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DIVING MEDICINE

THE UHMS MEDICAL LITERATURE FOR DIVERS SERIES:

MUCKING AROUND WITH DIVE TABLES AND THE LAW OF UNINTENDED CONSEQUENCES

+ IN THIS ARTICLE WE CONTINUE THE SERIES PRESENTED BY THE DIVING COMMITTEE OF THE UNDERSEA AND HYPERBARIC MEDICAL SOCIETY IN WHICH WE 'REINTERPRET' SOME INTERESTING PAPERS FROM SCIENTIFIC JOURNALS IN EVERYDAY TERMS. IN MOST OF THESE ARTICLES WE HAVE PRESENTED GOOD QUALITY PAPERS THAT WE CONSIDER TO HAVE PROVED AN IMPORTANT POINT. THIS TIME I'M TAKING THE SLIGHTLY UNUSUAL STEP OF PRESENTING A PAPER THAT DOES NOT REALLY PROVE ANYTHING AS SUCH, BUT IN MY VIEW IT DOES ILLUSTRATE AN IMPORTANT PRINCIPLE; A PRINCIPLE THAT WILL INTEREST TECHNICAL DIVERS IN PARTICULAR.

It is common on technical diving internet discussion forums to read of divers 'tweaking' their tables, 'padding their stops' or any number of other terms to describe self-adjustment of published decompression tables or computer generated decompression algorithms. The application of such adjustments is usually 'validated' by self reports of 'cleaner deco', and uneventful dives or series of dives. I must confess to cringing a bit when I read this sort of stuff. Not infrequently, these table-adjusting divers have little true knowledge of what they are doing, yet it has nevertheless become very trendy to be a 'table-adjuster' and to share your ideas on the matter with the rest of the technical diving world. Some of these ideas can become fashionable to the point where they gather a momentum that is unstoppable.

Now, I'm the first to admit that widespread support might mean that an idea is correct (rather than just a fashion), and one widely supported and potentially correct idea in the field of decompression practice is the notion that decompression stops should start deeper than prescribed by the 'traditional' decompression algorithms. While a description of decompression theory is beyond the scope of this article, a few lines of explanation are necessary.

The traditional approach to decompression originally described by Haldane and others (and therefore referred to as 'Haldanian') involved a stepwise decompression at 'stop' depths calculated to 'safely' maximize the pressure gradient for elimination of inert gas from tissues. In this context, 'safely' meant the absence of symptoms – in most cases! This style of decompression characteristically involved quite long and relatively rapid ascents to the first decompression stop in order to maximize that out-gassing gradient early on, and it has been utilized with usual success (and some failures!) for decades.

However, modern technology has generated a mass of evidence that this type of ascent frequently generate bubbles in the blood, albeit without symptoms in most cases. Bubble generation is not surprising since large inert gas out-gassing gradients are synonymous with significant tissue 'supersaturation'; a state in which dissolved gas pressure in a tissue is greater than the ambient pressure. This state of supersaturation is what drives bubble formation. It has been proposed (and its hard to argue with the logic) that reducing this bubble formation might make decompression safer and unexpected cases of decompression sickness less likely. Thus, some decompression modelers have adopted a focus on trying to prevent these bubbles from forming in the first place rather than 'blindly' trying to maximize out-gassing gradients. The resulting decompression models are frequently referred to as 'bubble models'. Although this is a gross over-simplification of a complex issue, an important strategy in this anti-bubble crusade is to limit supersaturation (and therefore the drive to bubble formation) by not initially ascending so far after leaving the bottom; in other words, by imposing deeper decompression stops.

My own opinion is that this strategy is correct. However, choosing deep stop algorithms is not a job for untrained amateurs. Despite these cautionary words it must be observed that few issues have piqued the interest of amateur decompression table 'tweakers' more than the use of 'deep stops', and all manner of personal strategies for their application are expounded on technical diving forums. Indeed, to post support for Haldanian style decompression on a modern technical diving forum is to invite all manner of criticism from the resident experts.

On this background, it was with great interest that I read a recent paper published by a French group in Aviation Space and Environmental Medicine. The full reference is:

Blatteau J-E, Hugon M, Gardette B, Sainty J-M, Galland F-M. Bubble incidence after staged decompression from 50 or 60msw: effect of adding deep stops. Aviat Space Environ Med 2005;76:490-2.

In this study, the authors designed three dives. Two were single dives to 60 metres for 15 minutes and 20 minutes respectively using air, whilst one was a repetitive dive (thus, two dives close together) to 50 metres for 15 minutes both dives, also using air. All dives were performed in the wet compartment of a hyperbaric unit with water at 15 degrees C, and a standard diving-relevant work load was imposed during bottom times. Eight divers performed each of the three dives twice. On one decompression a Haldanian French naval decompression protocol was utilized, and on the other a decompression utilizing deep stops was used. Doppler was used to count bubbles in the blood after each dive. Interestingly, the authors do not describe how the deep stop decompression profiles were derived, but on the 60 metres for 20 minute profile the deep stop decompression looks somewhat similar to that generated by popular 'bubble model' algorithms, while on the 60 metre for 15 minutes profile there was only a single deep stop.

The bubble count results were interesting. To summarize, on both the 60 for 20 and 60 for 15 profiles there was no difference in bubble formation between the deep stop and Haldanian decompressions, while on the repetitive profile the imposition of deep stops was associated with more bubble formation than for the Haldanian decompressions from the same dives.

Proponents of bubble models and deep stops will quite correctly argue that these data are difficult to interpret. The dives are unusual for the use of air to 60 metres, the depth range was limited, the Haldanian profiles were generated by a French naval table not in general use, and there is no detailed explanation as to how the deep stop decompression algorithms were derived. Indeed, some of the published technical diving deep stop algorithms would have started the stops even deeper.

For these reasons, and as I insinuated at the start of this article, I don't think the paper proves anything. In particular, it does not prove that deep stops don't work across the range of depths and gases used by technical divers, and I must add that the authors do not try to claim this either. They take the view that the efficacy of deep stops in this depth range has not been proven.
My interpretation is that the paper does illustrate a very important point – that is, if deep stops are imposed on certain dives and in a certain manner then the 'law of unintended consequences' may apply and there is the potential to actually increase the risk of the dive rather than reduce it. Ill informed 'tweaking' of decompression algorithms by enthusiastic amateurs would be particularly prone to such outcomes and I think that the moral of the story for believers in deep stops is that these stops should be applied in the manner prescribed by experts in the field who have modeled the underlying physiological processes.
In other words, I'd recommend sticking to one of the published bubble model algorithms, and to resist the temptation to muck around with it ourselves.

Dr Simon Mitchell (BHB, MB ChB, DipDHM, DipOccMed, PhD) began diving in his teenage years and what became a recreational passion sussequently drove his academic and professional career. Simon now looks back on a 33 year diving history that has spanned sport, scientific, commercial, and military diving and more than 6000 dives. Simon trained in medicine, completed a PhD in embolic brain injury, and received certification in diving and hyperbaric medicine from the Australian and New Zealand College of Anaesthetists. He has published more than 30 research and review papers in the medical literature, and wrote two chapters for the latest edition of Bennett and Elliott's Physiology and Medicine of Diving. He is an active technical diver, and in 2002 with Trevor Jackson completed a 178m dive to the wreck of the 'Kyogle' off Brisbane. This was the world's deepest wreck dive. Simon is a dual New Zealand and Australian citizen and currently lives in Auckland with his partner Sian.