More Water, Less Bubbles

What is dehydration and how does it influence Diving safety?

Dehydration occurs when the body loses more fluid than is taken in and this can lead to medical problems that should be avoided. Generally, these problems (especially in the case of chronic or severe dehydration) can result in headaches, decreased performance, irritability, confusion, fatigue, muscle cramps, reduction of thermoregulation, decreased level of consciousness, the production of kidney stones (long term) and can even lead to shock which is a life threatening condition. It is clear that these problems will negatively influence the medical condition of both divers and non divers and dehydration should therefore be avoided at all times.

For us divers there is another concern: dehydration is a contributing risk factor for Decompression Sickness (DCS).

Why? Dehydration reduces the volume of blood plasma and perfusion of tissues, so it thickens the blood and reduces blood flow. Since blood is partially responsible for the transportation of nutrients and for gas exchange, thickened blood will affect the off-gassing of Nitrogen and increasethe risk of developing DCS.

How big is the risk on DCS?

In principle, diving increases the risk of becoming dehydrated. We have seen during some of our DSL projects that many divers are not well hydrated before the dive (and even less after the dive). In normal conditions however proper hydration should not become the main concern of divers, neither should it be ignored.

However, when going on a diving holiday the risk factor rises due to increased frequency of diving and (usually) increased climate. Therefore, appropriate hydration should be a key concern.

Why does the risk factor changes during my diving holiday?

Obviously the risk does not increase just because you are on a holiday, but there are behavioural and environmental factors that contribute to the diver becoming dehydrated much faster and without realising it.

In reality dehydration begins to develop when you enter the airplane that takes you to your preferred dive destination. The air in the cabin is much dryer than the air on earth and our lungs have to work harder to humidify the air, meaning your body is constantly losing fluids whilst on board.

It is recommended to drink 240ml of water each hour of the flight. So, if you would be travelling from the UK to Egypt, you would need to drink 1.2litres of water to maintain a good balance of fluid, while you would need approximately 750ml when flying from Italy to Egypt. These are volumes not many will drink during a flight.

Many travellers also like to drink coffee, coke or a beer during their flight, but these liquids just don't have the same hydrating effect as water. Alcohol and drinks containing caffeine are diuretics, consuming these will result in dehydration as they absorb water from the cells in your body and increase urine production. Consequently, the diver arrives at their destination with mild dehydration.

But this is only the beginning of the holiday. What do divers want to do during their holiday?

Enjoy the sun, enjoy the sea, dive as much as possible and why not have some fun and drinks in the evening.

Let's take a look at why this dehydrates you faster than normal.

<u>Enjoy the sun:</u>

The most attractive dive destinations for the regular diver are those "warm water" locations where there

are nice, big coral reefs and nicely coloured fish. In these destinations there is a warm, sunny and sometimes humid climate.

It is clear that in these conditions you sweat and if you sweat you lose fluid, which if not replaced makes you dehydrated. If you then also get sunburnt you will lose fluids even faster. When you have sunburn, your skin gets red and hot (and sometimes becomes painful) and our body reacts to this by sending fluid to the skin. The sun and wind will evaporate this moisture and even more fluid gets lost in this way. Actually with these increased outdoor temperatures you also enjoy the wind and since most dives during holidays will be boat dives, you like to feel the wind on your skin which gives you that refreshing feeling. But in reality the wind (wind itself or the wind created by the velocity of the boat) evaporates sweat and moisture, increasing dehydration again.

Sea water – Salt:

When coming out of the sea, the (salt) water will dry and leave salt crystals behind on your skin. These can often visually be seen, and have the ability to absorb and hold water molecules. This means it will take the moisture out of your skin, which then will evaporate due to the sun and wind, increasing dehydration further.

Diving:

There are 3 things particular to diving itself that increase dehydration: Sweating, Immersion Diuresis (increased urine production) and breathing compressed air.While the dive suit keeps you warm during the dive, it also does not allow you to cool down. So if you already are in a warm climate and are sweating when only wearing a t-shirt, imagine how much you will sweat under the dive suit. During the dive, the increased ambient pressure and cooler water temperature will cause the blood vessels in the extremities to narrow and blood will be shunted from the extremities to the core of our body (heart, lungs and large internal blood vessels) in an effort to keep you warm. This increased blood volume in our core is seen by our body as a fluid overload. As a reaction the kidneys will produce more urine (which means losing water and salt again). This is also why divers feel the need to urinate during or immediately after the dive and this is referred to as Immersion Diuresis. Although one might think that when urinating a lot you are well hydrated, it actually means you are losing excessive fluids.

Another cause for loss of fluids while diving is the air you breathe. Just as in the airplane the air in the scuba cylinders is dry and you already know you lose more fluid to humidify this dry air. If you then also take into account that due to the colder water temperature, your lungs need to work even more to warm up the air, then you are increasing this moisture loss even more.

Alcohol:

You are on holiday and it is not uncommon to have some fun and a few alcoholic drinks when enjoying your free time.

While dinking and diving is never recommended, alcohol also makes you dehydrate faster. As you know already, alcohol (as well as coffee and other drinks containing caffeine) has a diuretic effect, increasing the urine output. This will make you urinate more frequently making you dehydrate.

Sickness:

Vomiting, because you have been drinking too much or because you suffer from seasickness or for any other reason will heighten the rate of dehydration because you lose large amounts of fluid and electrolytes in a short period of time.

The same negative effect can be seen when you have traveller's diarrhoea, which is an intestinal infection that occurs as a result of unsanitary food handling.

Medication:

Some medication, especially blood pressure medication has a diuretic effect and as you know this diuretic effect will lead to dehydration.

If you now consider that on a diving holiday, you like to dive daily and even twice a day, then you can understand the increased dehydration and DCS risk.
Obviously the risk does not increase just because you are on a holiday, but there are nine behavioural and environmental factors that contribute to the diver becoming dehydrated much faster and without realising it.

How do you know you are dehydrated and what can you do?
In general, a good indicator is the colour of urine. It should be transparent or light yellow. Darker coloured urine normally means you are dehydrated, although the colour can also be influenced by certain medication. Also little or no urine might mean you are dehydrated, although a lot of urine is not an indicator that you are well hydrated.

Symptoms of dehydration include:

Mild-Moderate

- Thirst (this means you should not only drink when you are thirsty as thirst already means you are dehydrated a bit)
- Dizziness
- Headache
- Muscle cramps
- Tiredness
- Dry or sticky mouth
- Dark coloured urine
- Decreased urine output

Severe:

- Extreme fatigue – Weakness
- Extreme thirst and very dry mouth
- Sunken eyes and/or eyes that do not produce tears
- Not passing urine for eight hours
- Dry skin that sags slowly into position when pinched up
- Rapid heartbeat, weak pulse
- Rapid breathing
- Low blood pressure
- Irritability and confusion
- Seizures
- Low level of consciousness

Most dehydration is mild and can easily be resolved by drinking more water. The use of Oral Rehydration Salts or Isotonic sport drinks in addition to water can also be considered as these will replace salts and electrolytes. However, where more severe symptoms are apparent, immediate medical care is required.

How to avoid dehydration?
It is much better to avoid dehydration instead of resolving it. Only by avoiding it, divers will reduce the risk of DCS.

After discussing dehydration and its effects on the body, we can conclude you should rinse yourselves down with fresh water after every dive, keep your dive suit off until right before the dive itself, avoid or moderate alcohol consumption or drinks with caffeine and protect yourselves from too much sun/sunburn.

But the easiest thing to do is to drink plenty of water. However, you do not want to increase plasma volume too rapidly as this will only increase urine production again and not hydrate the body tissues. Therefore the advice is to drink a glass of water every 15-20 minutes instead of drinking a litre of water just before or after the dive. This will allow the tissues to be hydrated and consequently avoid the decreased gas exchange which can lead to bubble formation and DCS. How much you actually need to drink depends on many factors, but drinking at least 2 litres extra (in addition to what you normally drink a day) will help you to keep hydrated. You can also consider eating foods with a high water content, such as fruits and vegetables. Some companies also sell drinking bags that can be used to drink under water, during the dive.

The DAN Europe "More Water, Less Bubbles" safety campaign.

DAN Europe started the "More Water, Less Bubbles" campaign at the end of 2012.

Articles such as this one have been published in the Alert Diver magazine and on the website. In addition, an email campaign was started amongst DAN members, informing them on how to avoid dehydration and thus reducing the risk of DCS. At the 2013-2014 dive shows 3000 aluminium drinking bottles with the campaign's slogan where distributed amongst new and renewing DAN members.Posters and banners, reminding divers to drink enough water have been made and placed in different locations in Egypt, where due to the climate, the amount of diving and the high amount of tourists, dehydration is one of the major risk factors in getting DCS.

DCS is caused by bubble formation and growth in the blood and body tissues which can result in hypoxia. In normal circumstances Nitrogen is washed out by the lungs after a dive, but this washout will be less effective when the diver is dehydrated, increasing this bubble formation and growth, which can lead to DCS.

The slogan "More Water, Less Bubbles" refers to the fact that when a diver is well hydrated, the risk on this bubble formation and growth will be less.

Additional info

Research was also done on pre-dive hydration (Report published on 4 march 2008; Preventive effect of pre-dive hydration on bubble formation in divers by E Gempp, J E Blatteau, J-M Pontier, C Balestra, P Louge).

Although this report is not particularly concentrating on dehydration it shows that pre-dive hydration significantly decreases circulatory bubbles, thus offering a relatively easy means of reducing DCS.

Additional Research was done by DAN Europe on Surface Tension. Surface tension (ST) is a potent natural force, typical of many substances, including body fluids and tissues. When dealing with bubbles, it is inversely proportional to the cubic root of the radius of the bubble. That is very small bubbles are subject to very high Surface Tension (pressure), larger bubbles are subject to lower Surface Tension. With high ST a bubble is subject to a force which contrasts its growth and may even lead to its disappearance. Low ST, on the contrary, will allow a bubble to grow faster and with less external impediments.

The graph below (left) shows that Urine ST is similar to Blood and Plasma ST and can be easily measured, whilst providing good information on Blood and Tissue ST. On the right of the graph it is shown that high ST corresponds to low Urine Specific Gravity (diluted urine), and low ST to high Urine Specific Gravity (concentrated urine). This shows how a very diluted urine (a well hydrated diver) contributes to high ST in the body fluids and tissues and may contribute to prevent bubble growth, whereas the contrary may happen with concentrated urine (a not sufficiently hydrated diver).

Circulating Bubbles detected by Precordial Doppler after a 45 meter,20 minute dive in normohydrated and hyperhydrated subjects.Hydration significantly reduces the amount of circulating bubbles.