Alert DIVER LITE

Your compact *Alert Diver* companion

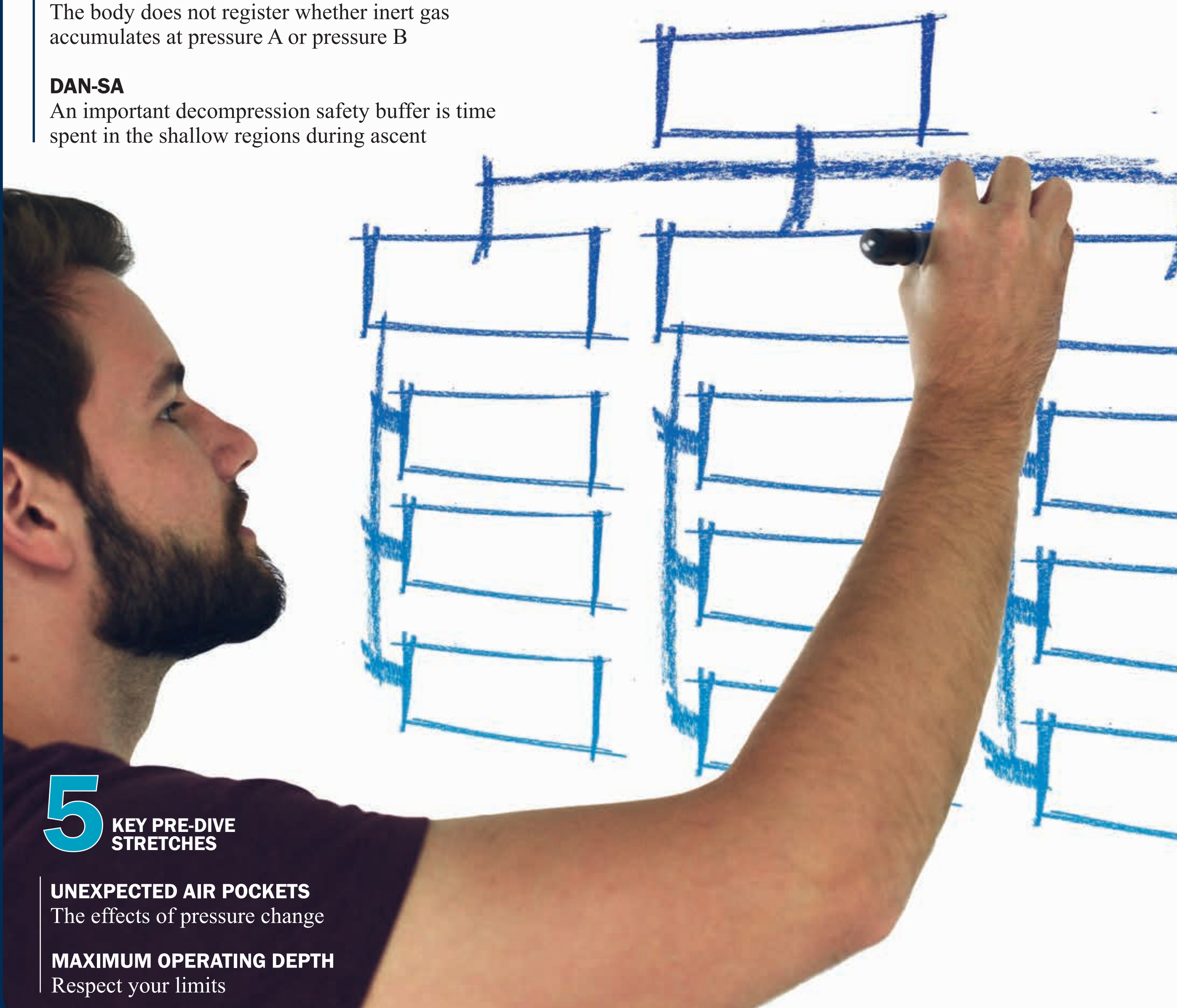
August/September 2018

DEFENSIVE DIVE PLANNING PROFILE

QUESTION
How does your ascent profile affect decompression stress?

CAUTION
The body does not register whether inert gas accumulates at pressure A or pressure B

DAN-SA
An important decompression safety buffer is time spent in the shallow regions during ascent



5 KEY PRE-DIVE STRETCHES

UNEXPECTED AIR POCKETS
The effects of pressure change

MAXIMUM OPERATING DEPTH
Respect your limits

PERSPECTIVES

Welcome to another edition of *Alert Diver Lite*.

In this edition, we address troublesome teeth, the factors of fizz, defensive diving, some nitrox notices and warming work-outs. Like to know more? Then read on!

Divers are all familiar with Boyle's Law, mainly as it applies to the lungs and middle ear. Breathing continuously and equalising early and often are drilled into us as entry-level divers from day one. However, Boyle's Law may also drill into our teeth in two ways:

1. when compressed gas gains entry to a semi-closed dental cavity (causing explosive pain)
2. when pressure forces pockets of gas under faulty fillings to contract (resulting in implosive pain).

Read on about how an experienced diver discovered that fillings and teeth grinding could lead to a pressure-aggravated toothache, called *barodontalgia*, and how to avoid it yourself.

There are several interesting topics in our Q&A section. Travel fatigue and jet lag are hot topics in travel and aviation medicine. Dr Petar Denoble explains what divers can do to alleviate its impact. Unlike in the USA, melatonin is not available as freely in South Africa or several European countries without a prescription. Its primary use is for alleviating jet lag, and it should not be used indiscriminately for treating insomnia. The timing of ingestion is crucial and there are several other areas of controversy regarding the routine use of melatonin that should be considered carefully. Flight crews are also advised first to assess the safety of taking melatonin while off flying duties, before taking melatonin to assist in restoring circadian rhythms disrupted by shift-work. Smaller and compounding pharmacies (i.e., where medicines are also made up by the pharmacy rather than only being sold as commercially branded, off-the-shelf-products) are more likely to sell 3 mg melatonin capsules – the recommended dose for jet lag – without the need for a prescription.

Lastly, warming up is a good idea before diving. DAN does not advise strenuous exercise within 24 hours after diving. However, warming up before diving is an entirely different matter. Apart from making the dives more enjoyable, pre-dive warm-up routines add to the whole diving experience: they afford an extra measure of preparedness and raise the "being in the moment" feeling. The exercises are easily memorable and straightforward – as in *one, two, three*:

- one for the trunk – twists
- two for the legs – the calf-stretcher and the squat
- three for the arms – the back-scratcher shoulder stretch; hanging arm circles, and push-ups.

Until next time – safe diving!

Dr Frans J. Cronje, MBChB, MSc
Founder of DAN Southern Africa

[Editor's Note: Just before releasing this edition of *Alert Diver Lite,* the Thai-Cave Rescue occurred in which a team of international divers saved 12 boys and their coach. A Thai Navy Seal died in the heroic effort; we wish to express our gratitude and to honour his sacrifice in saving 13 people's lives. We also want to celebrate the efforts of the other team members, including a South African diver. See the article on page 26.

ON THE COVER
The square profiles of the past can be replaced by complex dive profiles that are easily tracked by these little boxes.

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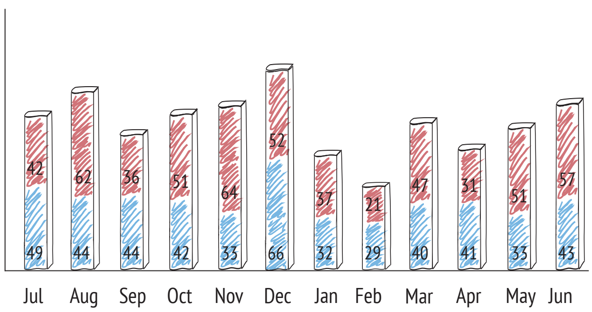
STATISTICS 2018

24-HOUR DAN HOTLINE

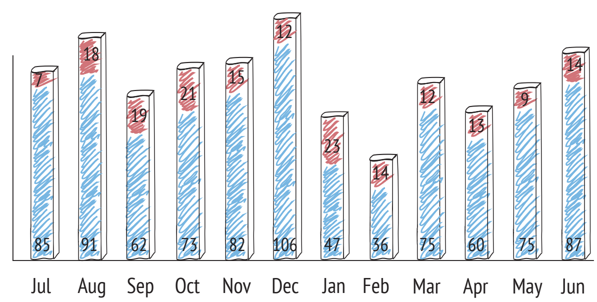
The hotline is available 24/7/365 at 0800 020 111 locally or +27 82 810 6010 from outside of South Africa. If you travel internationally, remember to ensure that your party has at least one phone available for emergencies with roaming activated. Contact the DAN hotline as soon as possible in the event of an emergency.

Statistics Period July 2017 – June 2018

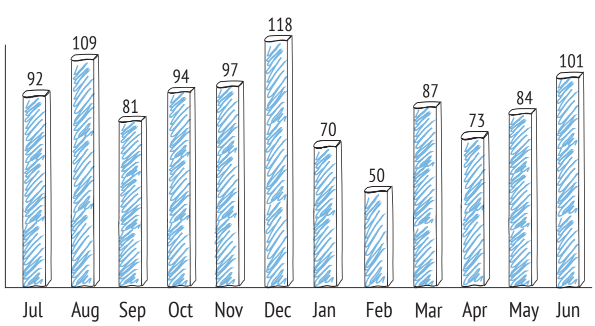
DAN Hotline Gender Usage Split



DAN Hotline Member Usage



DAN Hotline Cases



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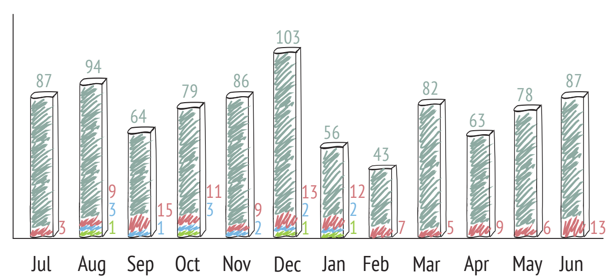

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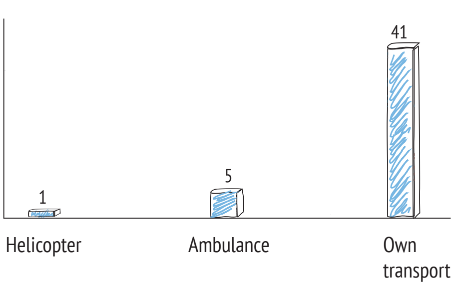
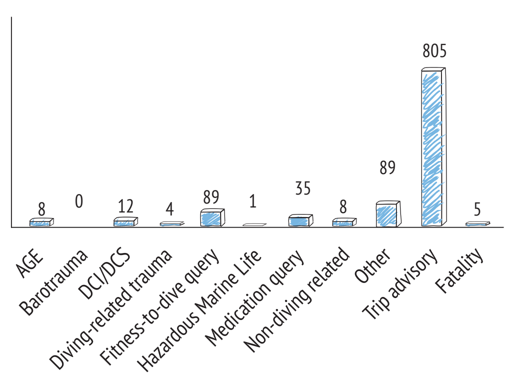


DAN Hotline Sub Categories



Unexpected Air Pockets

By Brittany Trout

THE DIVER

The diver, a 40-year-old male with more than 1 500 lifetime dives, had no known medical conditions and reported a healthy lifestyle. In the months before this incident, he had multiple root canals and other major dental work done. He made several decompression dives on a rebreather using a scooter without any problems in the week preceding the incident.

THE INCIDENT

On his last dive of a weeklong series, the diver felt a momentary dull pressure and pain in his lower teeth during his descent; he dismissed it since the pain seemed to vanish as he continued with the dive to a maximum depth of 47 m. When he started to ascend after spending 30 minutes at 41 m, he experienced sharp and severe pain in the same teeth. After ascending an additional 2 m, the diver became aware that several dental fillings had come loose. As he continued his ascent, two fillings fell apart and came out of his teeth. He halted the ascent for a few minutes to compose himself and assess how to reach the surface safely before proceeding.

To avoid further complications and prevent the dental-filling debris from damaging the bailout valve of his rebreather, he switched to his backup open-circuit unit and spat out the filling fragments. He then returned to the closed-circuit loop to conserve breathing gas. His dive buddy was attentive and assisted him with his scooter and reel throughout the ascent. The diver stayed at 29 m for 10 minutes to deal with the excruciating pain he felt throughout his lower teeth before proceeding with a safe ascent to the surface.

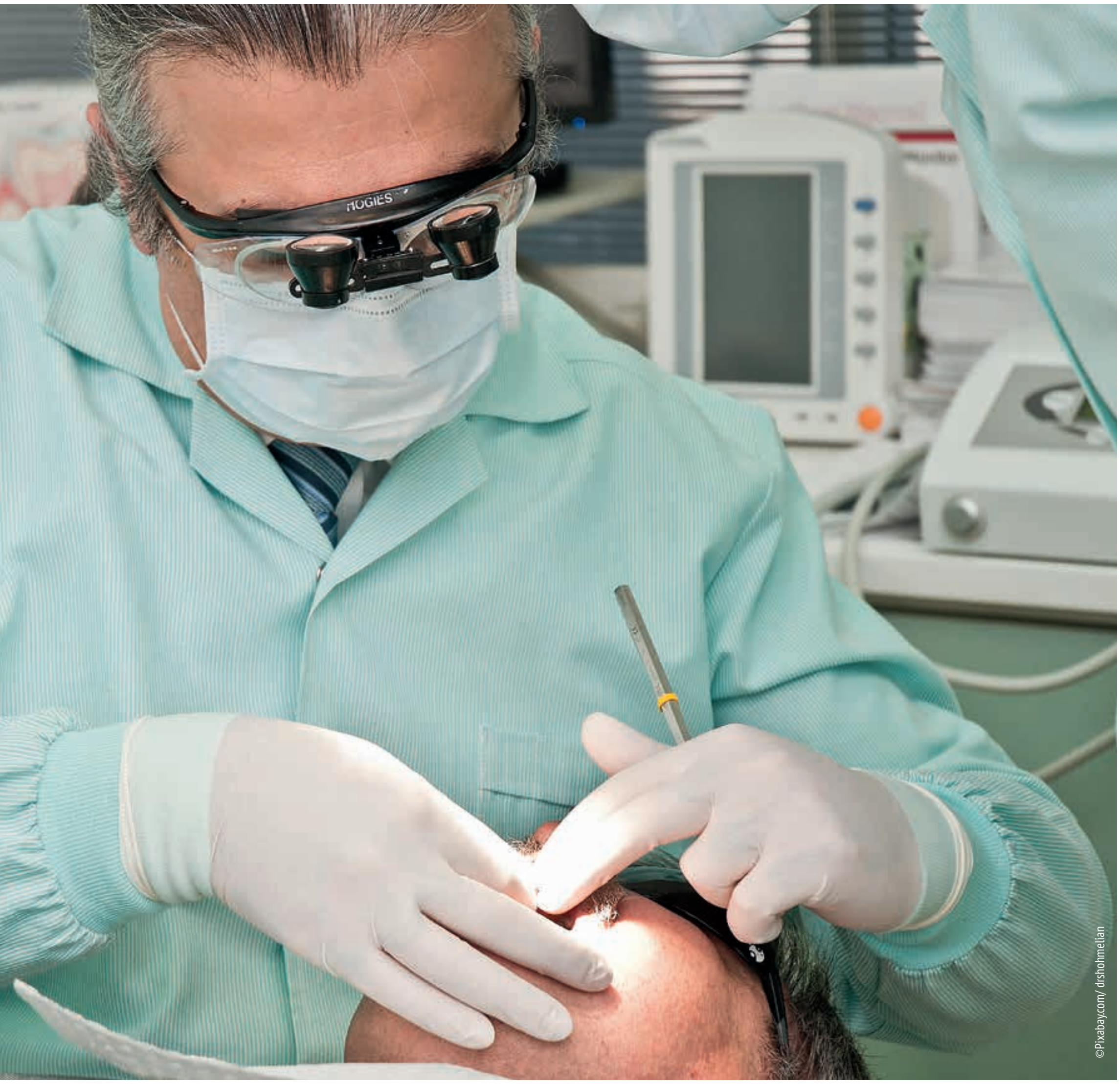
THE DIAGNOSIS

Several days after the incident, the diver went to his dentist, who suggested that biting too hard on the regulator mouthpiece had generated pain similar to that caused by bruxing (teeth grinding and clenching). Diagnostic X-rays showed the amalgam (metal) fillings in five of the diver's teeth were either damaged or missing entirely. Defective fillings may have allowed air to enter between the filling and the tooth, and become trapped. During ascent, the trapped air expanded and created pressure against the internal structures of the tooth, which triggered the tooth pain and caused two of the fillings to fall out.

The dentist replaced the damaged fillings, but the diver continued to experience tooth pain when diving. He sought a second opinion from another dentist, who identified through further X-rays that there were problems with the fillings of four teeth and recommended replacement. The diver had the fillings replaced, and he returned to diving without experiencing tooth pain. This was a case of barodontalgia (tooth pain caused by change in ambient pressure), also known as dental barotrauma.

DISCUSSION

As a diver descends into the water, the ambient pressure increases by one atmosphere every 10 m. This pressure change affects body cavities, such as the ears and sinuses, by creating unequal pressure between the body cavity and the ambient environment. This is relieved by equalising the pressure. When a tooth is damaged, restored defectively or has a loose crown, an opening may allow air to enter into the space and become trapped during a dive with no means of being equalised. The diver may experience tooth pain during descent, when pockets of air that exist under defective fillings are compressed, or during ascent as the



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trapped air expands and may crack teeth or loosen or even expel fillings.

In this case, the diver had tooth pain on ascent due to defective fillings, which subsequent dental diagnostics confirmed. The unusual aspect of this case was that a total of five teeth appeared to have been affected on the same dive, two of which were confirmed to have lost fillings during the dive. Barodontalgia generally originates with poor oral health, neglected dental maintenance and/or ineffective dental treatments. Of the 347 total cases of barotrauma reported in the 2008 edition of the DAN *Annual Diving Report,* two cases were categorised as barodontalgia. Although considered a rare occurrence, barodontalgia should not be dismissed; it can lead to potential safety risks, such as rapid ascents and impaired judgment during a dive due to severe pain.

This case, in which as many as five teeth were affected by barodontalgia during the same dive, is extreme. However, it serves as a reminder that being fit to dive is holistic and includes dental health. It is not necessary to seek a dentist specifically trained in dive medicine for dental check-ups; rather it is important to routinely visit a dentist that provides quality care so you can be confident your dental health is maintained. The FDI World Dental Federation advises that divers have regular dental check-ups, refrain from diving (or flying in non-pressurised cabins) within 24 hours of any dental treatment that requires anaesthetic treatment, and wait seven days after an oral surgical procedure before returning to diving.

Being fit to dive is holistic and includes dental health.

Fillings are prone to deterioration over time. Semi-annual dental exams allow the dentist to inspect existing fillings for damage, and to detect and treat tooth decay promptly. By maintaining good oral health, divers can avoid barodontalgia and smile easily after diving.

Defensive Dive Profile Planning

By Neal W. Pollock, Ph.D.

Limited gas supply and less-than-stellar thermal protection once worked to cap decompression stress for the typical diver. Increased choices for gas supply and improved thermal protection have enabled divers to go further and longer. Dive computers have likewise expanded the freedom to explore. The square profiles of the past can be replaced by complex dive profiles that are easily tracked by these little boxes.

Decompression safety may be achieved by staying within dive computer or dive table limits, but decompression sickness (DCS) can develop even after dives that remain within prescribed limits. Dive computers generally work as designed, but the mathematical algorithms do not evaluate many of the factors that can alter the decompression risk of a given exposure. Building in modest buffers at every step of the diving process can help ensure good outcomes. This article will discuss concepts important for conservative practices, some of the pitfalls that must be overcome, and practical strategies for defensive dive-profile planning and implementation.

CONCEPTUAL CONTROL

Know the risks

Diving is used for both work and pleasure, and in the vast majority of cases, it concludes without problems. The risks, though, should not be ignored. Understanding them is a critical step in preparedness. Early recognition of issues can resolve many before they become troublesome.

Take responsibility for your own safety

Do not give any other person or any device complete authority over your activity. Some divers will follow a divemaster they just met without question; others will follow a computer without thinking about what it does not know or will expect it to get them out of any trouble they may create. Any person or device can make mistakes. Make sure that you are actively and intentionally involved in every step of every dive, able to lead yourself when necessary.

Understand the available tools

Reliance on dive computers is now the norm for many divers. While you do not have to be a decompression modeller to dive safely, it is important to have a clear conceptual understanding of how the decompression algorithms that you will rely on work. It is equally important to know what they do not consider and that they can be wrong. Ask questions, learn, and develop plans for the “just in case” events.

Evaluate information critically

One of our human quirks is the abundance of faith we put in what appears on a screen or gauge, such as an air gauge or dive computer screen. This can even spill over to what we read on the Internet, regardless of provenance. The tendency for blind faith must be kept in check. Maintain an open, critical mind to fully assess information and use it appropriately.

One of our human quirks is the abundance of faith we put in what appears on a screen or gauge.

Know your risk tolerance

Risk is inherent to life; it cannot be fully avoided if one is to live, but it can be managed. Tolerance varies among individuals and situations. Generally, tolerance increases as the perceived benefit increases, and decreases as the severity of the potential injury increases. Knowing your own comfort zones will help you plan and act to stay within them.

Maintain a safety-oriented mental state

When rules are broken or limits are violated with no obvious repercussions, there can be a gradual shift away from thinking of them as important. This can lead to “normalisation of deviance,” in which something once thought of as unacceptable becomes acceptable. The problem is that decompression stress is a relatively invisible hazard. We do not change colour as we fill with inert gas, and decompression stress may not be perceived until a critical stage is reached. We can feel good right up to the


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point that we feel very bad. Vigilance is required to maintain good practice.

Reinforce safety messaging

Thinking or teaching "do this or get hurt" can be counterproductive to safety-oriented practice. As described above, the first time the line is crossed without injury, the rule will become less important. After it has been crossed a few times, the rule may seem irrelevant, or the individual may perceive himself or herself as being endowed with special protection. Both of these viewpoints can lead to poor choices. Flipping the focus to "do this and be safer" can provide much healthier reinforcement. When nothing bad happens, the positive benefits of the practice are reinforced. Both peace of mind and good practice are promoted.

Avoid mission creep

Even the best intentions can be pushed aside by trouble-free diving and personal comfort. This can be exemplified on multiday dive trips. The intensity of diving frequently increases as the trip continues. It is not uncommon for a person developing DCS during a trip to describe their most conservative practice as their norm. Electronic dive logs, however, frequently show an erosion of safety buffers over successive days.

Pick your partners well

The mind-set and practice of others in your group can radically affect your risk. Choosing those with complementary goals, objectives and attitudes can help ensure that the activity remains within your comfort zone. If someone you are diving with pushes you beyond your comfort zone, remember the first two rules: Know the risk, and take responsibility for your safety.

Use tools to defend your practice

Selecting appropriate conservatism settings on your dive computer can reduce the need to argue over no-decompression limits or decompression profiles. Going back to the faith we often have in computers, differences in the selected settings may prompt discussions that help everyone gain insight. A critical mind is essential at this point to weigh the merits of the often heartfelt beliefs of those participating in the debate. Understanding the available tools is important for understanding the options and levels of conservativism. An article about gradient factors in the Fall 2015 issue of *Alert Diver* might be helpful to this end.

PRACTICAL STRATEGIES

Solid knowledge, awareness, critical thinking and smart partner selection provide the foundation for good diving practice. Implementation requires further thought. Employing a number of small buffers can produce a web of protections that can mean giving up little in the way of opportunity while maintaining a high degree of conservatism.

Going deep increases the rate of inert gas uptake and the ultimate amount to be eliminated, but going to the extremes of one's training can be enticing.

The dive profile is the single most important determinant of the ultimate decompression risk of a dive. The shift from square profiles to multilevel profiles can produce powerful advantages.

Going deep increases the rate of inert gas uptake and the ultimate amount to be eliminated, but going to the extremes of one's training can be enticing. Multilevel diving offers a good way to scratch that itch while maintaining good decompression safety. Choosing sites appropriate for multilevel dives is a great way to start. In the simplest case, swimming outbound at one depth and back at a shallower

References

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depth can limit inert gas uptake and extend the controlled inert gas elimination period. Decompression stress is minimised, and the diver can experience different zones during a single dive.

Out and back is fine for many recreational exposures, but as maximum depths increase, it becomes increasingly important to spend progressively more time at progressively shallower depths. Dive sites that make this easy facilitate optimised dive profiles.

The high relative rate of pressure change in the shallowest zone makes it critical in determining the overall decompression stress. Next to backing off the intensity of a dive, the most important decompression safety buffer is time spent in the shallow regions during ascent. For much recreational diving, this can be considered the depth range shallower than 7.6 m. The popularisation of the safety stop was probably the most significant evolution in decompression safety for recreational diving in the past 30 years. The three-minute stop is good, but it is even better if it follows a progressive multilevel profile and is extended as gas supply and conditions allow.

There are times when over-applying well-intended rules can get in the way of safety. For example, divers are frequently taught to surface with a reserve of 500 psi in their tanks. If the concern for surfacing with this reserve becomes so compelling that safety stops are abbreviated, the rule becomes counterproductive. Dives should be planned to be finished with a reserve of air, but using some of that supply to extend a safety stop is probably a high-benefit compromise. Having said this, any deviations from established rules should be discussed post-dive and actions should be taken to avoid unnecessary future violations.

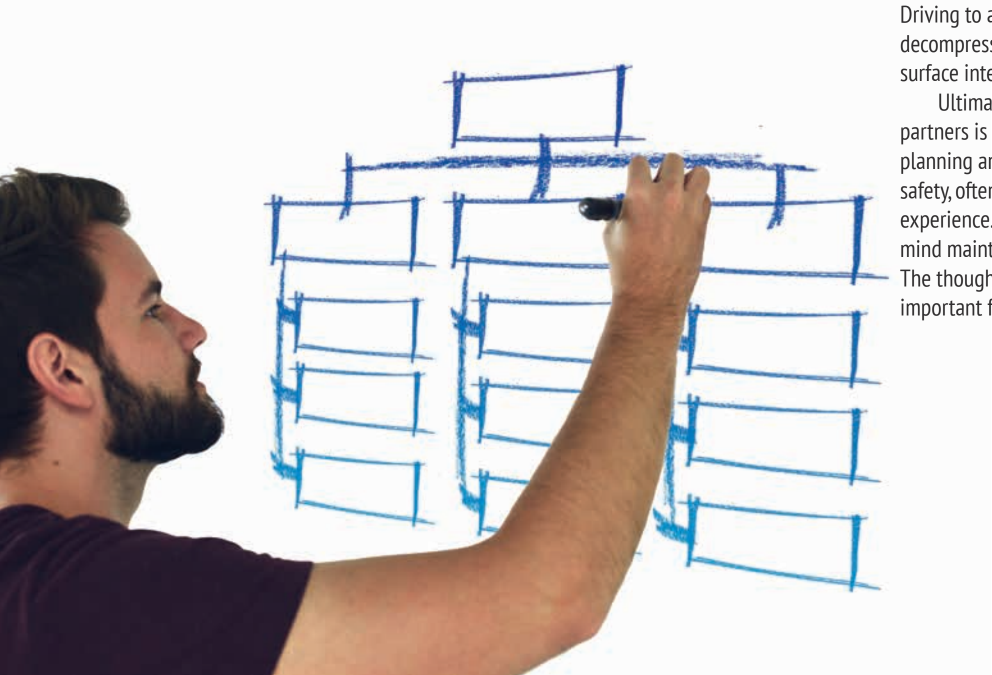
Another area in which safety can be put at risk is reverse dive profiles. If all other things are equal, planning the deepest dive first makes sense in that it is consistent with good practice for multilevel diving. However, all things are frequently not equal, and, as far as we know, the body does not register whether inert gas accumulates at pressure A or pressure B; the important thing is the total accumulation and the subsequent pressures achieved to eliminate it from the body. Practically speaking, the order of the maximum depth between two dives can be unimportant. Concerns arise when the "deepest dive first" rule is applied with such rigor that an unnecessarily deep dive is conducted for no other reason than to allow a second deep dive when it must be scheduled later (for example, to meet a suitable tide state). Mindless fixation on rules can create problems. Dive planning should be thoughtful.

Surface intervals also need to be considered. There is a trend toward progressive shortening, probably as a function of mission creep and perceived efficiency. Surface intervals are important for inert gas elimination. The minimum reasonable surface interval will vary with the exposure, but focusing on the minimum is not conservative practice. If short surface intervals are necessary, the severity of the dive profiles should be moderated.

Mindless fixation on rules can create problems. Dive planning should be thoughtful.

The ends of dive trips often require consideration of the final surface interval before flying. Flying-after-diving plans are often based on guidelines produced at a DAN workshop. The recommended minimum pre-flight surface intervals were developed from the available data: 12 hours after single dives within no-decompression limits; 18 hours after multiple dives per day or multiple diving days; and "substantially longer than 18 hours" after decompression dives. An added challenge is that these guidelines apply only to aircraft cabin pressures equivalent to altitudes in the 610 to 2438 m range. Additional buffers are recommended since it cannot be known with certainty whether cabin altitudes might exceed this range. Planning a surface interval of at least 24 hours following diving is a good rule of thumb, and an extra safety buffer can be gained through more conservative exposures on the final day of diving. Driving to altitude post-dive can similarly induce additional decompression stress; it also requires appropriate pre-travel surface intervals.

Ultimately, the best way to protect yourself and your partners is to build conservatism into all aspects of dive planning and execution. The net effect can be a high level of safety, often with relatively little compromise in your diving experience. When good habits are established and peace of mind maintained, the best diving in the world is possible. The thoughtful and well-informed diver remains the most important factor in producing safe outcomes.



DAN-SA HOTLINE

In a diving emergency, call:

0800 020 111 (local)

+27 828 10 60 10 (int.)

DAN SOUTHERN AFRICA

www.dansa.org

The Many Factors in Decompression Stress

By Neal W. Pollock, PhD.

For much of the past century, a small number of algorithms have been used to estimate divers' decompression obligations. Advances in recent decades, however, have produced an array of mathematical models used in personal dive computers.

All current computer models base their assessments almost exclusively on the pressure-time profile of a dive. While this is certainly the most important element of decompression sickness (DCS) risk and can provide excellent guidance, many factors influence the totality of inert gas uptake and elimination, and ultimately decompression safety. Divers can reduce their risk by thinking beyond the current algorithms. The variables affecting decompression stress can be clustered into four broad categories: Dive profile, exercise profile, thermal profile and predisposition factors.

DIVE PROFILE

Even for situations in which all other factors work against decompression safety, if the dive profile does not generate significant decompression stress, DCS will not develop. Critical elements of the profile include time spent at each depth, ascent rate, stop depth(s), stop duration(s) and breathing gas(es) used. Recent previous dives can alter the impact of these variables. Subtle effects are created by the water density, whether it is fresh or salt, and the atmospheric pressure at the surface. The lower the atmospheric pressure is at the surface, the greater the decompression stress is for a given dive. While the greatest reduction in atmospheric pressure comes with increasing altitude, fluctuating weather conditions also have a minor effect.

Most algorithms used in dive computers provide adequate protection for typical recreational exposures, but DCS can develop even in people who dive within the limits of decompression models. The risk results from the complex interplay of the dive profile, thermal and exercise states a host of individual factors. For some, the level of risk associated with current decompression algorithms is acceptable. Others may desire additional buffers to address differences in susceptibility or risk tolerance. Gradient factors offer one useful option for altering conservatism (see "Gradient Factors," *Alert Diver* Fall 2015 or *AlertDiver.com/Gradient_Factors*).

EXERCISE

The timing and intensity of exercise can have a substantial influence on decompression safety. In the broadest sense, exercise during the descent and bottom phases of a dive promotes circulation and increases inert gas uptake, effectively increasing decompression stress. Conversely, light to moderate exercise during the ascent and stop phases will increase circulation and promote safe, inert gas elimination, thus reducing decompression stress. Problematically, though, higher-intensity exertion during the ascent and stop phases or soon after the dive can promote bubble formation and increase the effective decompression stress. The best-prepared divers will have the equipment and skill to control the amount of exercise needed before, during and after diving.

Exercise intensity should be kept as low as possible during the descent and bottom phases. Light exercise – on the order of no more than two to three times resting effort

(2.0-3.0 metabolic equivalents [MET]) and with very low forces on the joints – is appropriate during the upper ascent and stop phases to help increase the rate of inert gas elimination. High-intensity exercise and exercise involving high joint forces should be avoided before and after dives. If undesirable physical activity is required, dive profiles should be made conservative to compensate for the increased risk.

THERMAL STATUS

The thermal status of a diver can also have a substantial influence on decompression status. A study by the U.S. Navy provides an elegant example. Dives were divided into two phases: Descent and bottom, and ascent and stopped. The water temperature was kept constant in a given phase to produce "warm" or "cold" (more accurately, "cool") status. Dives were carried out with the phases matched ("warm/warm" and "cold/cold") and mismatched ("warm/cold" and "cold/warm") with divers exercising throughout.

The greatest differences in DCS were evident between "warm/cold" and "cold/warm" exposures. The "warm/cold" condition yielded a DCS rate of 22%. The "cold/warm" condition was extended to more than twice the bottom time and still produced a DCS rate of only 1.3%. Even if the effects of this study are exaggerated by a prolonged ascent/stop phase that allowed for bottom-time changes, the results document a dramatic impact based on the timing of thermal status variations.

Diver thermal status – not water temperature, a potentially very different thing – will almost certainly be measured in the future, but meaningful monitoring will require new devices and much research data to adjust algorithms appropriately. Maintaining a neutral thermal status during the descent and bottom phases – certainly avoiding unnecessary overheating – and trying to achieve a mild warm status without high-intensity exercise during ascent will reduce the risk of DCS.

The difficulty comes in reconciling optimal practices for decompression safety with divers' desires and normal practices. Pouring warm water into wetsuits pre-dive or placing chemical hot packs inside suits is being replaced by active heating garments available for both wetsuits and drysuits. The problem with these strategies is that they increase inert gas uptake early in the dive when uptake is already typically highest. Since warm water and chemical hot packs lose their effectiveness over time, and active heating systems can weaken or fail, the warm-cool pattern associated with the greatest risk of DCS can develop.

Active heating garments can have legitimate value but should be used thoughtfully. Warming should never be greater than is needed, and divers should consider a low or off setting early in the dive and a gradual increase in warming during ascent. Caution is required in increasing active heating during ascent since gas solubility decreases in tissues as they warm, potentially promoting bubble formation before blood perfusion increases sufficiently to remove the gas. Divers must also be aware that post-dive warming can increase DCS risk. Taking a hot shower or getting into a hot tub will decrease the tissue solubility for inert gas and can promote bubble formation.

Divers need adequate warmth to preserve clear thinking and physical performance, but they should be mindful of the decompression hazards created by thermal manipulation.

Ultimately, divers need adequate warmth to preserve clear thinking and physical performance, but they should be mindful of the decompression hazards created by thermal manipulation. For many divers, passive systems are adequate to maintain physical and cognitive performance. Those who need or desire active warming systems should be aware that those systems can increase decompression stress even if they work correctly and that they may substantially increase decompression stress if they fail.

PREDISPOSITION

Predisposition is a catch-all category that includes an array of personal factors that can influence decompression stress. The impact of each may range from negligible to substantial for a given individual and dive. None of these parameters can currently be quantified sufficiently to incorporate into decompression algorithms. Understanding the potential impact, however, can help divers manage their actual risk.

STATE OF HYDRATION

Proper hydration is important for general and diving health. Dehydration can increase the risk of DCS, and hyperhydration can promote immersion pulmonary edema. Practically, it is probably fair to say that the diving community has sometimes focused too much on dehydration as a risk factor in decompression stress. This may arise from two realities: First, since fluid shifts and indications of marked dehydration can be a consequence of DCS, there can be some confusion over cause and effect. Second is the human desire to find something simple to blame.

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PHYSICAL FITNESS

Divers should be physically fit enough to meet the normal demands of diving with sufficient reserve capacity to handle emergency situations. The higher the level of physical fitness, the lower the relative strain of a dive. Optimal body composition reduces the amount of ballast weight that has to be carried to achieve neutral buoyancy and, in the case of an obligatory post-dive climb out, reduces the absolute effort required. Limited data have associated higher levels of physical fitness with reduced post-dive bubble formation and lower risk of DCS.

The biggest practical challenge typically arises with efforts to schedule exercise around busy diving schedules. While limited findings suggest that a single bout of high-intensity exercise conducted 24 hours before diving may have a protective effect, the data concerning exercise closer to the start of diving are fairly confusing. Exercise should probably be avoided pre- and post-dive where possible.

DCS history

An individual's history of DCS may indicate a greater predisposition, either physiologically or behaviourally. The importance of history may also extend to a buddy since his or her actions can influence the outcome of a shared activity.

Age

The impact of increasing age is hard to assess, since it may be confounded with reduced levels of physical fitness and changing health and practices. Increasing age is associated with increased bubble formation, and this potentially indicates a reduced tolerance for decompression stress.

Biological gender

There is no compelling evidence in the diving literature to confirm that biological gender plays a role in the development of DCS. This runs contrary to a limited amount of data from hypobaric chamber exposures that suggest that the physiological risk may vary somewhat across the menstrual cycle, with a slightly elevated risk during the first half of the cycle. Practically speaking, even if women do have a slightly elevated physiological risk in comparison to males, a tendency toward more conservative practice may reduce the net risk.

Circulation

Compromised circulation resulting from prior injury has been viewed as a possible risk factor, but with little empirical evidence. The presence of a patent foramen ovale (PFO) has the potential to alter circulation by allowing a volume of blood to reach the systemic circulation without undergoing filtration through the lung. PFO has been identified as a risk factor in serious DCS.

Perspective is required, though, for while the frequency of PFO is relatively high (about 25% of the population), the incidence of serious DCS is low. The degree of patency varies and can be important. PFOs are also not the only way to move bubbles into arterial circulation. Bubbles can cross in the lungs, particularly during exercise (while or after climbing out of the water, for example). Dive profiles that minimise bubble formation provide the greatest protection since there will be no bubbles to cross over.

Biological health

A host of factors falling under the category of biological health may influence decompression stress. Some probably play minor roles, while others may play important roles that have not yet been fully defined. Nutritional status, for example, is important for general health and physical fitness and may influence the biochemical response to decompression stress. Similarly, the potential interaction between drugs and diving is another area with virtually no research data but legitimate concerns. Genetic predisposition and epigenetic expression likely also have importance that is just beginning to receive research attention.

The potential interaction between drugs and diving is another area with virtually no research data but legitimate concerns.

Acclimatisation

Acclimatisation is defined as the adaptive change in response to repeated natural exposure. The effect may be positive or negative. Repetitive diving could influence decompression stress, and not just through the presence of residual inert gas. Positive acclimatisation could produce a reduction in the biochemical response – effectively a desensitisation that may reduce the magnitude of the insult. Negative acclimatisation could produce a heightened response – effectively a sensitisation to decompression stress.

The published data relevant to diving are conflicting, which may be in part a reflection of how divers dive. The effect of positive acclimatisation could easily be masked by patterns of increasing exposure intensity over dives in a series.

Summary

Most personal factors that affect decompression stress can be modified. Maintaining reasonable levels of physical fitness, nutrition, restfulness and hydration all contribute to good health and good diving health. Good health can reduce physical limitations and the need for medication. When selecting dive buddies, divers should consider the compatibility of goals, risk tolerance, skills, knowledge and capabilities. A shared understanding of both risk and best practices can improve operations and readiness.

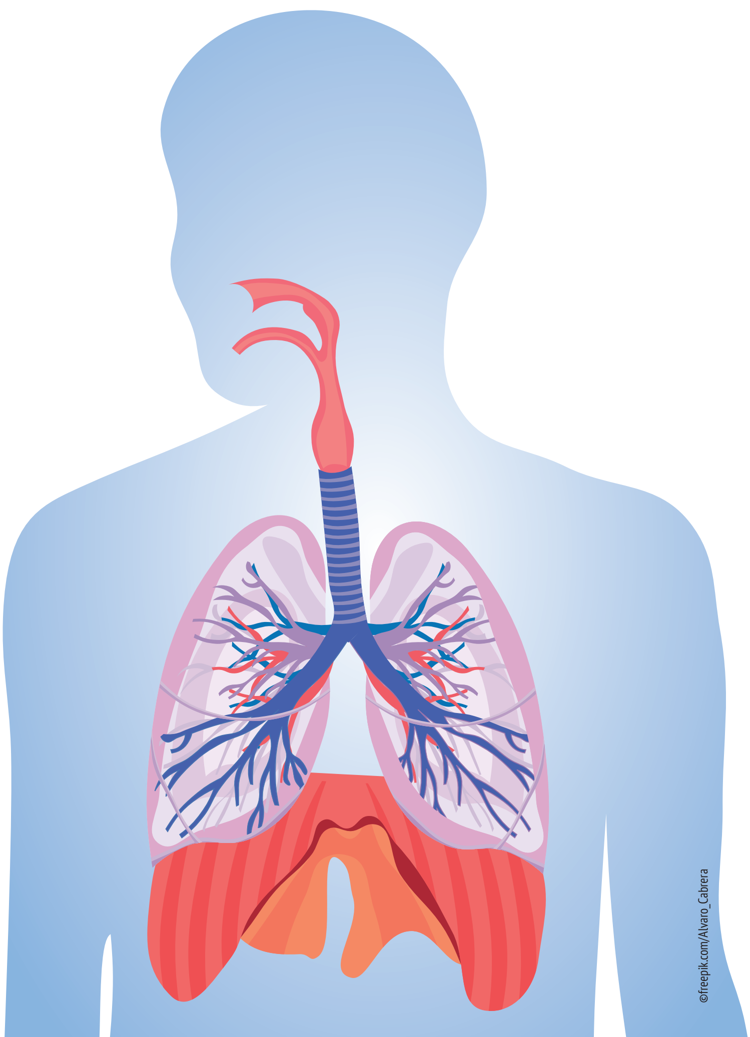
Thoughtful and well-informed divers know far more than current dive computers about conditions that may affect risk during a dive – and they will likely know far more than dive computers for many years to come. Being conscious in real time of conditions that may alter risk can make it easier to build in appropriate buffers to promote safety. Small changes toward conservatism, when applied across a variety of factors, can enhance safety with little impact on what can be accomplished during a dive.

Medical Queries

Diving with COPD, and Minimising the Effects of Jet Lag

By the DAN medical staff

Q | My doctor recently diagnosed me with mild COPD. Can I still dive with this condition? What are the risks?


©freepik.com/Alvaro_Cabrera

A | Chronic obstructive pulmonary disease (COPD), also known as chronic obstructive lung disease (COLD), encompasses a variety of respiratory health problems, including chronic bronchitis and emphysema. Regardless of what form of COPD a person may have, there are implications for diving and risks of which the person should be aware.

Chronic bronchitis is defined clinically as a productive cough that persists for periods of up to three months and occurs one or more times a year for at least two years. During these periods, the risk of infection, including pneumonia, is high. The inflammation of the bronchial passages and increased mucus production that characterise these periods are uncomfortable: Patients report wheezing, difficulty breathing and feeling as though they cannot get enough air.

For divers, the inflammation and excess mucus lead to the possibility of trapping dense compressed gas at depth. Upon ascent, the gas will expand in volume, potentially leading to pulmonary barotrauma, which could include pneumothorax (collapsed lung) and, in the worst case, arterial gas embolism (AGE). Of these, AGE is the most immediate threat to life, but a complicated pneumothorax can also be fatal.

Emphysema is defined clinically as permanent abnormal enlargement of the air spaces within the lungs due to the deterioration of the alveoli. These enlarged spaces are conducive to trapping air at depth, which creates the same possibility of pulmonary barotrauma as chronic bronchitis.

For medical management purposes, with regard to medications and other therapies, physicians classify COPD as mild, moderate, severe or very severe, as determined by the severity of airflow obstruction. Even with the clinical designation of *mild* there is measurable obstruction beyond what is considered safe among pulmonology experts trained in dive medicine. For these reasons, diving with COPD, even mild COPD, is not recommended.

Marty McCafferty, EMT-P, DMT

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Q | My next dive trip is taking me across the world. Whenever I cross time zones, I suffer relatively severe jet lag, which affects my ability to dive safely. What might I do to minimise the effects of jet lag?

A | Long-distance air travel that crosses several time zones causes jet lag syndrome because our circadian rhythms are out of sync with the time at the destination. Symptoms include fatigue, hunger and alertness at the wrong times of the day. Fortunately, within a few days, our internal clock tends to synchronise with the environment. The more time zones we cross, the greater the expression of the syndrome and the longer it takes to overcome it. To minimise the effects of jet lag, try the following strategies:

PREPARE

Before your trip, try to move your bedtime gradually to what it will be at your intended destination. For eastward travel, take one day to go to bed one hour earlier than normal for each time zone you will cross. To make it easier to fall asleep early, avoid caffeine and alcohol, and do not exercise within three or four hours of bedtime. Get up earlier, and try to catch some morning sunshine to help your body adjust. When preparing to travel west, go to bed later and stay in bed longer.

SLEEP IN FLIGHT

Losing sleep during your flight exaggerates the effects of rapid time zone change. During sleep, your body temperature falls, and the activity of some of your hormones changes. With the onset of darkness at night, the pineal gland in the brain starts secreting the hormone melatonin, which helps the body fall and stay asleep. Melatonin, however, is not strong enough to put you asleep on its own. To sleep during the flight, avoid alcohol and caffeine, which keeps you alert, and use earplugs and blindfolds to reduce noise and mimic night time darkness. If that is not enough, you can use 0.3 to 1 mg of melatonin 30 minutes before bedtime.

ADHERE TO A SCHEDULE

Upon arrival at your destination, try to stay active during daylight hours and go to bed in the evening at your usual time. In the morning, go out into the sunlight to help adjust your circadian rhythm. Of course, if you travel from a geographic area where it is summer to a geographic area where it is winter, this may not be possible; instead, try to start your morning in a gym or swimming pool.

Melatonin is no longer available as an over-the-counter product in South Africa. It has been registered as a Schedule 4 drug requiring prescription. Many manufacturers of nutritional supplements no longer offer melatonin in their range of products. A good rule of thumb when it comes to melatonin is to avoid taking more than 3 mg at once. While it is considered non-addictive and safe for short-term use, too much melatonin can also cause headaches, nausea, dizziness or irritability, and it can interact with various medications, including anticoagulants, immuno-suppressants, diabetes medications and birth-control pills. If you have any health conditions, check with your doctor before using melatonin.

Diving on the first day at your destination is probably not ideal after a long trip. To be well rested for the next day's diving, you may take melatonin at bedtime. It is not advised to engage in activities that require alertness, such as diving or driving, for four to five hours after taking melatonin. This means that if you arrive at your destination late at night and take melatonin after midnight, you should probably abstain from the first morning dive.

Petar Denoble, M.D., D.Sc.

ASK US ANYTHING

DAN-SA is here to answer all your medical questions. You can call the DAN-SA Hotline at 0800 020 111 toll free from inside South Africa or +27 828 10 60 10 from outside of South Africa. You can also email any questions to danmedic@dansa.org

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All orders can be placed through our new DAN Gear Shop at www.danshop.co.za
or by contacting the DAN Shop on +27 63 917 8371/admin@danshop.co.za.
All prices on the website include VAT at 15%. E&OE.

Featured product!

SOFT SIDED DAN OXYGEN KIT

The DAN Soft Sided Oxygen Rescue Kit unit was specially developed at an affordable price in an easy to use and portable Soft-Sided "Grab & Go" Bag.

DAN THERMAL RASH VEST

Available in black, this unisex rash vest made from Hight Stretch Lycra is fleece/fire skin lined and is great for cool water or for those who tend to get cold quickly. It is ideal for use under your wetsuit or for UV protection when in tropical locations. The DAN UV rash vest products have been tested and have all passed with a minimum UV50 factor. Using these products will decrease exposure to the sun's harmful rays and help protect against skin cancer. We still recommend using approved sunblocks for added protection while using our or any other brand's products.

DAN RASH VEST

With Rashies available in both red and white, this unisex rash vest made from Hight Stretch Lycra is a must-have for all divers. This vest is ideal for use under your wetsuit or for UV protection when in tropical locations. The DAN UV rash vest products have been tested and have all passed with a minimum UV50 factor. Using these products will decrease exposure to the sun's harmful rays and help protect against skin cancer. We still recommend using approved sun blocks for added protection while using our or any other brand's products.

DAN SURFACE SIGNALLING KIT

New and improved! This kit includes a 1.9 m orange safety sausage (with a low-pressure attachment, dump valve and reflective strip), a Windstorm whistle, a signal mirror and a signalling torch. The accessories are incorporated into the sausage's base and the sausage clips to your BCD.

DAN DRY BAG

The handy, 15 ℓ dry bag with shoulder straps and handle will soon become one of your favourite bags during dive excursions. It is ideal to keep materials such as your logbook, phone, wallet or purse dry in wet environments. A white DAN logo and the slogan "Dive Into Safety!" is printed on the bag.

Pre-dive Dynamic Warm-Up Routine

By Jessica B. Adams, Ph.D., and Jaime B. Adams, M.S.

Divers tend to be very invested in their gear. They clean masks, adjust straps, check computers, test regulators and shuffle weights prior to taking giant strides into the underwater realm. It is important that divers also remember to prepare their most important dive gear: Their bodies.

Before you dive, take a moment to inventory your body. If you were sedentary on the ride out to the dive site then your heart rate is probably near resting, so it is not circulating much oxygen to your muscles. Your muscles may be tight, which limits mobility. Your joints might be creaky, limiting comfort of movement. If you dive right in, you risk cramping up or starting the dive feeling less than optimal. You have invested a lot in your training, planning and preparation, so take a few minutes to prepare your body.

Diving is a physical activity. A proper warm-up and stretching routine is important for both enjoyment and safety during dives. A smart stretching session can boost circulation, lubricate joints and warm up muscles. It will allow you to don your gear and enter and exit the water with greater ease. It may also allow you to acclimate to the underwater environment more quickly.

A progressive warm-up gradually increases the heart rate and dilates the blood vessels, which promotes oxygenation of muscle tissue. Elevated muscle temperature optimises efficiency and flexibility. A pre-dive stretch reduces stress on muscles, tendons and joints, and increases range of motion.

Before you dive, spend five to 10 minutes completing a few rounds of the exercises below. Pay attention to how your body feels and focus on any areas that seem tight.

DAN NOTE

To avoid an increased risk of decompression sickness, DAN recommends that divers avoid strenuous exercise for 24 hours after making a dive. During your annual physical exam or following any changes in your health status, consult your physician to ensure you have medical clearance to dive

CALF STRETCH

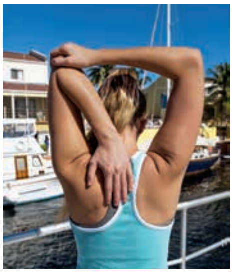
Calf cramps are a common annoyance in diving; the calf muscles (gastrocnemius and soleus) are primarily responsible for pointing your toes during finning. Tight calf muscles can lead to cramping, so stretch your calf muscles before you dive.

If you are already wearing fins, stretch your calves just like you learned in your open-water class:

1. Straighten your leg
2. Grab the blade of your fin
3. Pull the blade back toward your knee until you feel the stretch, and hold this position for 30-60 seconds
4. Repeat on the opposite side

If you are not wearing fins:

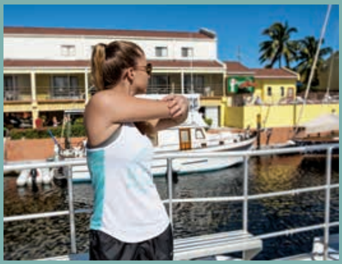
1. Sit with one leg straight (flat on the ground or seated on a bench)
2. Loop a towel under your toes
3. Pull until you feel the stretch, and hold this position for 30-60 seconds
4. Repeat on the opposite side



BACK SCRATCHER SHOULDER STRETCH

1. You do not want the first time you reach overhead to be when you need to reach a valve or locate your regulator.
2. Extend one arm straight overhead
3. Bend your elbow, and reach down your spine
4. Grasp the bent elbow with the opposing hand
5. Gently pull your elbow, and hold this position for 30-60 seconds
6. Repeat on the opposite side

Tip: Keep your head up.

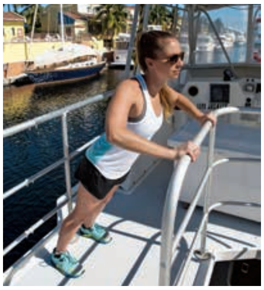


STANDING OR SEATED TRUNK TWISTS

1. Lower-back tightness is a common cause of back problems, so warm up before donning heavy dive gear.
2. Begin with a tall spine while either standing or sitting
3. Cross your arms in front of you like a genie
4. Slowly rotate to your right, hold this position for a two count, and return to centre
5. Repeat to the left
6. Move smoothly, and maintain control

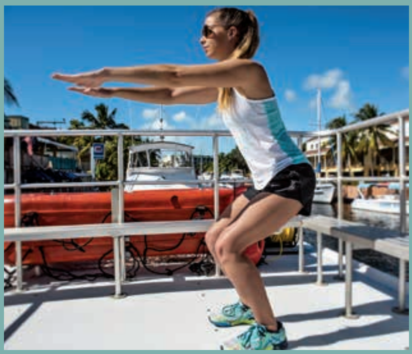
HANGING ARM CIRCLES

1. Rotator cuff issues are a common ailment as we age. Activation of the rotator muscles prepares the shoulder for action and increases joint mobility.
2. Bend over at your waist while maintaining a flat back
3. Let one arm hang freely, and rotate it 30 times clockwise and 30 times counter clockwise, gradually increasing the size of your circles
4. Use the other hand to brace yourself, if necessary
5. Switch arms after two to four sets



WALL PUSH-UPS

1. Push-ups are excellent for activating the major muscles of the upper body.
2. Stand facing a wall or a solid object at chest height
3. Extend your hands straight toward the wall with your palms flat and fingers facing up
4. Lower your chest toward the wall, hold this position for a two count, and slowly push away
5. Perform 10-15 repetitions



SQUATS

Squats activate all the major muscles and joints of the lower body, including the ankles, knees and hips.

1. Begin with your feet slightly wider than shoulder width
2. Push your hips back while maintaining a flat back
3. Lower your hips as if sitting down, and keep your knees from traveling further than your toes
4. Once you reach a comfortable seated position, stand up, pushing your hips forward

Tip: Keep your heels on the floor at all times and only do squats in calm seas.

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