Anyone who has ever experienced the feeling of vertigo will surely agree with Bono’s words in the U2 song, *Vertigo*.

The word “vertigo” is derived from the Latin word *vertere* which means “to turn”. It is a specific kind of rotational dizziness in which an individual experiences the sensation that they or their surroundings are moving, whirling or spinning in the absence of actual movement. They may also suffer from light-headedness, confusion and a loss of balance. “Giddiness” is a term frequently used when trying to describe what one is feeling. Vertigo may be accompanied by nausea, vomiting and even tinnitus (ringing in the ear) or hearing loss. Uncontrolled eye movement can be observed on close examination. Vertigo is a normal phenomenon following actual spinning, like after getting off a merry-go-round. Once the body has come to a standstill, the fluid in the semi-circular canals of the inner ear continues to move, which causes a mismatch between what your eyes are seeing and the internal sensory input. The lack of a stable visual reference point also adds to this effect.

“Hello, hello. I’m at a place called Vertigo. It’s everything I wish I didn’t know. Except you give me something I can feel, feel!”

Learn about the different types of vertigo that divers experience and how they can be avoided.
Vertigo is usually associated with various disorders that affect the balance organs of the inner ear or the vestibular nerve, which carries signals from the balance organs (for example Ménière’s disease, benign positional paroxysmal vertigo, ear infections and vestibular neuronitis) or the centre of the brain that receives the signals (strokes, head injuries and degenerative illnesses). Other causes of vertigo include concussions, migraines, alcohol or drugs.

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In the diving environment, there are many stimuli that may produce vertigo. There are also certain diving-related illnesses and injuries that may produce symptoms of vertigo. If vertigo is temporary, it is usually benign, thus stimuli-related. If not, it is usually more serious, thus pathology-related. The stimuli-related causes are broadly classified into two types, namely:

1. An unequal stimulation of the inner ear vestibular apparatus; and
2. An unequal response by the balance centres to the same external stimuli.

Some of the different causes of vertigo experienced in the diving environment are discussed below.

**CALORIC VERTIGO**

This is a transient form of vertigo that is experienced mostly due to the unequal vestibular stimulation by cold water. On immersion, cold water usually enters both ears symmetrically. However, if cold water enters only one ear canal or if one eardrum is perforated causing more direct stimulation of that ear, it can bring about vertigo. One-sided ear canal obstructions can be caused by one of the following: poor-fitting asymmetric hoods, a lump of ear wax, swimmer’s ear, bony outgrowths in the ear canal, or even foreign bodies, such as ear plugs or an air bubble.

The perforation of the eardrum is a brief but dramatic cause of significant vertigo. Following a “pop” or a sharp, stabbing pain in the ear, cold water rushes into the ear and is immediately followed by vertigo. As soon as the water warms to body temperature, the stimulus is removed and the giddiness subsides. In the diving environment, the three major predisposing factors that cause tympanic membrane perforation that lead to vertigo are middle-ear barotrauma of descent, forceful auto-inflation of the middle ear and shock waves (such as falling onto the ear when entering the water from a boat or with the discharge of explosives in the water).

**ALTERNOBARIC VERTIGO**

Alternobaric vertigo (ABV) is a common cause of vertigo which accounts for about 60% of vertigo in divers. Ironically, it is more evident in experienced scuba divers. ABV occurs mostly on ascent (block-version) but can also be experienced during descent (squeeze-version). With a change in depth comes a change in pressure in the middle ear air spaces. Thus, when one ear equalises normally and the other one fails to equalise at the same rate, there is an inequality of pressure across the inner ear, which sends a confusing signal to the brain and causes vertigo. A sudden ascent or bolting to the surface due to panic will only worsen the effect as it increases the asymmetric pressure difference (block-version). The best way to cope with this pressure difference is to stop, descend slightly, hold on to a steady object and focus on a fixed point and then wait for the pressure to equalise. Equalising techniques should not be attempted as it may worsen the problem. Symptoms usually resolve within seconds, but they may last up to 10 minutes.

Although not dangerous in itself, ABV is hazardous if it causes panic followed by an uncontrolled ascent or inappropriate behaviour, nausea and vomiting with the risk of aspiration, disorientation with trouble navigating (especially in cave or wreck diving) or drowning. Inadvertent descent when experiencing ABV may also lead to ear barotrauma if equalising measures are then neglected.

To avoid ABV, do not dive when feeling sick or congested or immediately after an upper respiratory tract infection or cold. Never force air into the ears.

If you have had previous encounters with ABV, avoid diving when the insides of your ears are feeling “sticky”.
Remember to ascend and descend slowly and to equalise early and often during a descent. It is important to consult a diving medical practitioner before diving if you have a history of Eustachian tube dysfunction, serious middle ear infection or swimmer’s ear.

INNER EAR DECOMPRESSION SICKNESS
One of the causes of vertigo that is harder to treat is an inner ear bend or decompression sickness (DCS), although, fortunately, this is rare. It is more common in technical or commercial diving, especially following deep dives using helium as a breathing gas. Helium is associated with the counter-diffusion of gases, which plays an important role in the development of inner ear DCS. It may, however, also be present in air scuba diving following a rapid ascent after a long bottom time and may also be accompanied by other manifestations of DCS, particularly mottled skin rashes. The vertigo is usually delayed and only starts after the decompression has stopped or when the person is on the dive boat. It also lasts a lot longer and will continue when the person is back ashore. Sensorineural hearing loss may also be present. Initial management is the same for all cases of DCS: It starts with the administration of 100% oxygen and (unless the diver is vomiting and it may compromise his or her airway) plenty of non-alcoholic isotonic fluids as he or she is transferred to the nearest chamber for recompression.

It is very important to distinguish between inner ear barotrauma and inner ear DCS when making the diagnosis, as the management of these two conditions differs completely. This can sometimes be tricky and difficult and a thorough history and examination by a practitioner who is experienced in diving medicine is essential.

BAROTRAUMA
Barotrauma of the external, middle and inner ear, and the forceful auto-inflation of the middle ear, can all bring about vertigo. This is more likely and severe in the upright position. The inability to equalise the middle ear space may produce unequal pressure gradients with vestibular confusion and may result in vertigo (similar to ABV). Alternatively, the forceful auto-inflation of the middle ear may cause the inner-ear membranes to rupture and may even cause fluid leakage due to a round window rupture. Vertigo, ringing in the ear and hearing loss after a no-decompression dive should alert to possible inner-ear barotrauma and requires urgent evaluation by a specialist for medication in order to preserve hearing and for the possible surgical repair of the fistula.

GAS TOXICITY
Because of the interference with cerebral functioning, various gas toxicities may cause sensory disturbances, including vertigo. Nitrogen narcosis, usually experienced when
breathing air at depths beyond 30 m, can cause dizziness that may mimic or even contribute to vertigo, especially in conjunction with a dysbaric or caloric stimulus. On the other hand, high carbon dioxide (CO₂) levels can lead to disorientation which may be confused with vertigo. A sudden reduction in high CO₂ exposure may, however, also cause vertigo due to the CO₂-off effect. Vertigo is also a well-known warning symptom of central nervous system oxygen toxicity. It is seen most commonly when divers use oxygen, gas mixes or rebreathing equipment and when the recommended safe oxygen exposures (oxygen time-pressure limits) are exceeded. Furthermore, high pressure neurological syndrome (HPNS) is seen in commercial divers. It is provoked by rapid compression and is characterised by vertigo, nystagmus, nausea and tremors. Other gas issues such as hypoxia (due to breathing mixture or rebreather problems), hyperventilation (or hypocapnia) and carbon monoxide poisoning may all present with the onset of vertigo due to the disturbance in the level of consciousness.

SENSORY DEPRIVATION
A lack of sensory input, especially spatial orientation signals, is likely to cause vertigo. An example is the fear of heights that is experienced by some scuba divers, causing dizziness when looking down into deep waters. This can be overcome by focusing on an object in the level plane of vision and by swimming along ledges, the seabed or the surface.

MOTION SICKNESS
Due to a disproportionate and unequal vestibular response to motion, some divers can suffer from nausea, vomiting, vertigo and even fainting on the dive boat or while decompressing during safety stops or even swimming.

THE TULLIO PHENOMENON
The Tullio phenomenon is a fascinating, albeit rare, occurrence of vertigo due to the exposure to loud noises. It has been observed in compression chambers without muffling systems over the air inlets, in helmet divers, in caisson workers and in aircrews. The most pronounced version is associated with a hernia (superior semi-circular canal dehiscence) of one of the semi-circular canals of the inner ear. This bulge permits abnormal fluid shifts in the presence of pressure of a loud sound, thus provoking vertigo. The condition usually requires surgical repair.

Vertigo in the diving environment is potentially hazardous and should be managed calmly and quickly.

IN CONCLUSION
Whatever the cause, vertigo in the diving environment is potentially hazardous and should be managed calmly and quickly. A controlled ascent is required with protection of the airway, if vomiting occurs. Unless it is transient (less than 10 minutes with no other symptoms related to the ear or otherwise), suspend further diving until a diving medical practitioner has been consulted. Treatment is mostly symptomatic and includes bed rest and sometimes drugs like antihistamines, topical decongestants, steroid sprays or antibiotics. Recompression is the treatment of choice for DCS but, if inner ear barotrauma is suspected, referral to an ear, nose and throat specialist is required.

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