



IT'S ALL IN THE EARS

by *Kenneth Capek RRT, CHT, MPA*

You may be wondering what it would feel like to have a hyperbaric oxygen treatment and I can tell you, it's all in the ears. As the pressure increases in the hyperbaric chamber, it pushes against the outside surface of the eardrum or tympanic membrane (TM). This can cause the patient to experience discomfort, pain, hemorrhage, or perforation of the TM if not corrected quickly by applying an equal amount of pressure to the inside or opposite side of the TM. This corrective process is called pressure "equalization". Equalization requires us to actively contract muscles in the ear to send air through the auditory or eustachian tube to the internal eardrum. The eustachian tube normally rests in a closed position and therefore allows air to passively exit (unless blocked). There are various techniques used to achieve equalization such as

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swallowing, yawning, performing a Toynbee maneuver (swallowing with nostrils pinched closed) or a Valsava maneuver (exhaling against a closed mouth and nose). Sometimes elevating the soft palate or pharynx with upward contraction of the tongue (Frenzel maneuver),

or moving the jaw forward and downward or side-to-side can help equalization.

I find the Valsava maneuver to be the most effective especially coming from a scuba diving background where equalization is routinely performed. Therefore I apply the second rule of diving in the hyperbaric environment; equalize early and often. (The first being; never hold your breath). When I dive I will equalize at the surface to get ahead of the pressurization curve. Therefore, I ask patients to perform their first equalization just prior to closing the chamber door. The patient should be instructed not to use excessive force when performing this maneuver. This may cause serious injury to the mucosal lining of the eustachian tube. I have found that equalization maneuvers are usually required at pressures of 2,4,7, and 11 PSI. If the patient has not been able to equalize initially, they may experience a "locked" auditory or eustachian tube, whereas equalization becomes impossible. This can occur at pressures as low as 100-125 Torr (2.0-2.5 PSI). At this point the patient must be decom-

pressed to a pressure level that will allow successful equalization to be achieved before recompression is attempted.

Sometimes equalization can be accomplished with slightly congested patients by using a quick acting spray decongestant such as oxymetazoline (Afrin), which has an onset of 10-15 minutes (duration 5-6 hours). Oral decongestants such as pseudoephedrine (Sudafed) have an onset of 15-30 minutes so they should be taken at least 30 minutes prior to treatment time but not more than 4 hours prior to therapy due to their limited duration time. These are not effective immediately and will not help if the patient is presently experiencing pain. If the decongestant should lose its effectiveness before the treatment ends, a "reverse squeeze" can occur. This is a situation where the patient was able to equalize upon compression but not on decompression due to the return of a congested eustachian tube. This will require a very slow decompression to remedy. I find it interesting that the eustachian tube employs a mucociliary transport function that when impaired, due to smoking, infection, allergies and dehydration, can result in air blockage. When a patient cannot equalize, we cannot proceed with hyperbaric therapy. In these cases we must determine what the cause may be and apply an appropriate remedy.

If a patient is unable to perform successful equalization after trying all the methods discussed there is another option. A method for automatic equalization *continued on next page*



"Congratulations. You're getting a raise. Let me know if the check clears."

can be created by means of a surgical puncture of the tympanic membrane. This is called a myringotomy. If only a few treatments are required, this procedure may suffice because the incision will usually heal in a day or two. If ongoing therapy is needed then middle ear vent tubes must be placed. These are the same tubes some children get who have frequent ear infections. This is a minor surgical procedure usually performed by an Ear, Nose, Throat physician with local anesthesia. These tubes will spontaneously fall out and the membrane will heal after a few months. There is some controversy about whether a myringotomy must be done on all unconscious (emergency) cases since the patient obviously cannot perform the equalization maneuver. In the textbook Hyperbaric Medicine Practice, the author advises against myringotomy, absent pain.

Physical examination of the ear is an important part of the initial hyperbaric evaluation and is routinely performed throughout the course of therapy. The entire area, starting with external ear, should be inspected for abnormalities that could affect the patients' ability to equalize. The physical examination is performed using an otoscope, which provides visual access to the tympanic membrane. The technique for using an otoscope is to grasp the auricle or (bottom outward edge of the ear) and gently pull it slightly back and up. The otoscope is inserted into the ear canal while bracing your hand against the patients face. Excessive earwax or cerumen may restrict your vision of the eardrum and must be removed. This can usually be cleaned out successfully using a bulb syringe and a warm mixture of water and hydrogen peroxide. Any stress or damage caused by compression without equalization is seen on the TM, the degree to which is classified using what is called the Teed scale. The Teed scale has four levels of barotrauma severity; Teed 1 is erythema (abnormal redness of the skin due to capillary congestion as in inflammation) on part of the membrane, Teed 2 has erythema spread to all of the membrane, Teed 3 is presented as hemorrhage into the membrane which look like bright red patches and with Teed 4, blood has filled the middle ear so the membrane looks dark or black or may actually be ruptured. Barotrauma to the ear is the most common complication of hyperbaric therapy. Injury to the middle ear can cause tinnitus (ringing), deafness, severe vertigo, nausea and vomiting, and disorientation and ataxia (poor coordination). In our Quality Improvement program we use a Teed 2 or higher (usually associated with pain) as an inclusion criteria for our tracking of adverse reactions to therapy. An ENT physician will be consulted for high level complications and some patients may need ear vent tubes placed at this point to continue therapy.

In summary, my best advice for achieving equalization and for the prevention of ear problems is to have the patient perform an equalization procedure prior to closing the chamber door and then almost continually for the first few PSI and frequently after that. As is the custom in the dive industry; perform equalization "early and often".

Ken Capek, RRT, CHT, MPA is Director of Respiratory Care and Hyperbaric Oxygen Therapy at Englewood Medical Center in Englewood, NJ. He can be reached at Ken.Capek@ehmc.com



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