risk wounds, even in critically ill patients.

How Hyperbaric Therapy Works

Hyperbaric therapy is all about the physics of gas flow and diffusion. Normally, at sea level, the atmospheric pressure (1 ATA) allows diffusion of oxygen across the alveolar-capillary membrane, from an area of higher pressure in the alveolus to an area of lower pressure in the capillary. At high altitudes, hypoxia occurs when lower atmospheric pressure creates less of a pressure gradient for diffusion. The amount of inspired oxygen (FIO_2) is still 0.21 — it's the drop in pressure that causes hypoxia.

Conversely, increased atmospheric pressure can produce hyperoxia. If all other variables, such as the FIO_2, remain the same, and the body is subjected to more than 1 ATA, the amount of oxygen dissolved in the blood will increase, and gas bubble volume (if present in decompression syndrome or air embolism) decreases.

About 97% of total oxygen content in the blood is carried by hemoglobin. The other 3% is dissolved in the blood, reflected as PaO_2. Increasing pressure has little effect on hemoglobin, but a great impact on PaO_2. If PaO_2 is 90mmHg at 1 ATA and pressure goes to 3 ATA, PaO_2 will approach 2000mmHg[1]. Yes, two *thousand*. That will feed lots of oxygen-starved tissue cells.

Indications for HBOT

Beside carbon monoxide poisoning and decompression illness, HBOT has been tried for many other conditions, particularly in a last-ditch effort to see if hyperoxia will help. The conditions for which Medicare and most private insurance companies will provide coverage, based on solid evidence of effectiveness from the Office of Technology Management[2], are: gas embolism, gas gangrene, acute traumatic peripheral ischemia, crush injuries and suturing of severed limbs, progressive necrotizing infections, acute peripheral arterial insufficiency, preparation and preservation of compromised skin grafts, chronic refractory osteomyelitis, radiation injuries, cyanide poisoning, and diabetic wounds in the lower extremities that meet certain criteria[2]. Wound care is based on the pathophysiology — if the wound is not healing because tissues are too hypoxic to heal as a result of poor blood flow, then HBOT will likely help.

Many of these conditions are present in critically ill patients, often those with multisystem trauma who require chest drainage.

Types of Chambers

Monoplace chambers are tubes into which a patient is slid on a mattress. The cylinder is approximately 33 inches in diameter, which allows a patient's head to be raised about 25 degrees. The wall of the chamber is typically made of clear acrylic so the patient can easily see the room around him and watch television as a distraction to reduce the feeling of claustrophobia. Monitoring wires and IV tubing can be passed through to the room via specially designed ports, but once the patient is pressurized, care providers cannot easily touch him. These chambers are best for wound care applications, and other out-patient, non-critically ill patients. If a critically ill patient needs therapy but cannot be moved to a multiplace chamber, the risk of very limited patient access is weighed against the potential benefits of therapy.

Multiplace chambers range in size from twice the size of monoplace chambers to actual rooms that can be pressurized. Patients can be on stretchers, in wheelchairs, or can be seated in built-in easy chairs for treatment. Care providers can be in the chamber with patients for the entire treatment time (for critically ill patients), or in large chambers, care providers can enter and leave through an entry lock in which treatment pressures are equalized with atmospheric.

Chest Drains in Hyperbaric Therapy

Untreated pneumothorax is one of the few absolute contraindications to HBOT[1]. If there is any question about a potential pneumothorax in any patient who needs HBOT, a chest tube should be strongly considered before therapy begins.

Researchers in Australia looked at how HBOT pressure changes affect a dry suction chest drain in a study published earlier this year.[3] Ideally, the disposable chest drain should move in and out of the chamber with the patient, to avoid changing devices for the therapy period. The key risk period is during decompression, when air spaces expand as the ATA is lowered, theoretically putting the patient at risk for tension pneumothorax. During pressurization, there is a risk of accumulation of high negative pressures within the drain and the pleural space.

When these researchers investigated their standard chest drain unit (Atrium Oasis™ Dry Suction 3600 Chest Drain), they made the following recommendations:

- To keep intrapleural pressures below -40 cmH_2O during pressurization, do not use source suction. Leave the suction tubing open to air for equilibration. Pressurization should not be any faster than 10kPa (75mmHg)/min (which would get to 2 ATA in about 10-15 minutes). The Oasis™ high negativity float valve automatically vented potentially harmful high negative pressures that normally occur during pressurization.
- Once maximum treatment pressure is reached, apply suction if clinically indicated for an air leak. Researchers found setting suction level at -10 cmH_2O on the drain will handle all but the largest leaks from a bronchopleural fistula.
- If there is no evidence of air leak at maximum pressure, there is no risk for positive intrapleural pressures during decompression. Otherwise, keep the drain on at least -10 cmH_2O suction until chamber pressure is equal to ambient pressure (1 ATA).

HBOT is a promising treatment for many conditions faced by critically ill patients. For the first time, we now have independent data confirming the safety of a specific disposable chest drain in HBOT — and other high pressure situations you face everyday.

See sources on page two.

Check Your Knowledge...

Q. Australian researchers examined one valve that automatically vents high negativity from the Oasis™ drain while maintaining the integrity of the water seal during HBOT. What other safety device helps you protect all of your patients from high negative pressures?

Answer on other side

Clinical Update is an educational newsletter provided by Atrium Medical Corporation and is edited by Patricia Carroll, RN,BC, CEN, RRT, MS.

In The Literature

Are You Simming?

Simulation is hot in health care education right now and will only become more instrumental in the near future. In fact, the North Shore - Long Island Jewish Health System in New York calls its simulation lab the "Patient Safety Institute." An article in the current issue of the *Journal of Infusion Nursing* describes a study that compared a "virtual reality simulator" with simulated limbs to teach phlebotomy. The virtual reality simulator showed an arm on a computer screen, and users interacted with a mouse and a special interface through which the user manipulated a syringe to simulate puncture. The simulated arm contained latex veins covered by vinyl skin. These researchers found better outcomes when the simulated arm learners were compared with the virtual reality learners. The research design is rigorous, and details are provided in the article, but this reminds us that for training, more sophisticated and expensive tools are not *always* better.

Source: Scerbo MW, Schmidt EA, Bliss JP: Comparison of a virtual reality simulator and simulated limbs for phlebotomy training. *Journal of Infusion Nursing* 2006;29(4):214-224.

More on Our Aging Workforce

Don't miss the report on the results of a nursing workforce survey in the July issue of *Nursing Management*. The headline is that after single digits for the years finishing this decade, next decade, fully half of the current workforce plans to retire. Look around, and you'll see more nurses in their 40s and older (as most of us can tell in the mirror) — particularly in periop nursing. This survey shows that workplaces are not even close to developing "redesigned roles for mature nurses" — such as allowing us to split a 12-hour shift into a timeshare of 2 six hour shifts. Nurses who work in physically demanding specialties such as critical care and ER are much more likely to leave their positions around age 50, unless modifications are introduced. This study's great because it provides recommendations for changing the work environment to make it more user-friendly.

Source: Hader R, Saver C, Steltzer T: No time to lose. *Nursing Management* 2006; 37(7):23-26,28-29,48.

On the World Wide Web...

Hyperbaric and undersea medicine is currently recognized by the American Board of Medical Specialties as a sub-specialty of Emergency Medicine or Preventive Medicine. There are many Web sites devoted to hyperbaric therapy. Keep in mind that not all sites touting hyperbaric therapy are legitimate — some are merely slick marketing tools. You can count on these sites.

Undersea and Hyperbaric Medicine Society

This organization was originally the Undersea Medical Society when it was founded in 1967, but changed its name and focus in 1986 when hyperbaric medicine therapy became more commonplace for treating a variety of medical conditions. The site at http://www.uhms.org, contains a link to a database of randomized controlled trials in hyperbaric medicine, along with a wealth of other resources. This organization is the international recognized authority on hyperbaric and diving medicine and it accredits hyperbaric programs as well.

Baromedical Research Foundation

This non-profit organization, based in South Carolina, but affiliated with researchers from the US and around the world, conducts research on the uses of hyperbaric therapy. They are currently recruiting patients for clinical trials. Visit at http://baromedicalresearch.org

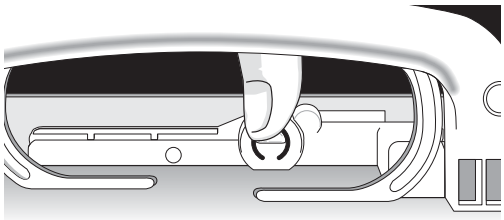
An affiliated group, National Baromedical Services, Inc. at http://www.baromedical.com provides hyperbaric training and services. Their online education arm is at http://www.mededonline.org

Evidence-Based Reports

This link, http://tinyurl.com/q6jhf, shortened from 433 characters, will take you to search results on hyperbaric treatment at the Cochrane Collaboration, which you can visit at http://www.cochrane.org.

Check Your Knowledge...

A. The filtered manual vent on the top of the drain, allows filtered air into the chest drain system to release negative pressure build-up and drop the water level in the water seal back down to baseline.



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2. Centers for Medicare and Medicaid Services: Technology Assessments for Hyperbaric Oxygen Therapy for Hypoxic Wounds and Diabetic Wounds of the Lower Extremities (CAG-00060N) 2001. Available online at: http://www.cms.hhs.gov/mcd/viewtechassess.asp?id=37

3. Walker KJ,Millar IL, Fock A: The performance and safety of a pleural drainage unit under hyperbaric conditions. *Anaesthesia and Intensive Care* 2006; 43:61-67.

Suggested readings:

Neumeister M: Hyperbaric oxygen therapy. E-medicine 2005. Available online at http://www.emedicine.com/plastic/topic526.htm

Moon RE, Camporesi EM: Hyperbaric medicine. *Respiratory Care Clinics of North America* 1999. Part I 5(1), Part II 5(2)