



opinion

Text by Simon Pridmore

This column is adapted from a chapter in my book, *Scuba Physiological – Think you know all about Scuba Medicine? Think Again!* The chapters in this book were originally written by scientists in the field of decompression research as part of a three-year project called PHYPODE (Physiology of Decompression). My (self-appointed) task was to rewrite their sometimes-complex research in a form accessible to all divers.

One interesting aspect they addressed was the concept of preconditioning as it may apply to scuba diving safety. In other sports, preconditioning strategies such as warming up, passive heat maintenance and prior exercise are used to ensure that athletes perform as well as possible on game day.

Tiny gas bubbles in the bloodstream are thought to be the main cause of decompression sickness (DCS), so the PHYPODE researchers looked at six preconditioning strategies that divers might be able to deploy before a dive to reduce the quantity of tiny bubbles produced during the dive, thus reducing both decompression stress and the risk of DCS.



Scuba Confidential: Preconditioning *for Safer Scuba Diving*

1. Pre-dive endurance exercise

An aerobically fit diver has a lower risk of developing DCS than an unfit diver and aerobically trained runners produce fewer bubbles on a dive than people who are mostly sedentary. Why this

should be the case is not yet clear. In the past, it was thought that a bout of aerobic activity immediately before diving had exactly the opposite effect. Pre-dive exercise was seen as a factor that increased the risk of DCS, because it was

thought that muscle contractions and tissue movement might produce gas nuclei leading to increased bubble formation. This theory has now been seriously challenged. In studies conducted in a hyperbaric chamber, divers produced fewer

bubbles when they had performed a bout of aerobic exercise 24 hours before a dive. Another study tested the effect of cycling for 45 minutes, two hours before a dive in the ocean. The results confirmed the data obtained in the chamber and

PIXABAY





opinion



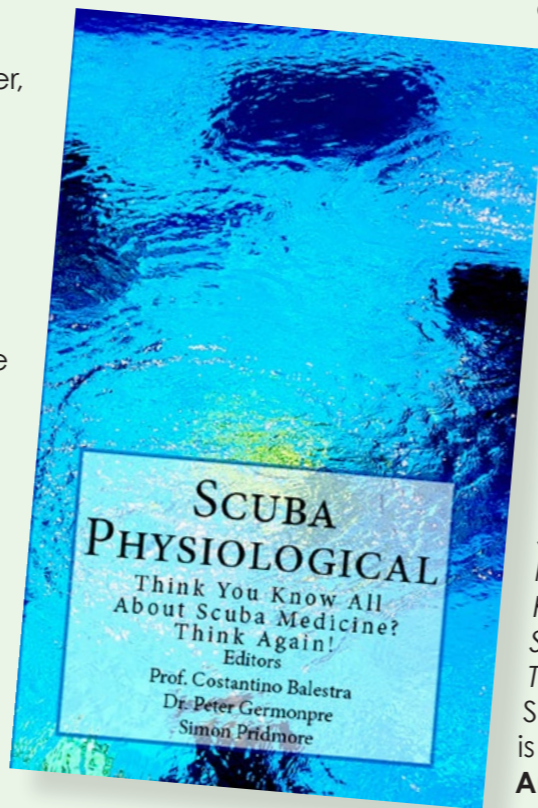
PIXABAY

A New Book for Scuba Divers!

If you are a diver, much of what you learnt about topics such as decompression sickness and narcosis in your scuba diving class is over-simplified and some of it is just plain wrong, as diver training agency texts have not kept pace with the science. Despite 170 years of research, the nature of decompression sickness and decompression stress remains unknown. Great

written by scientists in the field of decompression research as part of a three-year project called PHYPODE (Physiology of Decompression). Simon Pridmore is not an expert on diving medicine but, when he came across the material, he knew that many people in scuba diving beyond the scientific community would be interested in it. So, he contacted the original authors and proposed an

abridged, edited, simplified and re-formatted e-book, which would make the information more accessible to the general population of divers. They thought it was a great idea and *Scuba Physiological* is the result.



Scuba Physiological: Think You Know all About Scuba Medicine? Think Again! by Simon Pridmore is available on: **Amazon.com.**

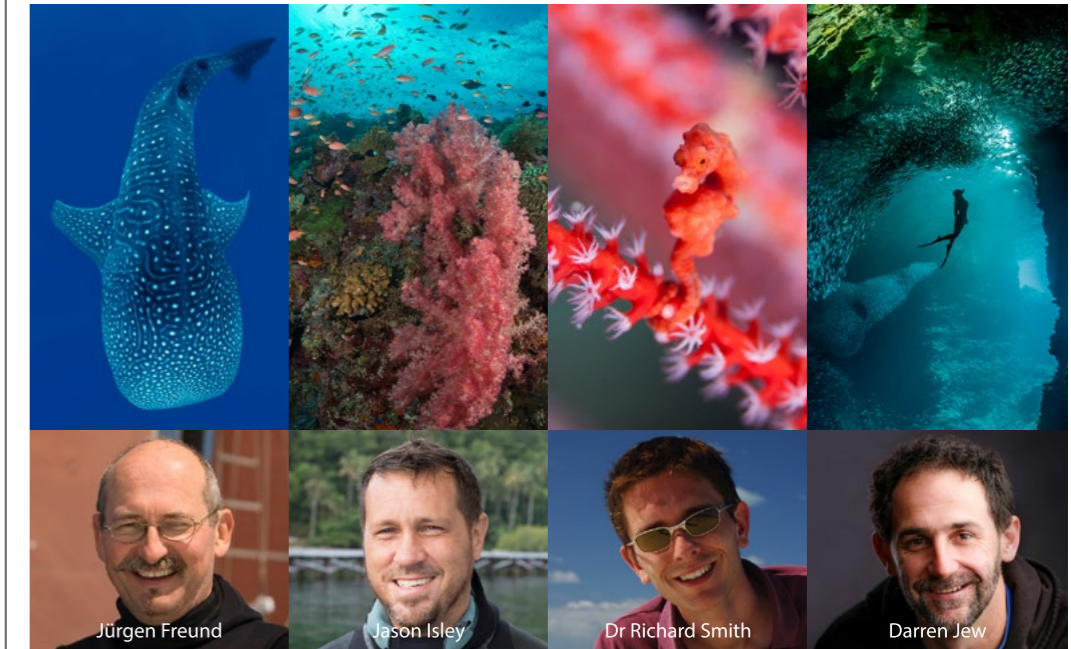


**4 Internationally acclaimed speakers on tour together
4 State capital cities in 4 consecutive days**

Join us in May for the inaugural Underwater Tour 2018, the first nationwide speakers tour in the Australian dive calendar featuring evening events in Brisbane, Perth, Melbourne and Sydney.

Each inspiring underwater photographer has their own specialist niche, and all will share with you their stories of adventure and discovery, from behind the lens.

Meet and chat, mix and mingle with representatives from our bucket list Touring Partners.



Major Tour Partners

Tour Partners

Organizers



Tickets on sale now at Underwatertour.com.au

TOUR DATES
Brisbane Wednesday 9 May
Perth Thursday 10 May
Melbourne Friday 11 May
Sydney 12 May



info@underwatertour.com.au

found that both moderate and strenuous exercise pre-dive reduced bubble production. A further study showed that running on a treadmill for 45 minutes, one hour before a dive, also significantly reduced the bubble count. Nobody knows yet what the optimal timescale is for doing pre-dive exercise, or even if there is one. Nor is it clear why pre-dive exercise should have this effect: but it seems clear that divers are best advised to keep aerobically fit.

2. Pre-dive hydration

Drinking water before a dive is an easy



PIXABAY

way to reduce the risk of DCS. When you are well hydrated during a dive, you minimise the negative effects associated with post-dive dehydration. The best way to stay well hydrated is to drink before you get thirsty, a little at a time, say a cup of water every 15-20 minutes. Drinking a large amount of water too fast will increase diuresis, the phenomenon that makes you want to pee, and will not hydrate your tissues.

A recent experiment involving military divers showed that drinking a saline-glucose beverage before diving significantly decreased the quantity of bubbles in a

diver's circulation after the dive.

A further study found that loss of body fluids during a dive correlated with bubble count, as measured approximately one hour after surfacing: the greater the fluid loss, the higher the bubble count. This suggests that it is also very important to rehydrate AFTER a dive, especially if you are doing more than one dive a day.

3. Pre-dive oxygen breathing

Oxygen breathing has been extensively investigated as a way of reducing DCS risk before altitude decompression and space walks. Oxygen breathing is also

routinely employed during decompression from deep air dives to accelerate the washout of nitrogen from the tissues, thus both shortening decompression time and lowering the risk of DCS.

In 2009, a study examined what effect breathing oxygen at ambient pressure for 30 minutes BEFORE a dive would have on post-dive bubble formation. The divers participating in the experiment stopped breathing oxygen 15 minutes before the dive. They did two dives, 100 minutes apart, to 30m (100ft) for 30 minutes with a 6-minute stop at 3m (10ft) on each dive. The divers were randomly assigned





opinion



A study found that pre-dive heat exposure in a sauna significantly decreased circulating bubbles in the bloodstream after a dive.

first performed three control dives in a 34m (113ft) deep swimming pool with no preconditioning. Then, further dives were carried out with a preconditioning procedure that involved a 30-minute infrared sauna session two hours before the dive. The preconditioning led to a significant reduction in post-dive bubbles.

So, it seems heat stress may give some degree of protection against bubble-induced injury from decompression.

5. Pre-dive vibration

In the old days, combat divers and commercial divers would drive their boat fast out to the dive site but return to shore

Preconditioning

slowly after the dive in the belief that this strategy would reduce the risk of DCS. The PHYPODE researchers decided to see if science could back up the theory and found that 30 minutes of whole-body vibration, (such as you would receive in a speedboat driven fast) before a dive could indeed reduce the quantity of bubbles produced after the dive.

6. Biochemical preconditioning (with dark chocolate)

The vascular endothelium is an organ you probably do not know you have. It is a single layer of cells that completely covers the inner surface of all

to one of four profiles: "air-air" (the control profile), "O₂-O₂", "O₂-air" and "air-O₂" where "O₂" was a dive with oxygen pre-breathing and "air" was a dive without oxygen pre-breathing.

The study found that oxygen pre-breathing resulted in a significant reduction in decompression-induced bubble formation, regardless of the profile. The beneficial effect of pre-dive oxygen was observed after the first dive and was maintained after the second dive even when oxygen pre-breathing did not precede the second dive. The "O₂-O₂" profile resulted in the greatest reduction in bubble scores measured after the second dive. The results also indicated that the beneficial effects were cumulative and long lasting.

This might be due to the physical effects of breathing gas without nitrogen (deni-

trogenation) although there are no data that suggest this. Instead, it might be because of the antioxidant and anti-inflammatory properties of hyperbaric oxygen itself. More research is needed.

4. Pre-dive heat exposure

Researchers also conducted studies to determine what effect pre-dive heat exposure in a sauna would have on bubble formation after a dive. Sixteen divers underwent a 30-minute infrared dry sauna session, followed one hour later by a dry chamber dive to 30m (100ft) for 25 minutes. Test results showed that the sauna exposure significantly decreased circulating bubbles after the dive.

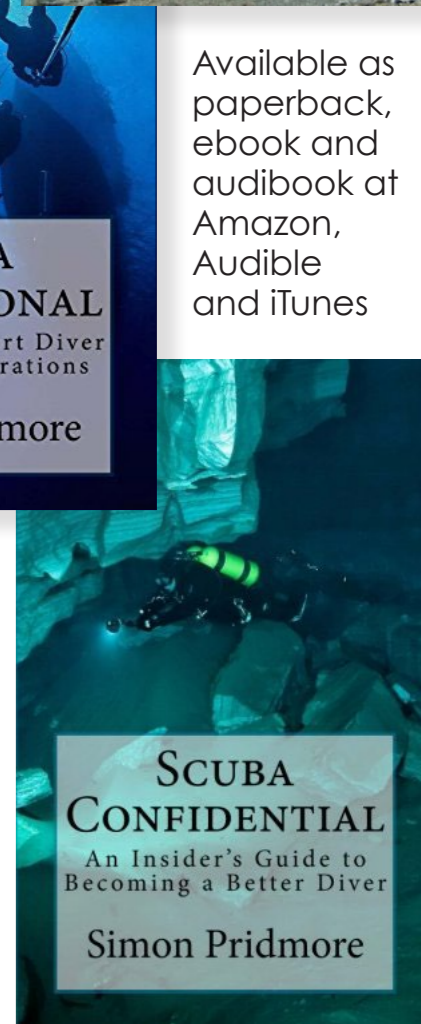
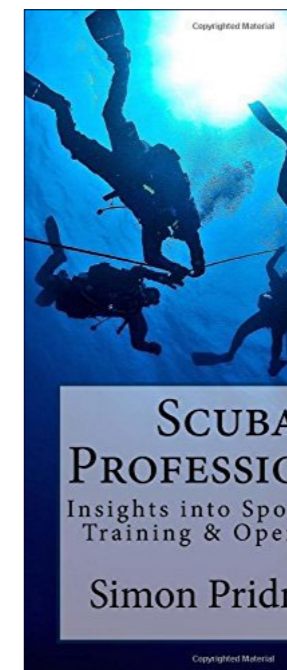
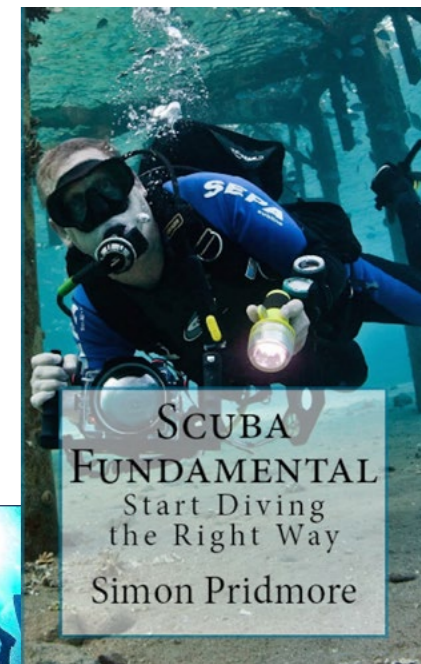
Another experiment was carried out, involving a group of divers who were known normally to produce particularly large numbers of bubbles after diving. In this study, the divers



A study found that 30 minutes of whole-body vibration (like one gets riding in a speeding boat) before a dive could, in fact, reduce the amount of bubbles produced in the bloodstream after a dive.

Get the trilogy!

Three books by Simon Pridmore no diver should be without



Available as paperback, ebook and audiobook at Amazon, Audible and iTunes

Click on the book cover to go to the order page, or go to the link below

simonpridmore.com





opinion

Studies have found that eating dark chocolate a couple of hours before a dive may reduce the adverse effects of bubbles in the bloodstream after a dive. Flavonoids in the dark chocolate generate nitric oxide secretion and decrease platelet adhesion, which makes it less easy for bubbles to form and maintain stability.

the blood vessels in your body.

Several studies on both animal and human subjects have shown that hyperbaric exposure results in dysfunction of the vascular endothelium. This may be the result of oxidative stress resulting from hyperoxia during diving and recent experiments have shown that taking antioxidants prior to diving can reduce the negative effects that diving has on endothelial function. Preconditioning by taking an antioxidant such as vitamin C might reduce endothe-

lial inflammation at depth and thus limit gas bubble formation.

Recently, some Belgian scientists studied the effects of dark chocolate on bubble production and endothelial impairment associated with diving and found that consumption of dark chocolate had a positive effect on the endothelium, although it had no significant effect on the quantity of bubbles developed during a dive.

Other recent studies discovered that eating 30 grams



PIXABAY

of dark chocolate two hours before a breath-hold free dive can prevent endothelial dysfunction, which is normally observed after free diving as

well as scuba diving. The flavonoids in dark chocolate seem to be the key ingredients. They generate nitric oxide secretion and decrease platelet

adhesion two hours after ingestion and this makes it less easy for bubbles to form and achieve stability.

The timing is critical. The decrease in platelet adhesion peaks two hours after chocolate consumption. Bubble production while scuba diving is not directly related to the preservation of endothelial function. Neither is it directly related to nitric oxide. However, preservation of good endothelial function after diving may reduce the adverse effects of the bubbles that have formed during the dive.

Conclusions

Further research is required into all of the

effects described here, but a few things are clear:

1. Divers should stay in good physical shape and maintain cardiovascular fitness.
2. Pre-dive procedures can help reduce decompression stress. Some help maintain endothelial function. Others are better at reducing bubble production.
3. Pre-dive oral hydration, exposure to heat, whole body vibration and oxygen breathing may represent relatively easy ways of reducing DCS risk. ■

For a more detailed summary of the PHYPODE findings on pre-conditioning, read Simon's book, Scuba Physiological – Think you Know All About Scuba Medicine? Think Again! available as an e-book via Amazon stores worldwide. For more information, go to: Simonpridmore.com.

SOCORRO VORTEX

LUXURY + ADVENTURE

We are currently redesigning her to be the ultimate liveaboard experience for the discerning diver.

140 FEET. 14 GUESTS

COMPLIMENTARY WIFI, BAR & NITROX.

AL FRESCO DINING & LOUNGE, JACUZZI, 4 LUXURY STATEROOMS, 2 JR SUITES AND A MASTER SUITE WITH A CALIFORNIA KING SIZE BED

PELAGIC FLEET

VORTEX SOLMAR V PELAGICSAFARI

For more info & reservations please contact: april@pelagicfleet.com | www.vortexliveaboard.com

SOCORRO VORTEX



THE FASTEST AND MOST EXCLUSIVE LIVEABOARD TO DATE FOR THE SOCORRO AND GUADALUPE MARKET.

For more info & reservations please contact: april@pelagicfleet.com | www.vortexliveaboard.com



All divers who become unwell after diving should be discussed with a diving medicine physician as soon as possible.

Updated: Pre-hospital management of DCI guidelines and “mild” DCI

A paper was recently published in the March issue of *Diving and Hyperbaric Medicine*, which discusses the pre-hospital management of DCI. The lead author is Professor Simon Mitchell, Head of Anaesthesiology at the University of Auckland, New Zealand and a EUROTEK stalwart.



The guidelines for pre-hospital management of decompression illness (DCI) have not been formally revised since 2004 when a Divers Alert Network / Undersea and Hyperbaric Medical Society workshop was held and five consensus points were agreed upon.

Thirteen years have passed, and therefore aspects of the management of DCI in the field have been reviewed by a multinational committee.

The key issues addressed were:

- First aid strategies for DCI
- Remote triage of possible DCI victims by diving medicine experts
- Evacuation of DCI victims
- Effect of delay to recompression in DCI
- In-water recompression

These subjects were discussed at a dedicated workshop at the 2017 UHMS Annual Meeting

in Florida, and at subsequent meetings of the expert committee.

Defining ‘mild’

An emphasis was placed on resolving controversies around the definition of “mild DCI” arising over 12 years of practical application of the 2004 workshop’s findings, and on the controversial issue of in-water recompression.

The expert group conducted a thorough literature review and contributed a lot of objective evidence, all of which is cited.

Signs and symptoms

“Mild” DCI signs and symptoms include:

- Fatigue
- Musculoskeletal pain
- Some skin sensory changes
- Rash
- Subcutaneous (under the skin) swelling



Some Key points

All divers who become unwell after diving should be discussed with a diving medicine physician as soon as possible.

A beneficial first aid strategy in suspected DCI is 100% oxygen, which should be administered as early as possible after symptoms arise.

Where possible, a horizontal position should be encouraged / maintained, including during evacuation, if practical. (If the patient is unconscious, the recovery position is recommended).

Provided the patient is fully conscious, hydration is recommended. Fluids should be non-carbonated, non-caffeinated, non-alcoholic and preferably isotonic. Drinking water is acceptable.

Keep the patient thermally

comfortable—warm, but not hyperthermic (too hot). Avoid exposure to the sun, unnecessary activity or excess clothing.

When to recompress

Recompression and hyperbaric oxygen therapy is the gold standard treatment for DCI. However, some divers with symptoms or signs meeting the definition of mild DCI may be managed without recompression therapy.

Determination that a case is “mild” and that the patient can be managed without recompression can only be made by a diving medicine physician on a case-by-case basis.

In DCI cases arising in locations without ready access to a suitable recompression chamber, in-water recom-

pression (IWR) using oxygen at a maximum depth of 9msw (30ft) can be considered provided:

- The team is trained, certified, practiced, and suitably equipped.
- The patient is not suffering from hearing loss, vertigo, vomiting, altered state of consciousness, shock, respiratory distress, or a degree of physical incapacitation that makes return underwater unsafe.

It should be noted that IWR may not result in a complete resolution of DCI, and all divers undergoing IWR should be discussed with a diving medicine physician as soon as practicable. ■