

DAN: Your Dive Safety Association

# ALERT Diver

Autumn Edition 2010, Vol 2 No 1

TO DIVE OR NOT TO DIVE • AIR QUALITY • EMERGENCY ASCENTS

**To Dive or not to Dive**  
All your medical diving-related questions answered

**Air Quality**  
Is your breathing air up to standard?

**Hotline Report**  
Activity statistics for 2009

**Emergency Ascents**  
Putting theory into practise

ISSN 2071-7628

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DIVERS ALERT NETWORK

“

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is unthinkable!*

”

Mark, DAN Member

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# To Dive or not to Dive

**Dear** DAN members

We are all excited about the prospects for 2010 and we are looking forward, together with the rest of our DAN members, to the FIFA World Cup this year. We hope, as the attention of the world becomes riveted on South Africa, that all South Africans will rise to the occasion and show the world the very best our country has to offer – including some of the best diving there is!

Because of the importance of international relationships and collaboration, this year DAN Southern Africa will focus particularly on building new, as well as expanding and strengthening existing relationships with diving operations and recompression facilities around the globe. This has a profound effect on improving the safety and emergency management of diving injuries by fostering trust and collaboration with DAN before an unfortunate accident demands this. Often, dive operators and local emergency facilities have the best understanding of local conditions, so it is very productive to develop contacts and relationships upfront to exchange information so that time-sensitive decisions can be made with the benefit of all the available information. DAN has been doing this for years already, but now we have two programmes that can provide additional structure to the process: the Dive Safety Partners (DSP) and Hazard Identification and Risk Assessment (HIRA) programmes. DSP and HIRA are laying the foundations for emergency preparedness and injury prevention and are taking the International DAN and diving communities by storm. During 2010, these two programmes will be further developed and expanded on an international level.

In this edition of *Alert Diver* we pay attention to several fitness to dive issues that receive regular attention on our DAN hotline. Having background information on why certain medical conditions may affect diving safety is helpful when speaking to someone with the condition – like a diving student. It may also be of relevance to you if you are the one suffering from them. Without this information, divers may either tend to ignore the safety implications or – perhaps just as unfortunately – have a nagging discomfort or concern that something may go wrong but choose to ignore or suppress the anxiety. This may introduce a completely unnecessary burden on the mind, increase the possibility of panic and rob the diver of much of the enjoyment of diving. It is always better to be informed and to manage the risks in a responsible way. Today, there are few medical conditions that represent an absolute contraindication to diving. Remember that you can always send an enquiry to [medical@dansa.org](mailto:medical@dansa.org) or call the hotline/medical information line if you need more information about a particular medical condition.

Last but not least, we are very pleased to welcome a new diving medical officer to the DAN Southern Africa medical team. Dr Cecilia Roberts is the manager of the Stellenbosch University Baromedical and Occupational Medicine Facility at Tygerberg, Cape Town. She has extensive training and experience in anaesthetics, emergency medicine, hyperbaric medicine and diving medicine. She is a welcome addition to our group. Welcome aboard Cecilia!

With that, we wish you all a joyful and productive 2010!

Until next time – safe diving!



Dr Frans J Cronjé  
President and CEO DAN Southern Africa

“

*It is always better to be informed and to manage the risks in a responsible way. Today, there are few medical conditions that represent an absolute contraindication to diving.*

”



# THE TEAM



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FRONT COVER



Image by Sean Sequeira

# IN A DIVE EMERGENCY

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OR

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from **OUTSIDE** South Africa

#### DAN PUBLICATION PHILOSOPHY

*Alert Diver* Southern Africa is a forum for ideas and information relative to diving safety, education and practice. Any material relating to diving safety or diving medicine is considered for publication. Ideas, comments and support are encouraged and appreciated.

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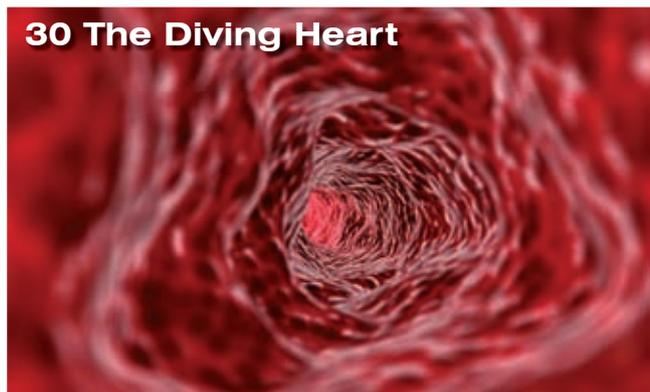
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# DAN Letters & Comments



Good day

I have spoken to a lot of people at DAN and have always been treated like royalty. It is much appreciated to know that there is a friendly face out there willing to help with a smile in times of need.

I am a keen technical diver and have been a member of DAN since I started with technical diving. I think all divers should be on the DAN scheme and thus, I will always promote it as such. As was discussed at a recent DAN talk, people often misunderstand who and what DAN is. For this reason, we always try to help people understand better.

I'm a proud supporter of DAN and hope to learn more from you.

*Rudi*

*DAN master member*

Dear Dawn

Thank you and the DAN team for taking care of me when I had my diving accident.

It is good to know that DAN helps when needed. You can be assured that we will promote DAN membership to all our dive colleagues.

In fact, we make it a condition of employment that all our staff members are active DAN members.

*Roland*

*DAN business member*

Dear DAN

I have today completed my DAN instructor course with Barbi Mueller and I would like to take this opportunity to thank you and compliment you on the following:

1. The quality of your teaching and learning material is beyond words, but let's say for now – fantastic!
2. I would also like to compliment your instructor trainers (in my case Barbi) for being the best instructors ever. Keep up the good work Barbi and DAN.

Once again, well done to your trainers and to you, DAN.

*Samer*

*DAN member, Mauritius*

Send your letters to:  
Alert Diver Magazine  
Private Bag X197  
Halfway House 1685  
or email to:  
alertdiversa@dansa.org

## FISH FUNNIES

**Sometimes fish have their funny moments too, you know.**  
Share your funny fish images with us by sending your image and funny caption to [alertdiversa@dansa.org](mailto:alertdiversa@dansa.org)



*Image by Steven Hartman.*

*Eye-yaai-yaai! Earl gives a new meaning to "double vision".*

## DR OCTO SAFETY FIRST



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# The DAN-SA Team

## The Core Team of DAN-SA

### DR FRANS CRONJÉ



Frans is the founder, president and managing director of DAN-SA.

### FRANCOIS BURMAN

Francois serves as the financial and operations director for DAN-SA. He is currently responsible for the operational, technical, safety, financial and insurance aspects of DAN and its programmes. He serves as treasurer on the board of International DAN and is the technical consultant for IDAN.

[francois@hydra.org.za](mailto:francois@hydra.org.za)



### HELIA VAN ZYL

Helia serves as our DAN office manager where she is responsible for the operational aspect of DAN-SA's membership services and the staff.

[helia@dansa.org](mailto:helia@dansa.org)



### MORNÉ CHRISTOU

Morné manages special projects and marketing. He is also our Diving Safety Partners (DSP) Programme co-ordinator.

[morne@dansa.org](mailto:morne@dansa.org)



### DAWN CARVER

Dawn is responsible for supporting the DAN-SA medical information and emergency hotline during office hours. She works closely with Netcare when further assistance or evacuation is required and provides important quality assurance and customer care related to these calls.

[danmedic@dansa.org](mailto:danmedic@dansa.org)



### SEL-MARIE PEREIRA

Sel-Marie is our DAN membership services administrator. She is responsible for all aspects of membership administration, data capturing and sales.

[sel.marie@dansa.org](mailto:sel.marie@dansa.org)



### TONI McQUILLEN

Toni serves as our membership services assistant and is responsible for assisting in the general day-to-day administration of DAN-SA membership as well as student membership.

[toni@dansa.org](mailto:toni@dansa.org)



# The DAN hotline is manned 24/7/365 by operators and doctors especially trained to deal with dive emergencies.

These are the doctors who take turns to be on call for the DAN-SA hotline:

## The Medical Team of DAN-SA

### DR JACK MEINTJES



Dr Jack Meintjes has served as the medical director of DAN-SA since 2007. Dr Meintjes has experience in hyperbaric medicine and has vast commercial diving medical knowledge and experience.

### DR ISABEL DU PREEZ

Dr Du Preez is currently one of the directors of the emergency rooms at Akasia Hospital in Pretoria. She has served as a DAN medical officer since 2006.



### DR MIKE MARSHALL

Dr Mike Marshall serves as the medical director for the St Augustine's Hyperbaric Medicine Centre since its inception in 2000 and has been a part-time medical officer to DAN since 2002.



### DR LOURENS DE KOCK

Dr Lourens De Kock is one of the partners in a busy diving, aviation and maritime medical practice in Cape Town.



### DR GARY MORRIS

Dr Gary Morris is a general medical practitioner from Scottburgh, KwaZulu-Natal.



### DR ROB SCHNEIDER

Dr Rob Schneider is a general medical practitioner practicing full time in emergency medicine in Pretoria.



### DR CECILIA ROBERTS

Dr Cecilia Roberts has recently joined the DAN-SA medical team and serves as the medical director for the SUN Baromedical Facility. She is currently completing her BScMedScHons degree in Hyperbaric Medicine.





# Hotline Activity Report for 2009

By Dawn Carver

“

*Sadly, we need to report three diving fatalities and one non-dive related fatality. This is a huge jump compared to the previous year of one.*

”

**This** table is a summary of hotline activity from 1 January to 31 December 2009 for the DAN-SA regions.

Six flight evacuations were facilitated in 2009. In each case, the patient was in a critical condition and required urgent medical or surgical care. One was a commercial flight where our patient travelled unescorted, the other five were fixed-wing flights.

There were 12 road ambulance evacuations, most of which were from the Sodwana Bay and Manguzi area, and two were from Aliwal Shoal.

We have also noticed an increase in dive-related trauma cases – please be careful when getting in and out of the boats. Potential injuries are lurking: falling cylinders, slipping/losing footing on the boat, falling out of the boat, getting stuck between the boat and rocks and catching fingers somewhere.

Sadly, we need to report three diving fatalities and one non-dive related fatality. This is a huge jump compared to the previous year of one. This is of great concern to us. We can attribute two deaths to lung barotrauma and the other two to drowning.

## Hotline summary: 1 Jan - 31 Dec 2009

Emergencies	139
Non emergencies	260
Email queries	110
Air evacuations	6
Road ambulance	12
Self drives	47
Chamber re-compression	26
Hospital admissions	39
Out patients	59
Surface O <sub>2</sub> provided at scene	38
DCS	34
Barotrauma pulmonary	5
Barotrauma ear	33
Barotrauma other	8
Air embolism	1
Hazardous marine life injury	9
Trauma dive related	13
Trauma non-dive related	1
Non-dive related	21
Other queries	140
Malaria queries	33
Fitness to dive	197
Swimmers ear	14
Fatalities	4

### EVACUATION OPTIONS

As a standard rule, always prepare an emergency assistance plan (EAP) for your dive trip, over and above planning your dive, even if you go to the same dive site regularly. Know what emergency resources are available in that area so that you can be prepared and informed of what time delay to expect before an ambulance or flight can get to you. This will also help in knowing what type of medical kit to take with.

The hotline can assist you with this if you are unsure where to start. You can simply email [medical@dansa.org](mailto:medical@dansa.org) with your plans, and we will advise you what recourses are available in the area and what time delays are expected. From there you will know how to prepare optimally for an emergency.

### IN THE EVENT OF AN EMERGENCY

We would like to remind all our members to please contact the DAN hotline as soon as possible in the event of an emergency. The dive medical officer on duty will pre-approve any services that may be required and advise whether you are getting the correct medical care. Claims received that have not been pre-approved will be assessed upon their merits. The DAN hotline also assists non-members with medical queries and emergencies, however, the services used will be for their own account. **AD**

**24-HOUR DAN  
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OF SOUTH  
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- Help in Diving Emergencies
- Specialised Diving Physician Referrals
- Access to Evacuation in a Medical Emergency

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International Number  
**+27 828 10 60 10**

Info  
**0860 242 242**

Website  
**www.dansa.org**

Email  
**mail@dansa.org**





Image by Cormac McCreesh.

# DAN

## Membership Options

**You've** been a DAN member for years! And thank goodness, you've never had to use your DAN membership.

The peace of mind that your DAN membership offers, and the opportunity to contribute towards its diving safety services, justifies your staying on, you keep reminding yourself.

"You are the kind of diver we truly appreciate," the DAN membership service

representative jokingly says in closing as you put down the phone after signing up for another year of DAN membership.

Indeed, it is great that you have never had to use your DAN membership, but allow us to remind you of everything DAN offers you and what the organisation you are supporting offers you.

### HELP IN DIVING EMERGENCIES

Our 24-hour emergency hotline (0800 020 111 inside SA or +27 11 82 810 6010 internationally) is available 365 days a year to deal with any dive emergency. It need not be serious – in fact, most dive injuries are not serious at all. And although DAN membership is secondary to any medical aid you may have, the operators and DAN doctors are always available to make sure that you are referred to the correct facilities and get the best possible care. DAN covers the costs of emergency medical treatment for dive injuries according to your membership level. This cover is valid worldwide! Remember, if you do not call the DAN hotline, we might not be able to guarantee payment of your claim.

### MEDICAL ADVICE

Our medical advice line is available through the DAN hotline during office hours or via email (medical@dansa.org) to answer any questions you may have. This service is FREE to the diving community.

### DIVING PHYSICIAN REFERRALS

If you need to see a diving doctor at any time, whether it's for an annual dive medical check-up or for equalising problems, the DAN-SA hotline will be able to refer you to a doctor

in your area that has specialist scuba diving knowledge. DAN only covers the cost of emergency medical treatment for a dive-related accident or injury, and does not cover the cost of routine medicals – but we can still assist you in getting the best possible care!

### INTERNATIONAL TRAVEL COVER

Over and above the cover DAN provides for diving emergencies, DAN members have access to 90 days medical cover for any other medical emergency whenever they travel internationally, as per the policy terms (valid for Plus and Master members only). This cover is also FREE to registered diving and non-diving family members of Plus and Master members.

### LOCAL EVACUATION COVER

Whenever you travel more than 100 km from home or are on a dive trip (which can sometimes be closer than 100 km), DAN will cover transportation to the nearest appropriate medical facility in the event of a medical emergency. This is a secondary cover to any medical aid or other cover you may have, but it may prove valuable if you are involved in an emergency and do not have evacuation cover.

### DIVE GEAR COVER

This is often the source of much confusion. DAN-SA does not provide cover for dive gear. Please make sure that you insure your gear adequately when you travel – this is usually available through your household insurance.

The only time that loss, damage or theft of dive gear is covered under DAN-SA is if it was due to a medical emergency or evacuation where the gear was left at the site and went missing or was damaged as a result of the dive accident.

### DISCOUNTS FOR FAMILIES – HAVE YOU TAKEN ADVANTAGE?

Since the introduction of the DAN Diving Family Membership, we've had hundreds of families convert their membership to this discounted package. DAN membership costs as little as R2.60 per diver per day for a family of four divers on the Master Membership. We urge you to take advantage of this package! **AD**

**Contact DAN Membership Services for any queries or questions regarding your DAN membership.**

**Email: mail@dansa.org or call: 0860 242 242**



# DAN Training and Education

# Dive Medicine for Divers



**When** you want to know more than just basic first aid techniques, Dive Medicine for Divers is your next step. Ultimately, more knowledge and a better understanding of how our bodies react to the pressures and stresses of diving lead to safer divers as we understand our limitations and the limitations of the situation.

Created as an educational programme to answer many questions divers ask, this new modular programme, Dive Medicine for Divers: Level 1, includes sections on fitness to dive, safety planning and basic physical examinations.

The course includes a selection of new skills and practical applications, along with lecture topics presented by a DAN instructor trainer or instructor using video programmes and additional self-study information.

The first three modules are:

- **Basic Examinations** – this module teaches you how to evaluate a diver's respiratory and cardiac function using a stethoscope.
- **Fitness to Dive** – this module discusses what it means to be physically fit enough to dive and the medical conditions that can keep divers out of the water. There is also a discussion on basic ear-clearing techniques.
- **Safety Planning** – this module includes processes and procedures to make your dives safer, but also discusses how to deal with the aftermath of a dive accident, including taking care of the diver's equipment for investigation and taking care of the rescuers afterward.

## OBJECTIVES

Level 1 represents advanced knowledge development for divers interested in better understanding diving medicine and dive safety. It includes topics on fitness to dive, safety planning, basic physical examinations, and incorporates the DAN Diving Emergency Management Provider and On-Site Neurological Assessment for Divers courses.

## PROGRAMME OBJECTIVE

The programme is designed to inform divers about what happens in a diving emergency and how diving affects their bodies. It provides a framework to educate interested divers in a series of topics not normally addressed in diving training.

## LEARNING OBJECTIVES

Upon completing the components of the educational programme, divers will understand the various skills involved in assessing and caring for an injured diver. They will also better understand how to prevent dive accidents and how to respond to them when they do happen.

DAN support materials for Dive Medicine for Divers: Level 1

- Fitness to Dive
- Safety Planning
- Basic Examinations

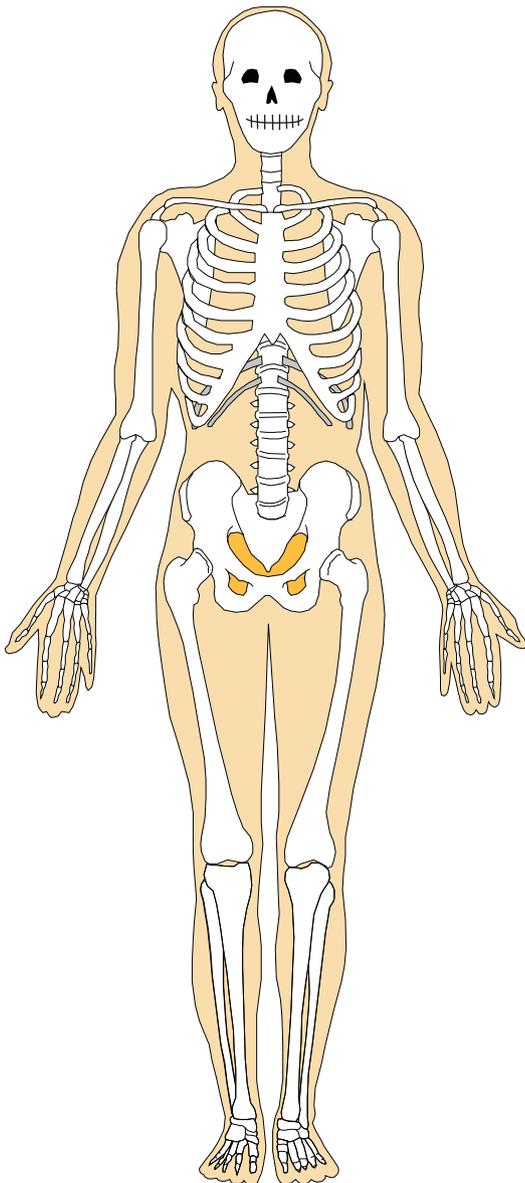
Additionally, to meet the requirements of this educational programme, divers must complete, or hold a current certification in the DAN Diving Emergency Management Provider (DEMP) Course and the DAN On-Site Neurological Assessment for Divers Course. These materials are separate from the Dive Medicine for Divers: Level 1 materials.

For more information, contact DAN Training at [training@dansa.org](mailto:training@dansa.org) or visit the DAN website to find an instructor in your region. 

# Diving with a MUSCULOSKELETAL condition

By Dr Ernest Campbell and Dr Frans J Cronjé

**Our bodies are suspended on a musculoskeletal frame that endures remarkable wear and tear during a lifetime. Sometimes infirmities may affect strength, flexibility and mobility or cause painful conditions that may affect our ability to dive safely. In this article we review some of the conditions that divers may face during a lifetime of diving.**



## AMPUTATIONS

Amputees dive regularly and with care, training and assistance, perform as well as seasoned divers. Several things need to be discussed, as far as the risks involved are concerned.

First, there needs to be an investigation into the reason[s] why the amputation[s] occurred. Traumatic amputations usually don't imply underlying disease, however, there are many reasons why amputations are done that can impact the diver adversely. Most of these are related to poor arterial or venous blood supply and include the following: phlegmasia cerulea dolens, thromboangiitis obliterans, diabetic neuropathy, arterial embolism, osteosarcoma, diabetes foot care and arteriosclerosis of the extremities. It is evident that some of these can impact the diver adversely and offer clues as to the appropriate advice to be given to the diver about whether or not to dive. These conditions should alert one to the possibility of hypoglycaemic-related incidents and related arterial problems in the heart.

Second, confusion as to the origin of missing limb pain, either phantom limb pain or stump pain, can be quite important in sorting out the cause of pain after a dive. Careful recording of the type, severity and location of missing-limb pain would be helpful in avoiding a trip to the chamber, post dive.

Avoiding other problems with gearing up and thermal protection are generally easily managed. Entry, exit, self rescue and buddy rescue are more difficult and require assistance from the instructor or dive master.

Prostheses usually do not pose a problem as they are usually waterproof and in some cases add to the safety of the diver by offering balance and assistance in movement in the water.

## ANKYLOSING SPONDYLITIS ("BAMBOO BACK")

Ankylosing spondylitis is a chronic or long-lasting disease that primarily affects the spine and may lead to stiffness of the back. The joints and ligaments that normally permit the back to move become inflamed. The joints and bones may grow (fuse) together. The cause is unknown but genetics seems to play a role. The condition is diagnosed by the patient's medical history, x-rays of the back and certain blood tests that show the genetic makeup of the patient. Treatments may include: exercise, non-aspirin anti-inflammatory medicines, sulfasalazine, non-surgical self-help aids and surgery.

Diving with this condition would be difficult when it is active due to the pain and disability from back stiffness. Depth and pressure would have little effect on the condition. Treatment options would pose no specific risk to the diver. Altered posture might present a problem with gearing up, water entry and exit but is probably manageable with planning and assistance.

## BACK ACHE

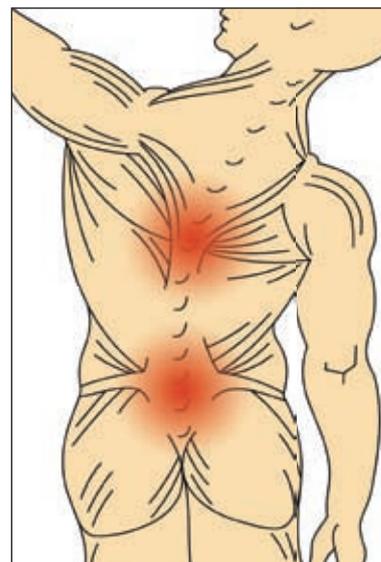
Most back ailments are located in the region of the lower back and are related to muscle and ligamentous problems.

Some of these problems are due to one or more of the following:

- Small fractures or compression fractures of the spine from osteoporosis (thinning out of bone)
- Ruptured or herniated disc
- Degeneration of the discs
- Poor alignment of the vertebrae
- Spinal stenosis (narrowing of the spinal canal)
- Strain or tears to the muscles or ligaments supporting the back
- Spine curvatures (like scoliosis or kyphosis) which may be inherited and seen in children or teens
- Other medical conditions like fibromyalgia and spondylitis

Diving obviously should be limited in situations where there is acute back pain with decreased ability to function.

Pain medications and muscle relaxers usually used to relieve this type of back pain would probably be averse to diving due to the decreased cognition and inability to multitask. Divers with chronic back pain that is being controlled by exercises, pain medications and muscle relaxers are also at risk for reinjury from excess weight bearing from heavy gear, injury from water entry and exit and worsening due to the head-up position required of divers in the water. On the positive side, divers report relief of back pain underwater due to the weightlessness of the dive.



## BODY WEIGHT

Questions are often asked about diving while overweight, body mass index and percent of body fat. There is no question that the risks are increased for divers who are overweight (BMI greater than 30kg/m<sup>2</sup>). There are several reasons why adiposity is important in considering whether or not a person is fit to dive.

### Obesity and Decompression Illness

There is a considerable body of work relating an increased incidence of DCS to increased percentage of body fat. Higher DCS rates have been noted in the older diver due, in part, to the gradual increase in skin fold thickness (percentage body fat) and possibly to the increased incidence of cardiovascular disease, commonly noted in the obese.

When one dives, nitrogen dissolves in all tissues of the body in proportion to the gas solubility and the blood flow to the tissue. Nitrogen is very soluble in adipose (fat) tissue and, in overweight people, the fraction of this tissue in the body is high. Nitrogen loads can rise in adipose tissue and bubble formation can be extensive. These gas bubbles would empty into the venous system where they are carried to the heart and lungs. If the gas bubble loads to these organs are high, the lung capillaries become blocked, blood pressures rises in the pulmonary artery and bubbles can pass through the lung vasculature (or a patent foramen ovale in the heart) and embolise the brain. This might lead to a vein-to-artery “stroke” and neurological DCS.

Dembert et al, in 1984, reported a higher incidence of decompression sickness in U.S. Navy divers who had higher measures of skin fold thickness. In the same year, McCallum reported a higher incidence of decompression illness in obese commercial divers. Chryssanthrou noted the incidence of osteonecrosis to be higher in those who had a higher degree of obesity.

### Cardiovascular Disease Risk Increase

#### BMI

In some areas of the world where medical fitness is stringently regulated, a high BMI (body mass index) would deter one from diving. Complicating conditions of adiposity include diabetes mellitus, dyslipidemia or hypertension and their associations with coronary artery disease. The BMI is important to divers due to the fact that people with high BMIs are more prone to coronary artery disease and an untoward coronary event while diving. A BMI above 30 kg/m<sup>2</sup> is thought to be excessively risky for diving. Of course, measured %BF can sometimes show that the diver is quite large and muscular and this needs to be taken into consideration.

“  
Nitrogen is very soluble in adipose (fat) tissue and, in overweight people, the fraction of this tissue in the body is high.  
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*Most diving physicians feel that post-surgical and healed vertebral fusions generally are thought not to impose any restrictions on diving.*  
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The Spine



SPINAL COLUMN  
 Lateral View

**Appetite suppressants**

Medications given for appetite suppression also have a risk for diving in that most have psychotropic effects and can cause elevated blood pressures. The possible ill effects of nitrogen added to the drugs are not known.

DAN's report, DCI and Diving Fatalities for 2000, shows a high incidence of cardiovascular disease fatalities in divers over the past nine years, surpassed only by AGE in 1998.

**Diabetes**

The overweight person is also at an increased risk for diabetes. Unknown and untreated diabetics are at risk for wide swings in blood sugar levels, often brought on by stressful situations such as diving and cold water. Low blood sugar (hypoglycaemia) is a risk factor for divers, known to cause drowning and gas embolism on ascent.

**Decreased pulmonary function**

The obese diver would be at risk for carbon dioxide retention and hypoxia due to decrease in all parameters of pulmonary function. This would be highly variable with the individual and would require PFTs to determine the real risk. Pulmonary function tests that are more than two standard deviations from normal would indicate high risk. Low vital capacity and FEV1 would be indicators of possible increased risk.

Decreased physical fitness, often associated with obesity can thus lead to the following:

- Increased DCS
- Decreased ability for self rescue
- Decreased buddy rescue ability
- Increased risk of panic in stressful situations

**CARPAL TUNNEL SYNDROME**

Carpal tunnel syndrome occurs when tendons or ligaments in the wrist become enlarged, often from inflammation. The narrowed tunnel of bones and ligaments in the wrist pinches the nerves that reach the fingers and the muscles at the base of the thumb. Symptoms are often a burning, tingling numbness in the fingers (especially the thumb, index and middle fingers), but can also be an inability to grip or make a fist, often causing the person to drop things. Causes range from work-related cumulative trauma of the wrist to predisposing conditions such as pregnancy, diabetes and obesity. Treatment includes immobilising the wrist in a splint, anti-inflammatory drugs or injections of cortisone in the wrist to reduce the swelling or surgery.

Problems with regards to diving would be difficulty donning gear, inability to self or buddy rescue and confusion with DCS as to neurological signs and symptoms. Careful recording of neurological deficits should be accomplished before diving.

If surgery is performed, one should be able to return to diving after complete healing of your incisions and satisfactory rehabilitation, as determined by your operating surgeon. We cannot give you specific time intervals as this differs widely between individuals and is highly variable. A reasonable period of time, such as four to six weeks, should suffice – barring complications or wound infections.

Healed nerve and tendon release operations generally are thought not to impose any restrictions on diving. However, there is the theoretical caveat that there might be an increased risk of bubble formation in regions of surgery where there has been some disruption of blood supply, leaving an increased or decreased vascularity. There have been no studies to prove or disprove these cautionaries, however.

**DISC HERNIATION AND SPINAL SURGERY**

An intervertebral disc is a fibrofatty cushion of tissue between each vertebral body of the spinal column. This can become weakened and protrude into the spaces between and behind the vertebral bodies, pressing on nerves and spinal cord tissue. This causes pain and neurological symptoms, such as numbness and loss of motor function of the extremities.

Diving with unoperated herniated disc disease is thought by some authorities to constitute a contraindication to scuba diving due to the further risk of neurological symptoms from protrusion of the disc with impingement on the spinal cord nerves and confusion with DCS. People with neck and lower back disc problems causing radicular neuropathy (damaged nerves with pain, numbness and muscle weakness) should not dive until this has been surgically repaired. It would be our feeling that if you dive, you should discuss this with your surgeon in terms of weight bearing, climbing and the hyperextended neck position that is required with scuba diving.

People with lumbar herniated discs without protrusion can and do dive, however, there is a definite risk of acute herniation with the lifting activity and strain of getting back into the boat. Acute herniation can mimic a decompression accident.

It would be wise to have a neurological examination carefully recorded and with you on your dives for comparison reference in case of a decompression accident.

Most diving physicians feel that post-surgical and healed vertebral fusions generally are thought not to impose any restrictions on diving. However, some feel that there is the theoretical caveat that there is an increased risk of bubble formation in regions of bone where there has been some disruption of blood supply – leaving an increased or decreased vascularity. There have been no studies to prove or disprove these cautionaries, however.

### Return to Diving Post Surgery

There are no set guidelines that govern the return to diving after disc surgery. This will depend, to a great extent, on the type of surgery, presence or absence of complications, whether or not a fusion has been done and if there have been any complicating factors, such as a wound infection or residual symptoms.

Generally, a person may return to diving in three months with the OK of the operating surgeon.

There is an absolute contraindication to diving after disc surgery that has failed and results in spinal stenosis. If there are major complications or deficit after the surgery, one probably should not dive. There is a relative contraindication to diving after having a herniated disc repaired below L1-2 and a repaired cervical disc from the anterior approach – both should wait at least three months and then dive only if there are no residua.

It should be obvious that minimising bubble formation is essential for safe diving and to avoid long-term damage to the central nervous system. Consequently, it would probably be wise to emphasise conservative diving in those who have had operative procedures near or about the neurological system.

## COMPRESSION FRACTURES OF THE VERTEBRAE

Compression fractures of the vertebrae occur when the body of the vertebra collapses. This condition may be caused by osteoporosis (the most common cause), a tumour or trauma to the back. Symptoms depend upon the area of the back that is affected, however, most fractures are stable and do not produce neurological symptoms.

People with compression fractures with nerve root or spinal deficit symptoms, even if episodic, should not dive until the problem is repaired by spinal fixation. Symptoms of numbness and pain are mimicked by decompression sickness and pose problems in differentiation after a dive. The chances of even more scar tissue developing postoperatively are great. Weight bearing and donning gear on the surface can be real problems to the affected diver, even though it is stated that once in the water they are more comfortable due to the loss of gravity effects.

DAN feels that diving should be postponed until the back is surgically stabilised. With significant symptoms, it wouldn't take much to become paraplegic (and then the diver would be in a jam). Ironically, if the diver were paraplegic and stable we could make some arrangement for him/her to dive, but that's certainly not what we want!

A diver has to carry his equipment on land (or on a boat) and be able to perform hard physical work on occasions. Weight bearing with grade 3 spondylolisthesis can certainly lead to nerve root compression, resulting in severe pain, paralysis and loss of function. In addition to causing its own difficulties, this can mask neurological symptoms caused by decompression illness. Until surgically repaired, significant spondylolisthesis would be disqualifying – a three month postoperative period should be allowed and no diving at all if there are significant residua.

## DYSBARIC OSTEONECROSIS (BONE ROT)

Dysbaric osteonecrosis is the death of a portion of bone that is thought to be caused by nitrogen embolisation “blockage” of the blood vessels in divers from pressure changes. Although the definitive pathologic process is poorly understood, there are several hypotheses:

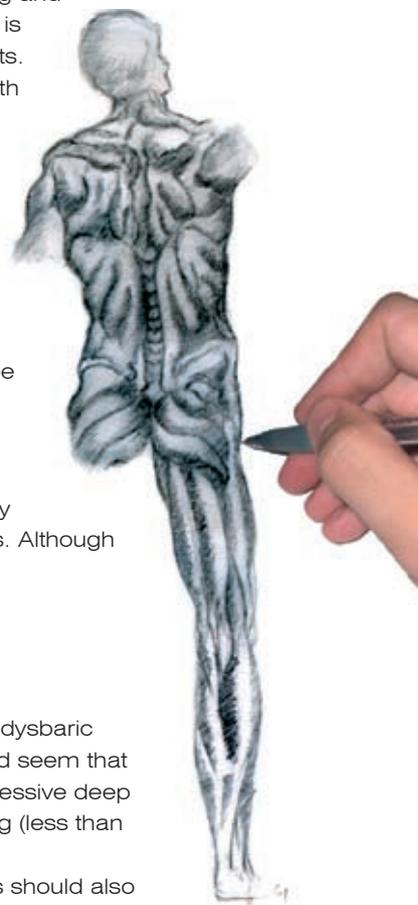
- Intra- or extravascular nitrogen in bones (nitrogen embolisation)
- Osmotic gas effects due to intramedullary pressure effects
- Fat embolisation
- Haemoconcentration and increased coagulability

Advising the diver on returning to diving depends on the type of diving that caused the dysbaric osteonecrosis in the first place. The condition is rarely seen in sports divers and it would seem that the person would be particularly susceptible to the illness if it had occurred without excessive deep or decompression-type diving. It would probably be wise to limit diving to shallow diving (less than 40 feet/12 m) and avoid experimental or helium diving.

Caveats concerning weight bearing, self and buddy rescue and entry/exit problems should also be addressed by the dive master or instructor.

### NOTE:

Because spinal disc herniation is considered a degenerative condition (i.e. something that occurs as a function of aging rather than accidental injury), this is excluded from cover under the DAN group policy even if it is precipitated by a traumatic event. Divers presenting with acute back problems during diving activities may receive assistance and evacuation until the diagnosis is confirmed. Thereafter, all expenses related to the medical or surgical management of disc herniation are excluded from coverage.



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*Divers with acute bone or joint injury or inflammations should not return to diving until the injury has healed and there is a full range of motion and strength, and until they have received the OK to return to diving from their physician.*

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## FIBROMYALGIA

Fibromyalgia (FM) is an increasingly recognised chronic pain illness which is characterised by widespread musculoskeletal aches, pain and stiffness; soft tissue tenderness; general fatigue and sleep disturbances. FM is characterised by the presence of multiple tender points and a constellation of symptoms. The cause is unknown, the diagnosis is one of exclusion and the treatment is symptomatic.

It is entirely possible that a person with this condition will seek to become certified in scuba diving because of the perceived benefits of weightlessness. The instructor should be aware of the psychological aspects of the condition and the medications that some of the patients require for relief. Antidepressants and pain relievers that are often required can blunt the sensorium and cause decreased cognition and ability to multitask. Add to this the possibility of nitrogen narcosis and we have a scenario for disaster.

## FRACTURES

Disqualification of divers with musculoskeletal injuries, surgery and inflammations should be considered during the period of an incompletely-healed fracture, sprain, ligamentous injury or inflammatory process for several reasons:

- The loss of mobility and dexterity with a cast (donning and doffing gear, entry and exits from water)
- The possible alteration in the uptake of inert gas at the site of injury, resulting in delayed healing and inability to climb into boats (theory, never proved)
- Other aspects of diving requiring mobility and strength (self and buddy rescue)
- The possibility of wound infection from marine organisms
- The possibility of reinjury to a fracture resulting in non-union or disruption of a surgical repair

Divers with acute bone or joint injury or inflammations should not return to diving until the injury has healed and there is a full range of motion and strength, and until they have received the OK to return to diving from their physician. Residual pain should not be present to impair the diver's ability to perform in emergencies. In addition, there should be no pain patterns that could be confused with a decompression accident.

Consideration should be given to the particular arrangements of diving gear, straps and equipment and what effect this will have on weight bearing and the possibility of further injury to other underlying structures.

### Diving After a Fracture

Healed fractures are thought to not impose any restrictions on diving. Generally, a fracture should be properly healed in four to six weeks, barring complications. However, there is the theoretical unproven caveat that there is an increased risk of bubble formation in regions of bone where there has been some disruption of blood supply, leaving an increased or decreased vascularity.

There are a couple of other factors that one might consider:

1. There is significant pressure applied to the arms and legs in exiting the water and climbing back into boats from weight bearing from the heavy scuba gear. Arrangements should be made with the dive master for assistance in donning and removing gear in the water.
2. There is significant loss of muscle strength and sometimes actual muscle atrophy with a fracture and disuse.

### Diving with a Cast

Moisture weakens plaster and damp padding next to the skin can cause irritation. Two layers of plastic or waterproof shields can keep a splint or cast dry while showering or bathing.

Waterproof cast construction uses a waterproof cast liner made of Gore-Tex to replace the traditional stockinette and cast padding. The Gore-Tex liner repels water and permits evaporation, allowing bathing, swimming, sweating and hydrotherapy without any special drying of the cast or skin. The liner material is available in rolls of two-, three- and four-inch width and is applied directly to the patient's skin. Fibreglass casting tape is then wrapped around the waterproof liner.

In addition, one will encounter logistical difficulties in gearing up. Water entry and exit and locomotion in the water could also be risky to the diver and others on the dive boat.

## RHEUMATOID ARTHRITIS AND OSTEOARTHRITIS

### Risk Factors for Arthritis

Divers of all ages will need to be aware of the few but important relationships to this widespread

condition. Age and sex are two of the most important risk factors for the rheumatic diseases. Most of the major joint conditions show a remarkable sex difference in incidence, e.g. systemic lupus erythematosus (SLE) occurs primarily in women, whereas ankylosing spondylitis (spine) is more frequent and more severe in males. The reasons for this are unclear.

The musculoskeletal system does not wear out; it thrives on usage and, unlike most mechanical systems, lasts a lifetime. The underwater weightlessness lends itself nicely toward allowing this great sport of scuba to be enjoyed by many people who would otherwise not be able to participate in athletics. However, like gender, age very strongly affects the incidence, expression and impact of musculoskeletal diseases. Some conditions only occur in childhood; others, like SLE and ankylosing spondylitis, usually start in young adults, while polymyalgia rheumatica and giant cell arteritis rarely begin in those less than 55 years. Rheumatoid arthritis (RA), SLE, gout and other major inflammatory rheumatic diseases are expressed differently if they begin in older patients. With minimal assistance with entrances and exits, the arthritic diver can usually manage a moderately difficult dive with ease. Some arthritic divers have described significant relief from pain at depth.

### Treatment

A few types of arthritis are treatable with specific therapy (e.g. gout can be completely controlled with drugs, or Lyme disease can be treated with antibiotics), but there are no “magic bullets” for most chronic rheumatic disorders. Most arthritic divers will want to know what effect diving will have on their drugs, such as aspirin, NSAIDs, steroids and the numerous other medications in use for secondary (fallback) treatment of certain arthritic illnesses (gold, Cyclosporin, Immuran, etc.).

Scuba diving can be an important part of the physical therapist’s armamentarium. Physical therapy is useful for prevention as well as for treatment, since keeping physically fit and active helps prevent musculoskeletal pain and morbidity; and, in early disease, the maintenance of muscle strength and a full range of joint motion will help prevent subsequent disability. Physiotherapy also plays a central role in rehabilitation and pain management.

None of the drugs used to treat most forms of arthritis alter consciousness and therefore, are not dangerous to the diver. Some blunt the immune response, however, and divers need to be aware of the increased possibility of infection in polluted and sea water.

Conditions easily misinterpreted as arthritis by the patient include phlebitis, arteriosclerosis obliterans, cellulitis, edema, neuropathy, vascular compression syndromes, the stiffness of Parkinson’s disease, periarticular stress fractures, myositis and fibromyositis. Add to this the joint pains associated with the bends or decompression illness and you have the possibility of confusion in diagnosis. Dysbaric osteonecrosis affecting the joint cartilage can easily be mistaken for an arthritic joint.

Prominent tenderness of bones adjacent to joints and joint effusions occur in sickle cell disease and hypertrophic pulmonary osteoarthropathy. Both sickle cell disease and pulmonary osteoarthropathy pose dangers to the diver – scuba diving being capable of causing a sickle cell crisis through hypoxia, and pulmonary disease of the extent to cause arthropathy being adverse to diving due to the possibility of barotrauma.

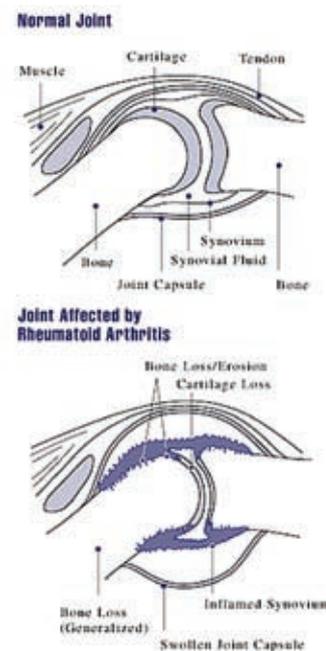
Changes from previously recorded physical findings are important in differentiating pre-existing arthritis from suspected decompression sickness. Application of pressure will offer relief to the diver with DCS.

The foot and ankle: The prospective diver should test his weight-bearing ability with full equipment and weight belt. Inability to handle the weight should not preclude diving, however, since suiting up can be done while sitting on the dive platform. Since finning is such a vital part of safe diving, disorders of the foot and ankle might be adverse to diving.

The importance of a good physical examination of the arthritic diver has been highlighted as vital for differentiation of the many signs and symptoms of decompression sickness that can mimic arthritis and nerve compression. Weight bearing has been discussed, as well as the difficulties specific to such illnesses as sickle cell disease and pulmonary osteoarthropathy.

## JOINT SURGERY AND METALLIC IMPLANTS

There should be no diving limitations or restrictions placed on diving with a knee or hip replacement, or any other metallic inserts or implants. The effects of pressure are not any specific danger for implants that do not contain compressible gasses. Gas laws (Boyle’s and Henry’s) don’t affect an implanted solid; the supposition that there is an increased chance of gas bubble formation in scar tissue or areas of deranged blood supply has no firm basis in man or animal studies. Main limitations would be purely those imposed by rehabilitation from surgery, i.e. ability to walk



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 ”

around with heavy gear prior to entry and climb ladders (or shore) for exits. All wounds should be completely healed and the diver should have been released by the surgeon for full weight-bearing activities. Physical rehabilitation should have been accomplished.

### Dividing After Knee or Hip Reconstruction

Much depends on the original cause of disability. Generally, the guidelines for the new diver are much more stringent than for an experienced diver who is returning from an injury. The sport diver should have no problem as long as there is a good range of motion and the diver is able to bear weight.

The candidate must have excellent mobility and dexterity and must be in a robust physical condition in order to meet the demands for personal safety and that of others; all joints must have a normal full range of mobility.

The knee and hip are especially susceptible to dysbaric osteonecrosis and this must be kept in mind with the injury. Differentiating between residual x-ray findings and osteonecrosis may be difficult.

### SCOLIOSIS

The spine has natural curves when viewed from the side. The lower back bends slightly inward and the upper part of the spine bows a little outward. Viewed from behind, however, the spine appears straight with little side-to-side curvature, except in people who have scoliosis where the spine curves to one side.

Of every 1 000 children, three to five develop spinal curves that are severe enough to need treatment. Scoliosis rarely occurs in adults.

Usually scoliosis is painless. Most cases are mild, requiring only follow-up and observation. Severe scoliosis can cause ongoing back pain and difficulty breathing. Surgery may be necessary.

Probably the main concern with diving with scoliosis is the possibility of decreased pulmonary function. Scoliosis varies considerably in the extent of the curvature. Some cases are so severe that the chest cavity is distorted and the affected person can have abnormal lung function. This would need to be assessed carefully to be sure that you don't have any airway obstruction that could possibly lead to barotrauma or a burst lung.

Another concern would be possible injury to the spine from lifting heavy weights and tanks. Proper gear fit, degree of physical capacity and cardiac reserve (the ability of the heart to handle stressful situations) might also play a part in the decision to dive.

There will likely be more difficulty with gearing up, entries and exits, but this difficulty disappears in the relatively gravity-free environment of the sea. The advice of one's personal physician should be sought with these factors in mind.

### TENDONITIS/BURSITIS

Tendonitis is inflammation or irritation of a tendon. Tendons are the thick fibrous cords that attach muscles to bone. They transmit the power generated by a muscle contraction to move a bone. A bursa is a space surrounding a joint that is covered by fibrous tissue; it is similar to housing a moving part of a machine that is protective and at the same time lubricating. Bursitis is inflammation or irritation of a bursa.

Diagnosis is mainly by medical history and physical examination since tendons and bursae are generally not visible on x-rays. MRI and ultrasound may be useful in the detection of bursitis and tendonitis. Aspiration of a swollen bursa may be performed to exclude infection or gout. Blood tests may be ordered to confirm underlying conditions but are generally not necessary to diagnose tendonitis or bursitis.

Treatment of these two conditions is based on the underlying cause. In overuse or injury, reduction or avoidance of a particular activity is useful. The use of modalities, especially ice, may help to reduce inflammation and pain. An adequate warm-up before and correct posture during exercise is useful. Braces, splints, using a cane, anti-inflammatory medications, steroid injections and physical therapy are all helpful in the treatment of these conditions.

In addition to possibly worsening the condition, diving would not be wise during the acute phase of the illness due to the functional limitations of the patient/diver. Depending on the part of the body involved, there might be difficulty donning and doffing gear, water entry and exit, in-water locomotion and self and buddy rescue – any of which might lead to a cascade of events leading to a diving accident. Medications required for pain relief could blunt the ability of the diver to multitask as necessary in the underwater environment. Diving should be allowed when the acute inflammatory process has subsided and the person is able to function normally. **AD**





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Image by Cormac McCreesh.

## Theory Into Practise

# Emergency Ascents: Managing the Risks

By Dr Petar Denoble and Eric Douglas

**When divers lose control, the result can be injury and even death.**

“

*The most frequent trigger of an emergency ascent is running out of breathing gas during the dive – an entirely preventable cause.*

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**An** emergency ascent is the response of a last resort to an adverse event or perceived threat during a dive. Divers are trained in standard emergency ascent procedures that, when performed successfully, mitigate the dangers. However, few people practise these skills, and when called to perform them in a crisis, a diver may be at risk for serious injury or even death.

### THE STATS

In a recent analysis of 964 diving fatalities, we found that emergency ascents were involved in 30% of cases – 288 to be exact. In 189 of these emergency ascents, a rapid ascent (faster than 60 fpm) was witnessed or recorded. In 10% of emergency ascents, divers attempted a free ascent without using a breathing gas supply. Buddy breathing was involved in 8% of fatal emergency ascents. In the remaining cases, the mode of emergency ascent was not specified.

The most frequent trigger of an emergency ascent is running out of breathing gas during the dive – an entirely preventable cause.

The most common cause of death in fatal emergency ascents is arterial gas embolism (AGE), accounting for 54% of cases, followed by drowning at 18%, acute cardiac events at 7% and decompression sickness at 5%. AGE is a stroke-like condition with a sudden onset of weakness and unconsciousness that usually occurs within minutes of surfacing. It often renders a diver unconscious before getting out of the water or soon after.

## MANAGING THE RISKS

As divers, we all learn never to hold our breath underwater. Unfortunately, in an emergency situation, divers often forget this information and why it is important. As a diver ascends and the surrounding pressure drops, the air in his lungs expands. If the diver is breathing normally, this isn't a problem as the expanding gas escapes with every exhaled breath. The danger comes when the ascent is too rapid for this expanding gas to escape or when a diver holds his breath on ascent. The expanding gas has to go somewhere, and it can literally tear a hole in the diver's lung, leaking into the body. Lung overexpansion injuries include mediastinal emphysema (air between the lungs), subcutaneous emphysema (air underneath the skin) and pneumothorax (collapsed lung). But the biggest problem occurs when escaping gas is introduced into arterial circulation. At that point, there is nothing to stop it from being delivered directly to the brain, forming an embolus and blocking blood flow.

In the crisis of an emergency ascent, divers may forget their training or be afraid to exhale for fear of running out of breath before reaching the surface. When ascending from recreational diving depths, the expanding air in the lungs is usually more than enough to sustain the diver. It's a rare instance when a diver drowns before reaching the surface.

## REMEMBER YOUR TRAINING

So how do you deal with emergency ascents and the risk of injury? Like any diving emergency, the best way to deal with it is to avoid it in the first place. Keep your training current and in practise. Plan each dive carefully, and surface with a reserve supply of air. Follow your plan. And, of course, remember to monitor your air closely.

Let's say you do everything right and you still find yourself in a situation that requires an emergency ascent. What's the best way to proceed?

First, don't panic. You received training on how to do emergency ascents in your original certification course. Remember the preferred order of options:

1. Make a normal controlled ascent, with your regulator in your mouth.
2. Find your buddy and obtain his secondary air source (or his primary if he will be taking the secondary, depending on the configuration of his gear). The goal in this scenario is for both divers to have a continuous air source, enabling you both to make a slow, controlled ascent to the surface.
3. If you cannot reach your buddy or another diver, or if your buddy is also out of air, complete a controlled emergency ascent on your own. But again, don't panic. Remember, you most likely have enough air in your lungs to sustain you to the surface. Follow the procedures you learned in training: Keep your regulator in your mouth at all times; sometimes air expands and gives you one more quick breath. Exhale slowly and continuously all the way to the surface, and keep your ascent slow.

Like all other dive skills, emergency ascents should be practised regularly. Head for the pool with a buddy to shake the cobwebs off your alternate air source breathing, and practise your emergency ascents by swimming horizontally in the pool.

Emergency ascents are a response to a life-threatening situation underwater. Despite the urgency in the circumstances surrounding them, with proper training, practise and preparation, they can and should be the safe solution they are intended to be. **AD**

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Image by Cormac McCreesh.

# Breathing Air QUALITY



Image by Cormac McCreesh.

By Dr Jimmy Stanbury

**Scuba diving is a popular and growing sport. South Africa has some wonderful diving reefs, Aliwal Shoal in particular is rated one of the top diving sites in the world, with an estimated 40 000 dives taking place annually. More and more international divers are attracted to South African dive sites, helped by the excellent infrastructure, accessibility of international airports, the good condition of the roads and the additional tourist attraction of "African adventures". But is South Africa's breathing air quality up to standard? Jimmy Stanbury investigates and reports back on the operators diving Aliwal Shoal...**

In order to explore the underwater environment, all divers need a supply of compressed air to meet their breathing needs for the duration of their dive. This air is usually obtained from the dive charters with whom they dive.

It is essential that the compressed air that divers breathe is free of contaminants which may have adverse health effects. Prevention of contamination involves ensuring that the intakes of compressors are in uncontaminated areas, the compressors are suitable and well maintained and that the air is adequately filtered and stored in clean storage tanks (Ref 2). Quality control by means of regular gas analysis will ensure that no contamination has taken place. Portable petrol-driven compressors are especially likely to create problems with contaminants, and these require even more vigilance (Ref 3).

Most divers assume that the air they obtain at these sites meets the required standards and is actually safe for breathing. This assumption has proved wrong on occasion, including an incident in May 2008 involving a number of dive tourists in the Maldives, where one diver died (Ref 4). No such incident has been reported in South Africa yet. Breathing air supplied to recreational divers has never been formally studied in South Africa.

In South Africa, the Vessels Under Pressure Regulations, 1996 (soon to be replaced by the Pressure Equipment Regulations) require that scuba cylinders comply with specific design and maintenance standards. The quality of breathing air is also regulated. South African National Standards (specifically SANS 10019 and SANS 347) are referred to in these regulations and describe the standards for breathing air quality. Although these standards and regulations are in place, they are not enforced by the Department of Labour because of a shortage of manpower to regularly inspect and test filling stations.

Although exposures to low levels of contaminants are acceptable in some environments, this is not the case in diving. An increase in partial pressure has a multiplying effect on the toxic effects of breathed gasses and contaminants (Ref 5). The effect of some contaminants is cumulative. In divers, a contaminated breathing medium may contribute to a diving accident, and may mimic decompression illness (Ref 6-8). Recreational diving (excluding technical diving) limits maximum diving depth to 40 m (5ATA). Breathing contaminated gasses at recreational diving depths (40 m) may have a serious detrimental effect on the health and safety of the diver.

During training, divers are taught to sniff the air from their cylinder during the pre-dive set-up before attaching the first stage regulator. An odour renders the air unusable. Although a smell

may indicate contamination by oil or other aromatic compounds, carbon monoxide and carbon dioxide are odourless and tasteless and their presence will go undetected. For a clinical problem to develop as a result of bad air, a large deviation from the recommended standards would be required, but a diver will not be aware of any deviation from accepted and expected levels (Ref 8), unless these are measured.

The aim of this study is to survey the air quality obtained from the dive operators at a popular South African dive site. Levels of O<sub>2</sub>, CO<sub>2</sub>, CO and oils in the compressed air used by divers was measured with Dräger Tubes using the Dräger Simultan Gas Sampling Kit.

## METHODS

This prospective observational study was approved by the ethics committee of the University of Stellenbosch, and was performed with the informed consent of all participants.

Data was obtained from all dive operators in the Umkomaas area providing dive tourism to Aliwal Shoal, who have compressors and supply air fills. Private individuals with their own compressors, and commercial diving operators that do not provide air fills to tourists, were excluded.

All permanent dive operators in the Umkomaas area participated in the study. Each operator was visited unannounced, in order to ensure that no corrective actions were taken which would bias the results. All dive operators were enthusiastic and welcomed the opportunity to take part.

None had formal air tests done previously. They all relied on maintenance of their compressors and regular filter changes to ensure that they were providing clean air.

## AIR SAMPLING METHOD AND TESTING OF AIR QUALITY

Each participant was requested to complete a questionnaire and to make one of their hire cylinders available for air sampling. The testing of hire cylinders ensured that maintenance, testing and filling was all done by the same operator. This was to exclude contamination from other compressor fills.

Oxygen can be measured using a hand-held analyser, familiar to nitrox divers, but the levels of contaminant gasses being tested for are very low and require specialised techniques for their detection. Specialised air testing can be done in a laboratory using gas chromatography (GC) to detect contents of a sample. Field tests are, however, more convenient and (although still expensive) are practical and have the accuracy required to ensure meaningful results.

The air quality of the supplied cylinder was tested in this study using the Dräger Simultan Air test kit with Dräger detection tubes®, for carbon

monoxide, carbon dioxide and oil. These are the contaminants for which maximum levels are specified in air quality standards tables.

Contaminants such as pollens, other particulate matter and trace gasses require specialised techniques for detection and are thought to be less common in areas where air is compressed for diving cylinders (away from unusual industrial atmospheric contaminants). Suggested acceptable levels are also not listed in breathing air quality standard tables.

Although water vapour content is regulated, this is not primarily for the protection of the diver's health, but for the prevention of cylinder corrosion. Oil and water contamination are independent in cause, although a saturated filter will allow both to pass through. It is common for water vapour to exceed tolerance levels, while oil remains well within specification. Although this air is suitable for breathing, it is not so good for high pressure cylinders and regulators. High moisture content can accelerate corrosion, and condensation in the regulator can freeze and lock it up, causing a free-flow during the dive.

## RESULTS AND DISCUSSION

All operators used electrically-driven compressors, of which 80% are Bauer, and 55% used synthetic oils, which is the oil choice when supplying nitrox.

None of the operators will fill a cylinder out of the hydro date, but a third will fill it if the visual inspection date has passed, and will advise the owner to have the visual test done before the next fill or dive.

Three operators had previously received complaints of "bad air", of which two actually followed a major compressor service. One was apparently due to an oil spill after the compressor was steeply tilted, the second due to the filter being wet when returned from service. The contamination was detected by smell. Both required cleaning of the filter housings and replacement of the filter



## ABOUT THE WRITER

Jimmy Stanbury holds the following qualifications: MB BCh (Wits), DA (SA), MMed Anaes (Natal) and FFA (SA). He recently completed the BScMedScHons in Underwater Medicine (Stellenbosch).

Jimmy has been in an Anaesthesiology private practice in Durban for the past 24 years. Prior to that, he spent several years in general practice in Gauteng.

Jimmy and his family are all keen scuba divers. Locums abroad and several posts as ship's surgeon with the Mediterranean Shipping Company have enabled him to dive in exotic locations around the world.

His diving medical interest is diver safety for both recreational and commercial divers.

Table 1: The regulated national standard (Ref 9), SANS 019 table 12, and international standards (Compressed Gas Association - Grade E) for breathing air used by divers, compared to atmospheric air.

COMPRESSED AIR				
		Atmospheric air	CGA grade E PADI 5 star	SANS 019 table 12
Oxygen	%	20.9	20-22	20-22
Carbon dioxide	ppm	340	1000	500
Carbon monoxide	ppm	0.16	10	10
Hydrocarbons	ppm	0.16	25	
Water vapour	ppm		67	
Dew point			-50	
Oil and particles	mg/m <sup>3</sup>		5	0.5
Odour		nil	nil	nil

“

*Divers should enquire about the procedures in place to prevent contamination.*

”

cartridges, which remedied the fault. After a thorough inspection of the third case, the source was found to be the result of an already-contaminated cylinder presented for top-up. All other fills from the same compressor at the time were uncontaminated, which ruled out the compressor as the source of contamination.

Very few operators keep detailed log books and only one operator logged all cylinder fills taking place. The time to record all the details during the hectic time of filling cylinders before a dive was given as the reason for not logging the air fills. Two operators required the diver to measure the O<sub>2</sub> content of their nitrox fills and complete the register to sign out their filled cylinder.

Although none of the operators had formally tested the quality of the air that was being delivered, not one operator supplied contaminated air and all operators were grateful for the confirmation that the levels of potential contaminants were within specification. This included the testing of the air from a compressor immediately before a filter change, at the end of the life span of the filter in use.

All operators relied on compressor maintenance, oil changes and high pressure

filter changes at regular intervals, recommended by the manufacturer for air quality control. The majority of operators use factory-packed filter cartridges; only three operators re-pack their own filters. None of the operators thought it was necessary to do regular air quality tests, the reasons being availability and cost of the equipment required.

The study did prompt the operators to think about their air quality again and (as a result of the study) one operator plans to relocate the position of the air intake to an even safer area, to eliminate contamination sources. This is very reassuring to recreational divers at Aliwal.

While such a once-off sample of results provides an accurate reflection of what would be available to divers on that day, it does not reflect the real situation present the rest of the time. Divers should enquire about the procedures in place to prevent contamination. Although all the tests were safe from the larger operators, it has been shown in similar studies elsewhere that portable (non-electrical) compressors carry a higher risk for contamination.

#### ACKNOWLEDGEMENTS

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Image by Cormac McCreesh.

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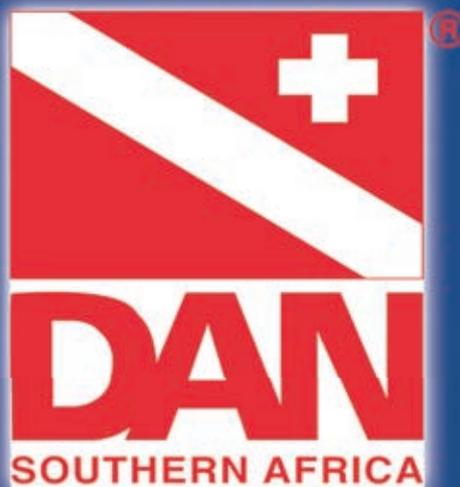
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# SKIN DEEP

## Skin Conditions and Disorders

By Dr Peter B Bennett and Dr Frans J Cronjé

**The skin covers 1.8 m<sup>2</sup> of our body surface. It is exposed to the elements and is the organ most vulnerable to wounding. It is one of the most important barriers to infection and, with the exception of several openings, it is the only part of us that is accessible for direct visual scrutiny. Loss of integrity of this barrier makes us vulnerable to dehydration and infection. Diving may affect the skin in direct and indirect ways: exposure to moisture and sunlight has consequences. In this article we review three common conditions – athlete’s foot, rashes and skin cancer.**

### ATHLETE’S FOOT

Due to the nature of diving, wet skin is part of scuba diving, but it can aggravate many skin disorders. Athlete’s foot is a fungal infection due to a fungal organism called *tinea pedis*.

The condition results in an itchy skin with burning, peeling, cracking and a red discolouration. It



is especially prevalent between the toes and the bottom of the feet. It usually starts between the fourth and fifth toes. Some individuals are more susceptible than others and recurrences may occur after treatment. From a diver’s viewpoint, it may be contagious and treatment should be sought before diving.

Treatment, at first, can be administered with over-the-counter anti-fungal creams. The feet need to be kept dry after diving or swimming, especially between the toes. The use of talcum powder and cotton socks may be helpful. It may also be a good idea to help prevent many dermatological diseases by wearing sandals in public showers and pools. Diving booties should not be shared and should be kept as dry as possible.

If the condition does not heal after two weeks and blisters form or the infection is spreading and there are signs of a bacterial infection with pain,

pus and fever, then you should consult a physician as antibiotics may be required.

Scuba divers are not prevented from diving because of athlete’s foot but should take additional care due to the wet environment.

### RASHES

There are many kinds of rashes and only those likely to be affected in some way by diving are considered here. Due to exposure to moisture from salt or fresh water, sometimes in humid environments, any acute or chronic dermatitis may be exacerbated, including bacterial skin infections like acne. Allergic reactions may also be induced from wetsuits due to the glues and neoprene.

Atopic dermatitis is a type of eczema that presents with intense itching and a red raised rash and sometimes fluid-filled blisters, particularly on the hands, neck, face and legs. Common in babies and children, and sometimes called eczema, it can go on in some individuals into adulthood. The condition often occurs in families and may have a genetic link. It can be triggered

by contact with irritants such as dyes in face masks and wetsuits, stress, dry skin and heat. The condition need not prevent diving, but the diver may wish to ensure the skin is well moisturised and keep in a cool, non-humid environment when not diving.

Psoriasis is a chronic rash that affects 2% of the population and is caused by very rapid growth of the cells of the skin, commonly occurring on the elbows, knees, scalp, feet and lower back. The rapid growth causes patchy red skin with whitish scales. These may itch and be tender to touch. Treatment by a dermatologist is recommended.

For divers, the condition may be embarrassing and cause some discomfort and aggravation, however, it is not a contraindication to diving.



## SKIN CANCERS

Over 1 million people living in North America contract skin cancer every year, most often due to excessive exposure to the sun. This is especially likely in divers who may travel to resorts in very sunny climates and be exposed between dives on the dive boats, snorkelling or just tanning on the beach. There are three types – basal, squamous and melanoma.

Basal cell carcinoma is a relatively benign cancer which is not life threatening and is the most common of the three. It is usually seen on the head, face and torso. It may show as a new smooth skin bump which may be shiny like a mole with a pearl-like appearance or just as a red irritated area or a small sore that bleeds and will not heal. Treatment requires a visit to the dermatologist for surgical removal and biopsy.

Squamous cell carcinoma is also relatively benign. It shows as a persistent small red lump, much like a wart that does not heal. Treatment involves surgical removal of the lump. Both basal cell and squamous cell cancers are more likely in freckled, light-skinned people who may be of Celtic origin with red or blonde hair and who have experienced severe sunburns at an early age.

Many such cancers could be prevented by protection from the sun with suitable clothing to cover the arms and legs and a wide brim hat. Sunglasses with ultraviolet protection are also advised. Any exposed skin should be protected with frequent application of sunscreens with an SPF (sun protection factor) of 30 or more. Tanning booths should be avoided.

Melanoma is a very serious form of skin cancer affecting the pigment-producing cells which grow aggressively and may spread to other parts of the body, causing death. It is most important to catch melanoma early as it may be surgically cured if caught early enough.

Signs of melanoma are particularly related to any sudden change in growth or colour of a mole, which may be a dark colour and irregular in shape. They can be quite small and may bleed. Treatment requires surgical removal and biopsy as soon as possible.

Prevention, as with basal and squamous cell carcinoma, is to avoid the sun and tanning salons. Due to the frequency of exposure to the sun, divers are at an added risk.

Those taking certain photosensitive medications should be extra careful not to develop severe sunburns while in the sun on dive boats, etc. **AD**



# First Aid Refresher Using an AED

**If you are called upon to use an AED, will you be ready?**

*By the DAN Team*

**You** see them everywhere these days – shopping malls, airports and, more and more often, dive boats. Yet if you are called upon to use an automated external defibrillator (AED), will you be ready?

Assuming you've assessed the scene and completed the initial assessment of basic life support (BLS), follow these simple steps:

- Do not delay defibrillation to perform CPR. If the unit is available, turn it on and follow the verbal and text prompts the unit provides.
- Place the unit on the person's left side, near the head, if possible.
- Place the defibrillator pads on the person.
- Bare the chest (it may be necessary to cut away clothing).
- The chest must be dry; wipe it off, if necessary.
- Apply the pads firmly to the chest.
- Place the right pad on the upper right chest, just below the collar bone and to the right of the breastbone.
- Place the left pad on lower left ribs just below the breast. (Note: pad position does not have to be exact.)
- Follow the AED's verbal and text prompts.
- Deliver the shock if indicated and if safe.
- Make sure no person or equipment is touching the person.
- Visually scan the person from head to toe to ensure that no-one is touching him or her. Then say, "I'm clear, you're clear, all clear," or simply, "Clear".
- Press the shock button.
- After a shock, immediately deliver two minutes of CPR. This circulates blood to the heart and gives the heart time to establish blood flow.
- The AED may also determine that no shock is required.
- Reassess breathing. If the patient is still not breathing normally, begin CPR.
- Deliver compressions and breaths for two minutes (about five cycles) and have the AED unit reanalyse the heart rhythm.
- If breathing is present, support the airway and frequently monitor the patient.



Automated External Defibrillators for Scuba Diving



Automated External Defibrillators for Aquatic Emergencies



## Hand over to the EMS (emergency medical services)

While you are waiting for emergency medical personnel to arrive:

- Continue to monitor the airway and breathing.
- Leave AED in place.
- Provide a brief report to the EMS. This allows personnel to treat the person accordingly, indicating:
  1. Nature of the dive accident or incident
  2. Initial condition
  3. Care delivered
  4. Current condition
  5. Estimated time diver was not breathing and without circulation

Remember, a refresher does not take the place of actual training. If you're not trained in CPR or in using an AED, consider taking the DAN Diving Emergency Management Provider or the DAN Basic Life Support First Aid Course.

**For more information check out DAN's AED Training Course. <sup>A</sup>D**



Image by Cormac McCreesh.

# DAN Training & Education COURSES OFFERED



## Entry-level courses



### OXYGEN FIRST AID FOR SCUBA DIVING INJURIES

As a recreational diver, you can receive training to provide vital first aid that can make a difference to a scuba diver with decompression illness. The DAN Oxygen Provider Course provides entry-level training in the recognition and management of possible diving-related injuries using emergency oxygen first aid.



### OXYGEN FIRST AID FOR AQUATIC EMERGENCIES

This course trains non-divers and professional rescuers (such as lifeguards) to recognise near-drowning/submersion incidents and other aquatic medical emergencies and to provide basic life support including the use of oxygen first aid.



### FIRST AID FOR HAZARDOUS MARINE LIFE INJURIES

Serious hazardous marine life injuries are rare. Most divers experience minor discomfort from unintentional encounters with fire coral, jellyfish and other marine creatures. This course teaches divers to minimise these injuries and reduce diver discomfort and pain.



### AUTOMATED EXTERNAL DEFIBRILLATORS FOR SCUBA DIVING

More than 10% of all dive fatalities are actually caused by cardiovascular disease, according to DAN dive accident and fatality statistics. This course teaches divers and other interested parties to provide care for sudden cardiac arrest including the use of an automated external defibrillator (AED).



### AUTOMATED EXTERNAL DEFIBRILLATORS FOR AQUATIC EMERGENCIES

When a person drowns, they may or may not inhale water. They normally enter cardiac arrest because of the inability to breathe. This course teaches interested parties to provide care for cardiac arrest by using an automated external defibrillator (AED).



### DIVE ACCIDENT FIRST AID FOR NON-DIVERS

This programme is designed for non-divers and teaches them how to recognise the warning signs of decompression illness and help provide care for a diver involved in a dive emergency.



## Intermediate courses



### BASIC LIFE SUPPORT FOR DIVE PROFESSIONALS

The remote nature of dive accidents, whether a few hours from shore or days from civilisation, frequently requires more advanced levels of care than are offered by traditional or entry-level CPR programmes.



### ON-SITE NEUROLOGICAL ASSESSMENT FOR DIVERS (Pre-requisite: Oxygen First Aid for Scuba Diving Injuries)

Learn how to conduct a neurological assessment on a potentially injured diver in this course. The information gained in this assessment can help convince a diver of the need for oxygen first aid, and help a dive physician determine the proper treatment.



### ADVANCED OXYGEN FIRST AID FOR SCUBA DIVING INJURIES (Pre-requisite: Oxygen First Aid for Scuba Diving Injuries)

This advanced-level programme is designed to train existing DAN oxygen providers to use the MTV-100 or a bag valve mask while providing care for a non-breathing injured diver.



## Advanced courses



### DIVE MEDICINE FOR DIVERS (Pre-requisite: DEMP and NEURO)

When you want to know more than just basic first aid techniques, Dive Medicine for Divers is your next step. Ultimately, more knowledge and a better understanding of how our bodies react to the pressures and stresses of diving lead to safer dives as we understand our limitations and the limitations of the situation.



## Combination courses



### DIVING EMERGENCY MANAGEMENT PROVIDER PROGRAMME

Learn the knowledge and skills from several courses in one single approach to dive emergency management.



## Leadership programmes

### INSTRUCTOR QUALIFICATION COURSE

To become a DAN instructor, you must complete the DAN Instructor Qualification Course (IQC). Instructor candidates will complete a core module that offers more information about DAN and explains how to teach DAN programmes. Candidates will then complete the course module for each DAN training programme they are interested in teaching.

### INSTRUCTOR TRAINER WORKSHOP

This programme teaches scuba diving instructor trainers to teach the DAN Instructor Qualification Course and train DAN instructors. Only DAN staff members and examiners can offer this programme. <sup>A</sup>D

Contact a DAN instructor in your region to take any of these courses. A full list of instructors is available from DAN-SA on 0860 242 242 or [www.dansa.org](http://www.dansa.org) under training.

# Matters of the DIVING HEART

By Dr Peter B Bennett and Dr Frans J Cronjé

**DAN receives many inquiries regarding cardiovascular problems and diving. In this section we will review some of the most common problems, their implications on diving and how to decide whether or not it is safe to dive with them. As always, we recommend divers with questions regarding diving fitness to be assessed by a medical practitioner who is trained and experienced in diving medicine.**

“  
*There is a tendency for blood pressure to increase with age, a sedentary lifestyle and obesity.*  
 ”

## AORTIC ANEURYSM

The aorta is the largest artery in the body. It takes blood from the heart to the rest of the body and runs through the chest and abdomen. For various reasons, this vessel may develop a weakness and become dilated. This makes it more prone to rupture with catastrophic bleeding, causing death if not surgically repaired at once. The risk increases with age and high blood pressure.

Any physical exercise likely to cause a sudden rise in blood pressure may precipitate such a rupture. It is therefore advisable to have an aneurysm evaluated and surgically repaired before undertaking a vigorous recreational sport such as scuba diving.

## BLOOD PRESSURE

For many years, a “normal” blood pressure was accepted to be below a systolic pressure of 140 mmHg (during contraction of the heart) and a diastolic pressure of 90 mmHg (during the period of relaxation of the heart). Today, there is an attempt to get closer to 120 over 80. Extreme or chronic elevations in blood pressure may cause a stroke due to rupture of blood vessels in the brain. Long-term effects can cause heart, kidney and eye problems as well as an increased risk of coronary artery disease or, so called, heart attack.

Conversely, blood pressure that is too low (also called hypotension) may cause reduced blood flow to the brain resulting in dizziness, nausea and even lapse of consciousness, especially due to changes in posture. Individuals prone to hypotension are usually aware of feelings of impending black-outs upon standing up rapidly. Medications such as Effortil are sometimes prescribed but are not considered safe with diving.

There is a tendency for blood pressure to increase with age, a sedentary lifestyle and obesity. High blood pressure has been associated with sudden death due to coronary artery disease, especially in older divers during the increased exercise of diving. Another phenomenon that has been associated with elevated blood pressure is acute pulmonary edema of immersion (i.e. congestion of the lungs with fluid in divers). Divers affected by this condition may suddenly become very short of breath under water, and upon evaluation, have fluid in their lungs.

In order to prevent problems due to chronic high blood pressure, various medications are commonly prescribed to artificially lower it. These may have adverse effects, in particular, the ability of the cardiovascular system to respond to stress and exercise. Divers or student divers with blood pressure problems require assessment by a health care professional familiar with diving medicine.

Control of blood pressure by loss of body weight, restriction of salt in the diet and regular, moderate exercise is safe and



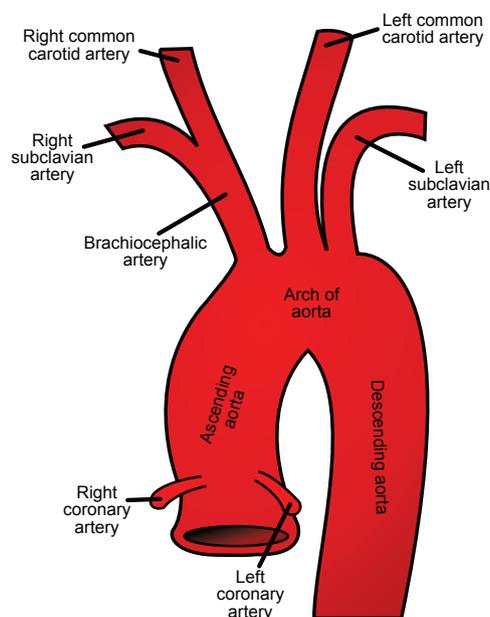
appropriate, as is the use of selected medications. It is unwise to dive with uncontrolled high blood pressure. Borderline hypertensives or individuals taking medication to control their blood pressure should take a maximal stress exercise electrocardiogram test to assess how the diver and their cardiovascular system responds to the exertion of recreational diving and to detect early coronary artery disease and dangerous disturbances in heart rhythm.

## CHOLESTEROL

Cholesterol is a kind of fat used in the body for such things as making new cells. However, under certain inherited conditions and lifestyles, such as a high intake of fatty foods, the levels may increase and cause hardening of the arteries, leading to coronary artery diseases, a heart attack or stroke.

Cholesterol levels are measured by means of a blood sample. Normal cholesterol is less than 5 mmol/L (200 mg/dL). Borderline cholesterol is 5–5.4 mmol/L (200 mg/dL to 239 mg/dL). High cholesterol is 5.5 mmol/L (240 mg/dL) or higher.

Cholesterol problems are usually asymptomatic and go undetected unless specifically tested. It is generally recommended that all people over the age of 35 be tested. People with relatives who have suffered or died from heart attacks – especially at a young age – should definitely be tested for elevated cholesterol. Although a healthy diet containing low fat will lower the cholesterol levels in most people – and is strongly recommended for all – people with hereditary cholesterol problems will require medication. Such medication is usually safe with diving as long as there are no complications of the high cholesterol or side-effects from the medication that would make diving unsafe. If unaddressed, cholesterol problems will lead to early death that may be precipitated by the exercise of diving. Accordingly, it is important to lead a healthy lifestyle and to control cholesterol so as to reduce the risk of cardiovascular disease.



## CLOTTING (DEEP VEIN THROMBOSIS)

Although this condition is not specifically associated with diving, it is increasingly associated with flying. Due to the fact that many divers fly to distant, pristine dive spots, the possibility is there. This is also a common complication of major surgery and injuries to the lower limbs. Some caution is therefore advisable if this applies.

DVT is a condition where blood clots form in the deep veins, usually in the legs or lower abdomen and pelvis. A far less serious condition of blood clots in the superficial veins is called phlebitis and is usually only of cosmetic importance, although if ulcerations form, diving is contraindicated until they have healed.

The problem with clotted deep veins is that pieces of these large clots may become dislodged and move up the circulation to the lungs where they can cause severe breathing difficulties or even death due to lack of oxygen. This risk is greatest when veins above the knee are involved. Rarely, these clots may contribute to other serious medical conditions such as strokes and heart attacks. While phlebitis is commonly accompanied by signs of redness or tenderness, DVT may have no signs or symptoms at all, or only some mild pain and swelling or local tenderness deep in the legs, followed maybe several days later by sudden death.

There is much controversy as to the numbers affected, but it has been estimated that 1 in 100 patients with DVTs above the knee will die of complications. As many as 300 people per year die from DVT as a result of flying. Prevention is therefore important.

Prolonged immobilisation is one of the key causative factors. For this reason, long distance air, car, bus and train travel in cramped seats can possibly precipitate DVT – the greater the distance travelled, the higher the risk. Prolonged bed rest after surgery can also bring on DVT.

At greater risk of DVT are pregnant women, women taking oral contraceptives, individuals over the age of 40 or with a history of cardiovascular disease or stroke and individuals with high blood pressure or high cholesterol. Other factors which increase the risk are a history of a previous DVT incident, a history of inflammatory bowel disease, or a history of recent surgery.

A number of suggestions have been made to help prevent DVT. These include walking about the flight cabin as permitted; drinking plenty of fluids other than alcohol to prevent dehydration, adding to the likelihood of clot formation; wear loose and comfortable clothing; exercise your legs by flexing and extending the ankles while in your seat; wear compression stockings if at extra risk

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*Although deep vein thrombosis is not specifically associated with diving, it is increasingly associated with flying. Due to the fact that many divers fly to distant, pristine dive spots, the possibility is there.*

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of DVT; avoid crossing your legs and elevate your legs where you can. And where applicable – stop smoking and lose weight.

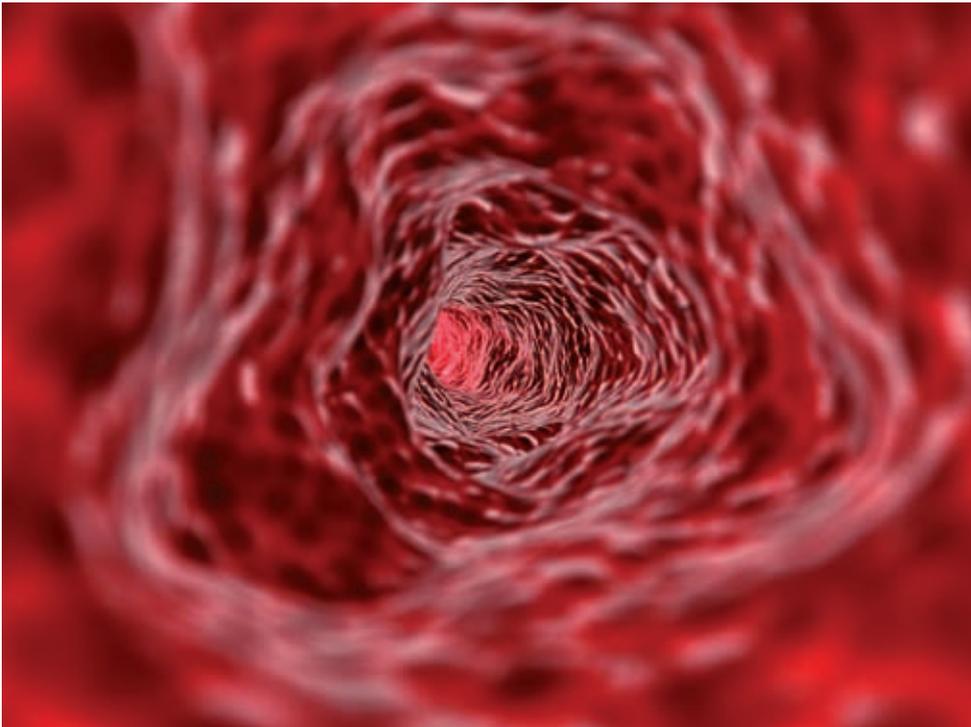
Aspirin is not recommended as a blood thinner. Divers who have made a very long flight to a destination may be advised to wait 24 hours before diving, until they are rehydrated and rested and the possibility of DVT is lessened. Since diving also tends to increase dehydration, it may potentiate any latent DVT effect from a long flight.

Treatment for DVT will involve the use of anticoagulants to dissolve the clots, such as Coumadin (Warfarin or Dicoumarol) and Heparin. If these anticoagulants are being taken, they can affect bleeding from various diving hazards. The increased haemorrhage from these injuries may potentiate injury. Although divers who take Coumadin apparently have no difficulty, most diving medicine experts would advise not to dive while taking this medication.

The constrictive actions of diving equipment such as belts and wetsuits may also add to DVT.

## CORONARY ARTERY DISEASE (CAD)

Coronary artery disease is well known today as it affects nearly three million people. Over 700 000 people die from CAD every year in the United States. It is commonly called “hardening



of the arteries” and is due to deposition of cholesterol in the coronary arteries supplying blood to the heart muscle. This causes a partial or complete block causing lack of blood, and therefore oxygen, to the muscle. If such lack of oxygen is prolonged, the heart muscle will die (called heart attack or myocardial infarction). It can also lead to irregular heartbeats (dysrhythmias) resulting in sudden death.

A number of factors potentiate the likelihood of CAD, including smoking, high fat and cholesterol diet, increasing age, increased blood pressure, diabetes, a family predisposition and obesity.

Although symptoms are commonly thought to be pain in the chest (angina), quite

often following heavy exertion or sudden excitement, many individuals have no symptoms before a sudden, fatal heart attack.

With an aging population, there is a real increased risk of such cardiovascular deaths in scuba divers over the age of 40. Indeed 20-30% of fatalities in sports divers are due to CAD.

If symptoms are present, some medications such as beta blockers or nitroglycerin may help but in most cases, coronary bypass surgery will eventually be required. It has been suggested that sports divers over the age of 40, or even those under the age of 40 who are obese and out of condition, see a cardiologist and take an exercise electrocardiogram (see Coronary Bypass Surgery). Such an exercise tolerance test should successfully reach 13 METS (1 MET is equivalent to normal resting oxygen consumption). Swimming against a 1 knot current will require 8 METS, so 13 METS is the potential for an emergency reserve.

If CAD is present and coronary bypass recommended, then after surgery and with sufficient time for healing, an increasing exercise regime and further stress electrocardiograms, it may be possible to return to diving.

## CORONARY BYPASS SURGERY

Coronary artery bypass surgery is a relatively common procedure today, especially in the older population. It involves transplant of a vessel from the leg to reestablish blood supply of a blocked coronary blood vessel supplying blood to the heart muscle.

Many years ago, it was considered that divers who had had coronary bypass surgery should not dive. Today, divers may be fit to dive provided their postoperative cardiac function permits this and there is no significant cardiac damage or tendency to have rhythm abnormalities.

A period of 6 to 12 months is usually recommended post surgery to permit healing and recovery. After this, a potential diver should be evaluated by a cardiologist, be free of pain and have a normal stress electrocardiogram and an exercise tolerance of 13 METS. Normal diving would require 3 to 5 METS with some movement, and increase to 7 or 8 METS with vigorous exercise. A potential emergency reserve of 13 METS is recommended. For comparison of the work load, you would need 8 METS to swim against a 1 knot current.

A recommended regimen for a diver who has had bypass surgery of the heart is rehabilitation for three to four months, followed by regular swimming or other conditioning. At six months, a stress electrocardiogram should be done to show that adequate blood flow is sustained to the heart muscle during exercise. If this is done with normal blood pressure, and no serious changes in heart rhythms result, a return to diving may be contemplated.



## HEART ATTACK (MYOCARDIAL INFARCTION)

A heart attack occurs from coronary artery disease (CAD) leading to blockage of the arteries to the heart by cholesterol and the resulting lack of oxygen delivered by the blood to the heart muscles. Small blockages may cause minimal damage and have little or no effect until a large blockage occurs which may damage large sections of the heart muscle and cause a sudden heart attack. At this time, the heart ceases to function and results in sudden death, often without warning.

Some 20-30% of scuba diving deaths are the consequence of cardiovascular problems and this is more common in those over 40 years of age. The cause is coronary artery disease (see Irregular Heartbeat, Cholesterol and Coronary Bypass Surgery).

The first indication of a potential heart attack may be a crushing-like pain in the chest and numbness or pain in the left arm. Sometimes, sudden heart attacks can occur without warning, with failure of the heart resulting in hospitalisation or death. The exercise required in diving for a diver with a heart suffering from coronary artery blockage may result in sudden death due to the inability to get the extra amount of oxygen required for the heart to function. Should the diver recover, a cardiologist experienced with diving medicine needs to decide if the diver can return to diving after suitable medical evaluations, including a stress electrocardiogram.

It may be necessary, in severe cases, to have coronary bypass surgery or the insertion of "stents". It may be possible for the diver to return to diving if, after the surgery, sufficient time (three to four months) is given for healing, followed by swimming and conditioning and a stress electrocardiogram at 6 to 12 months. It should, however, be realised that it is likely that there may have been some residual damage done to one or more parts of the heart muscle at the time of the heart attack, which may make for a greater risk for a further heart attack in the future.

## HEART VALVE PROBLEMS

Heart valve problems may be a contraindication to diving. Such factors as regurgitation, backflow from a valve between chambers of the heart or valve obstruction of transfer of the blood will affect the efficiency of the heart, especially if required to work hard (as when swimming underwater). As such, the presence of valvular heart disease usually results in a recommendation not to dive.

Divers who have artificial valves inserted are also not recommended to dive. Aside from potential failure of the valves under the heavy exercise is the use of anticoagulants commonly used with such valve implants. This is likely to cause excessive bleeding which could add to the dangers to the ears from barotrauma and to decompression sickness in sites such as the spinal cord. These divers should be advised to have a stress electrocardiogram with an exercise tolerance to 13 METS (see Coronary Bypass Surgery).

### NOTE:

Because myocardial infarction is related to a degeneration of the coronary arteries due to an underlying risk factor like cholesterol or ageing, (i.e. an underlying, pre-existing condition) this is excluded from cover under the DAN group policy, even if it is precipitated by exercise during diving. Divers presenting with acute myocardial symptoms during diving activities can receive assistance and evacuation until the diagnosis is confirmed. Thereafter, all expenses related to the medical or surgical management of the occluded vessels including thrombolytics, stents or bypass surgery, are excluded from coverage.

## IRREGULAR HEARTBEAT (DYSRHYTHMIAS)

Most divers with normal hearts will not have serious dysrhythmias, although minor irregularities may occur sometimes without a problem. Normal hearts beat between 60 to 100 times per minute. In healthy athletes, such as runners, it is not unusual for their hearts to beat as slowly as only 40-50

beats per minute. With such an athlete, increased exercise will cause the beat to increase in rate. Should it not do so, then it may be a more serious indication of heart defects requiring medical intervention. Other common causes of slowing of the heart or bradycardia are medications in common use today to control increased blood pressure, such as beta blockers.

Normal hearts may have extra beats or skip a beat. This may be precipitated by caffeine, alcohol, stress, dietary supplements, decongestants, analgesics, anti-allergy medicines or fatigue. When extra heartbeats occur in the atrial or upper chambers of the heart, the condition is called supraventricular or atrial dysrhythmia. If they occur in the lower heart chambers, it is called ventricular tachycardia. Should the irregularities be frequent, careful medical evaluation by a cardiologist experienced with diving medicine is required.

Those with such serious, frequent irregularities may be well advised not to dive due to the potential for sudden loss of consciousness and therefore drowning or dying of heart failure. Such cases have occurred not only underwater, but on the surface, swimming back to the boat.

If the irregular heartbeats are of a minor nature and can be sufficiently controlled without additional problems, then the individual may be fit to dive. However, very often the therapy and medications are associated with other factors that are not compatible with fitness to dive.

It is probably wise for a potential diver with any irregularities of the beating of the heart to have a complete medical evaluation by a cardiologist prior to diving.



## MITRAL VALVE PROLAPSE (FLOPPY VALVE SYNDROME)

This is a rather common condition of the heart, especially in women, and is present in some 1.4 to 17% of people, depending on the age of the population. Sometimes called "click-murmur syndrome", it was first noticed in the 1960s. Usually, no symptoms are present. In a few cases there may be unusual chest pain, palpitations, a feeling of air hunger (dyspnea) and fatigue. Interestingly, mitral valve prolapse is often associated with panic disorders.

Usually, a diver who has had no symptoms and has not been prescribed medications, should be able to dive without concern and reassurance should be all that is necessary.

If there is chest pain, palpitations or abnormal heartbeats, which might produce palpitations, these should be controlled by appropriate medications, such as a beta blocker. Although this medication may affect the degree of exercise level achievable, it may not be a problem unless in an emergency situation. If there is doubt about the presence of arrhythmias, a 24-hour Hölder ECG recording is recommended before passing them as fit to dive.

## PACEMAKERS AND IMPLANTED HEART DEFIBRILLATORS

Commercial and military divers are not permitted to dive with pacemakers. However, for sports diving, the decision is based on individual evaluation.

Pacemakers and defibrillators are usually required due to a malfunction of the neuroelectrical impulses controlling the beat of the heart. This can result in fainting, or if the cause is a previous heart attack, the diver may be limited in his or her ability to handle the extra exercise requirement of diving.

Pacemakers are usually installed over the heart between the rib cage and the skin and muscle. Today, they can be quite small and will control unusual electrical conduction in the heart which may lead to malfunction. The heart defibrillator is not really a pacemaker. This device gives a shock to the heart when life-threatening effects of heart contraction occur. Quick action is needed to intervene to prevent death. Today, automatic external defibrillators (AED) are increasingly common on aircraft and in public places.

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*Divers who have artificial valves inserted are not recommended to dive.*

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These devices, when implanted, need to work to pressures equivalent to at least 40 m (130 ft) for recreational scuba diving and be capable of rapid increases or decreases in pressure and temperature changes .

Before being accepted for diving, the cardiologist should expose the diver to a stress electrocardiogram with exercise up to 13 METS (see Coronary Bypass Surgery) workload.

Since a number of recreational diving fatalities are due to cardiovascular problems, any diver with a history of cardiovascular disease with compromised exercise tolerance should be discouraged from scuba diving and requires a thorough evaluation by an experienced cardiologist. Those with defibrillators are usually advised not to dive due to the risk of sudden death while underwater.

## PATENT FORAMEN OVALE (PFO)

Commonly called the “hole in the heart”, patent foramen ovale is an opening between the upper right and left chambers of the heart which collect the blood to be pumped by the ventricles or lower heart chambers. When babies are still in the uterus of the mother, blood bypasses the lungs and goes directly around the baby’s body. Once born, the upper right and left chambers are required to pass the blood through the lungs and this “foramen ovale” closes in most cases. However, this hole or PFO is still found after birth in 25-30% of the population.

Thus, bubbles formed in decompression on the venous side of the body may transverse to the arterial side through this patent hole. It is not necessarily easy because the blood pressure on the left side (arterial) is higher than the right side (venous). However, a strong valsalva effect on trying to clear the ears, or heavy leg exercise, such as pumping up and down, can trigger the bubbles to transverse through the hole.

The hole may vary in size. In general, 60% of PFOs are small and not a real problem, but 40% are large and could allow bubbles to enter the arteries and cause arterial gas embolism or cause severe decompression sickness (DCS). Although the actual role of PFO in the incidence of DCS remains unclear and there is little conclusive evidence of the increased risk of a PFO. The presence of a skin rash soon after surfacing, or severe symptoms such as paraplegia, may implicate its presence. Nevertheless, the risk of DCS in divers with a PFO is small.

But DCS occurring in a low risk dive or repeated DCS with no indication of the reason or the occurrence of severe neurological decompression occurring from dives well within the decompression table limits may merit investigations for the presence of a PFO.

It has also been suggested that divers may wish to stop strenuous arm, leg or abdominal exercises after diving as this could precipitate shunting of blood through a PFO.

If a PFO is found, it may be closed by a transcatheter occlusion and the diver may return to diving without this potential extra risk.



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*Normal hearts may have extra beats or skip a beat.*

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## VARICOSE VEINS

A varicose vein is a permanently distended vein commonly seen in the legs due to weakening of the blood vessel walls. They can be treated by injection to collapse the vessel, or various surgical interventions. Diving has no specific action on varicose veins. Indeed, the water pressure may be supportive. However, there is an increased risk of injury and haemorrhage due to contact with underwater rock or coral or trauma when getting on or off a boat, etc. A wet suit or support bandages are recommended. 

# Medical queries and answers...

**Note:** Many of the original questions and answers have been altered slightly to ensure confidentiality.

**Q** Between two recent shore dives, I slipped and fell, resulting in a serious bruise on my left knee. It was almost black. We took about a 20-minute break and back in we went. When I came out after the second dive, the bruise was gone. We were only diving in about 20 ft (6 m) of water. Could the pressure have caused the bruising to go away?

**A** It is entirely possible that the blood that collected as a result of broken blood vessels could have been affected by the increased hydrostatic pressure. The pressure is evenly distributed from all directions. The blood may have been compressed into deeper tissue where it was eventually reabsorbed. It was only due to the injury being so recent that this phenomenon occurred.  
*Marty McCafferty, EMT-P, DMT-A  
 DAN medical information specialist*



Image by Sean Sequeira.

**Q** What problems could occur while scuba diving and taking Vicodin?

**A** Before we discuss the potential issues associated with diving while taking a narcotic pain reliever, let's discuss the underlying condition or injury that prompts the need for the medication. Any condition or injury that can compromise your ability to function normally is the first concern. You need to be able to physically perform all necessary skills, especially in an emergency. This is not only for yourself but also for your buddy. Be sure to consult a physician knowledgeable about the sport, and make sure you're physically ready to dive. If the pain being treated results from an injury, most dive physicians would recommend waiting until you have recovered more fully before diving. If the pain is due to a chronic condition, then the condition should be as stable as possible.

Also consider the possibility that increased pain after a dive might be mistaken for decompression sickness. Being treated for DCS when it is not really the issue is less problematic than not being treated when DCS is the cause. It is also unknown how potentially injured tissue may respond to inert gas uptake and off-gassing.

As for the drug itself: narcotic pain medicines, like Vicodin, can affect a diver's mental alertness and physical ability to function and should be avoided. In fact, any medication that carries a warning about consuming alcohol may be problematic with diving. In dives deep enough to create nitrogen narcosis, the diver may find that the narcosis intensifies the effects of the medication.

A dose that is manageable topside may create significant impairment at depth. To avoid these effects, consult a knowledgeable physician who understands dive medicine. If you are cleared to dive, stay conservative in your profiles and limit your depth to avoid narcosis.

*Marty McCafferty, EMT-P, DMT-A  
 DAN medical information specialist*



I have been diagnosed and treated for spontaneous pneumothorax (collapsed lung). Will it keep me from diving?



The short answer is yes. If you've experienced a spontaneous pneumothorax it's time to hang up the regulator for good. Here's why:

Your lungs are not attached directly to the chest wall. They remain open and capable of drawing breath by the negative pressure in the intra-pleural space. When too much pressure builds up (when a diver holds his breath while ascending, for example) the lung tissue can tear, allowing air to leak into the intra-pleural space, interrupting the negative pressure that holds the two pleural layers together. Eventually, the entire lung collapses, resulting in rapid, shallow breathing, a bluish cast to lips, skin and fingernails (due to a lack of oxygen) and chest pain.

A collapsed lung that occurs during everyday activities is referred to as a spontaneous pneumothorax and is a particular concern for divers because it can happen again without warning. The root cause is usually weakened lung tissue. Disease, previous injury or inflammation (often caused by smoking) form blister-like swellings in the lung's tiny air sacs, called blebs or bullae. These areas of weakened tissue tend to empty air slowly. In divers, the normal pressure build-up that occurs during ascents can cause the blebs to rupture.

Blebs are likely caused by degradation of elastic fibres in the lung and are hard to detect. There are generally no signs or symptoms until they rupture. Blebs are most frequently found in smokers, but they can also appear in non-smokers. Some lung diseases (such as asthma, emphysema, sarcoidosis, eosinophilic granuloma or interstitial fibrosis) can also lead to spontaneous pneumothorax because they predispose the lung to weakening and possible injury. Other causes of spontaneous pneumothorax include chest injury, such as a penetrating wound and rare cases of congenital weakness.

When spontaneous pneumothorax occurs, it usually causes sharp pain on the affected side of the chest. If the volume of air leaked into the pleural space is large enough, it can cause further collapse of the lung and shortness of breath. There's another level of concern with pneumothorax. Sometimes injuries to the lung can result in the creation of a one-way valve, where air leaks into the pleural space that surrounds the lung and does not return to the lung. This results in a progressive enlargement of the pleural space and compression of the lung. If left untreated, the pleural space can compress the heart and opposite lung and restrict blood from returning to the heart. This is known as a tension pneumothorax and is associated with gasping, low blood pressure, shock and ultimately death if not treated promptly.

#### **Treatment for Pneumothorax**

Any form of pneumothorax requires medical treatment. In some cases, a physician may insert a chest tube, withdraw air from the chest cavity and allow the lung to reinflate. If the pneumothorax is small, breathing 100% oxygen may hasten the resorption of gas without the need for a chest tube or invasive procedure.

Unless it occurs with decompression illness in divers (where bubbles enter into the arterial system and affect the brain), pneumothorax does not require recompression. In the event of a chamber treatment, a chest tube may be required to help equalise the pressure and prevent further injury or enlargement.

#### **Long-Term Implications**

There are a few treatment options for blebs or recurrent pneumothorax that merit mention. We should stress from the outset, however, that none of the following treatments alter the medical recommendation regarding fitness to dive with a history of spontaneous pneumothorax. Blebs can be removed by surgery. Another approach, called pleurodesis, introduces a substance into the pleural space that causes scarring and permanent obliteration of the pleural cavity. However, after experiencing any form of pneumothorax or treatment, an injured person should not dive until cleared by a physician familiar with dive medicine.

For the reasons explained above, physicians trained in dive medicine would be very reluctant to provide medical clearance for someone with a history of spontaneous pneumothorax. Individuals who have experienced an episode of spontaneous pneumothorax are at a high risk of recurrence. While diving, pneumothorax can lead to a deadly arterial gas embolism, but the biggest risk may come from a tension pneumothorax that can evolve rapidly as gas expands on ascent (or during decompression). The risk of tension pneumothorax is why most dive physicians will recommend that you give up scuba diving to any depth. When you get that yearn to be underwater, try snorkelling. You can still get wet and enjoy the sights of the underwater world without the risk of serious injury.

*Richard Moon, M.D.*

*DAN senior medical adviser*

# When I needed it most... DAN WAS THERE FOR ME



Image by Justin Barker.

By Morné Christou

**Whilst spearfishing in a remote location, Mark, a DAN member, experiences an unruly bump-in with a zambesi shark. With an emergency plan in place, and having notified DAN of his intent to travel, Mark is evacuated to hospital within hours...**

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*Before he knew it, the shark was well within his personal space, and with its mouth open, bumped into his legs.*

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**Internationally,** DAN has many members who enjoy a combination of water sport activities. With so many activities taking place in the water, encounters with hazardous marine life are bound to happen and last year it was a DAN-SA member that had a very close encounter with a shark in Mozambique.

Mark enjoys spearfishing and planned a trip to Vilanculos in Mozambique with a group of experienced spearfishing dive buddies. Mark and his team are meticulous when it comes to dive safety and therefore, their preparation before and during a spearfishing dive trip is planned to the very last detail in case of an emergency. Before departing on any dive trip, Mark informs the DAN office of the dive trip and when visiting remote locations, he submits an emergency assistance plan to the DAN office. These simple considerations help DAN improve emergency assistance when needed, especially when diving in remote locations. Each morning before their diving starts, they leave a dive plan with the lodge. This helps the lodge track their clients out at sea and also helps identify boat launching times during the day.

It was the third morning of their stay at Villa Mar near Vilanculos, the time was about 06:45 and the conditions perfect. All the divers were excited and ready for a long day out at sea.

Before entering the water, they circled around for awhile and soon found a pinnacle at 15 m. They moved up current and found a steep drop-off to 30 m with loads of fish activity. They decided that the first drift should be approximately 200 m from the pinnacle, just enough time to get settled before reaching the upwelling.

As is the usual case, Mark was the first diver ready to get into the water. His float line uncoiled and he loaded his spear gun, accidentally dropping the flasher to about 12 m. At this stage, it is important for Mark to relax and breathe, which improves his awareness of the

other divers and the underwater environment.

As he drifted on the surface, he spotted the usual reef fish – this meant that it was time to get going. While he descended, the ocean suddenly cleared and revealed a decent-sized kakaap. He took aim and landed the fish and found that the fish attached to the spear. *Great shot*, he thought to himself as he let go of the spear gun and ascended to the surface. With the float line running through his fingers, he noticed a large zambesi shark in the area. On reaching the surface, Mark immediately called Rob for assistance. It is not unusual for spearfishermen to see sharks while diving but it is not as frequent as in the past.

Mark was not keen to lose his catch to the shark and started pulling up the speared fish as fast as possible. Finning vigorously on the surface to stay afloat, he kept a lookout for the shark which had moved out of sight. Looking down again, he noticed the shark directly below him, swimming towards the speared fish. The shark, now about 15 m away, turned around, swam past the speared fish and started in the direction of Mark’s fins. Before he knew it, the shark was well within his personal space, and with its mouth open, bumped into his legs. All that was left to do was curl up into a ball, forcing his body to pull his legs out of the shark’s way and hope for the best. The shark bit down and got hold of Mark’s left foot. He was then shaken around violently. Suddenly, the shark let go and swam away. There was no doubt about it, Mark knew that he was in trouble as the boat approached to assist him. As he swam closer to the boat, his foot was not reacting and he was worried.

Filled with adrenalin, he climbed into the boat and pulled off his badly-damaged fin and boot. A gaping wound was exposed on the top of his foot. Thankfully, his experienced dive buddies were able to control the situation and calmly started initiating their emergency plan.

With their first aid training and experience, they managed to control the bleeding. Mark's spearfishing gear was also recovered, and included the speared fish. After securing the gear on board the boat, the long ride home began. Mark recalls this being the worst hour and a half he had ever endured.

As the boat beached back at the lodge, Mark was carried to shore. Fortunately, the lodge manageress was a qualified nurse who was able to attend to his wounded foot. It was clear that Mark needed proper medical treatment as soon as possible, however, the Vilanculos hospital was closed for the day due to the election campaigning taking place at that stage. Suddenly, Mark remembered that he was a DAN member and asked his wife to phone the DAN hotline for assistance. DAN was able to respond immediately and sent a fixed-wing aircraft to evacuate him back to South Africa. During the painful wait<sup>1</sup>, the lodge manageress cleaned and dressed the wound, and they then reflected on the day's events.



### TIPS FROM SHARKLIFE

Shark incidents, like what Mark experienced, are very rare but do give us insight into ways to avoid these situations. Sharks will avoid humans in almost every situation, however, the presence of struggling prey will cause any predator to become more alert and inquisitive of potential feeding opportunities. During this stage, the animal is assessing your reactions and looking for any signs of vulnerability.

In Mark's situation, he needed to make every effort not to appear vulnerable – his movements should have become slow and controlled, even aggressive towards the shark. Sharks are not equipped to struggle with large prey and they seldomly risk injury for a potential meal.

Things to remember while diving with sharks:

- A minimum of 8 to 10 m visibility is recommended when diving with sharks.
- Avoid diving with sharks from dusk till dawn.
- Always be aware of where the sharks are. Look out for, and react to, shark investigations by changing your body position to acknowledge the shark.
- Establish a confident role in the water by maintaining your position and not swimming away from the sharks.
- Avoid waving your hands around. Use controlled gestures if you have to.
- Maintain good buoyancy and monitor your depth at all times.

What Mark and his fellow divers learnt:

1. Having prepared an emergency assistance plan helped them manage the situation with a clear head and prevented them from panicking, even though they were under a great deal of stress.
2. Informing DAN and the lodge of their plans before their dive trip certainly played a major role in the assistance of the divers. After informing the DAN hotline, they were prompted to activate the roaming function on their mobile phones. This proved to be very useful advice.
3. They realised the value of completing a first aid and CPR course. Without this training, who knows what would have happened. Mark was amazed at the effectiveness of the basic first aid training they received. He has vouched to keep this training up-to-date as it has proven to be invaluable.
4. Having functional and well-serviced equipment is very important. The lodge boat used was in good working conditions and Mark recalls it having a DAN Diving Safety Partners decal on the console - the mark of safety excellence! The experienced skipper knew exactly what to do. He used the two-way radio on board the vessel to contact the lodge and informed them of the emergency and asked the lodge to inform the medical services of the injured diver. Mark was impressed when the skipper opened a DAN oxygen unit and offered him oxygen after he had been stabilised.
5. After the unfortunate event, they realised the importance of contacting the DAN hotline as early as possible during an emergency. Fortunately for Mark, the DAN hotline was contacted just after 9:00, whereafter the fixed-wing aircraft arrived at 13:30<sup>2</sup>. He arrived at the casualty section of hospital at 17:30 and was immediately prepared for theatre. He needed one and a half hours of reconstructive microsurgery to reconnect the tendons.
6. Lastly, they realised the importance of having an active DAN membership.

Fortunately, this story has a happy ending. Mark was kept in hospital for a few days after receiving further surgery to remove dead tissue. After he was released from the hospital, the doctor was confident that Mark would fully recover with minor loss of feeling on the top of his toes.

Thanks to good planning, the divers were able to contact DAN and get the support needed to set the ball in motion. "DAN was there for me and arranged the rescue team immediately," Mark said. The idea of not being able to contact DAN, or worse, not having someone like DAN to help in a dive emergency like Mark's, is unthinkable. **AD**

### IMPORTANT POINTS TO REMEMBER WHEN DIVING IN REMOTE LOCATIONS:

- Call the DAN hotline as soon as possible.
- Ask the tour operator about the area where you will be diving and travelling and be prepared – remote locations can prove difficult and challenging when it comes to arranging evacuations and medical care.
- Make sure your DAN membership and medical aid are active and notify both if you intend to travel.
- Let the resort and your dive buddies or travel companions know that you are a DAN member and give them the numbers to call in an emergency.
- Have your cell phone roaming activated or make sure there is a phone you can use to call in an emergency.
- Follow the advice and recommendations of the DAN hotline – they are trained professionals and are there to make sure you get the best possible care.

### FOOTNOTES:

1. Usually, the air evacuation is authorised, mobilised and ready to take off within two hours. This particular flight left Lanseria at roughly 12:00 with a 1 to 1.5 hour flight time to Vilanculos.
2. It is important to remember that in remote locations it might not always be possible for the aircraft to land at any time of the day as some runways are not suitable to land on in the dark.

# GASTROINTESTINAL problems and diving

By Dr Peter B Bennett and Dr Frans J Cronjé

**With the exception of acute infections and bleeding ulcers, it is rare for gastrointestinal problems to preclude divers from diving. Nevertheless, there are potential hazards to consider. In this section, DAN reviews some of the common medical problems related to the gastrointestinal system.**

## ABDOMINAL SURGERY

Surgical intervention of the abdomen in the past often utilised large incisions (laparotomy) to permit the surgeon to examine the abdominal contents. This imposed all the risks for infection of the wound during recovery. Long recovery was usually required with many days in the hospital. Today, however, endoscopy permits same-day surgery in many cases. This technology permits access to the abdomen through several small (less than two inches) incisions. Through these incisions, the surgeon can carry out appropriate surgical procedures.

As a result, endoscopy has significantly reduced the risk of infection, shortened hospitalisation and improved the time for recovery. This is important to the diver. Although there are little or no direct effects of diving on abdominal surgery, clearly a laparotomy is likely to be more debilitating in recovery than endoscopy. Diving may occur in water with various degrees of contamination and the smaller the surgical wound, the better because infection would be prevented. In either case, diving should not occur until after the surgical incision is well healed, which may take as much as six weeks. This will give sufficient time for the supporting abdominal muscles to heal. It will also permit time to deal with a small number of abdominal surgeries that end up trapping parts of the bowel, leading to what is called incisional hernias.

The surgeon responsible can best advise when to return to swimming or diving, and when fatigue and reduced fitness, resulting from major surgery, are likely. Until then, divers should not be lifting dive tanks or other heavy diving equipment. A gradual increased programme of physical therapy could be of help.

## BOWEL OBSTRUCTION

An obstruction of the bowel can be caused in a number of ways. These include twisting or entrapment of the intestines, possibly within a hernia (refer to Hernias), adhesions or scarring due to infection and diseases of the gut or unusual abdominal compression. The symptoms include acute abdominal pain, often accompanied by nausea and vomiting.

It is unlikely that anybody with a bowel obstruction would wish to dive as it will need immediate hospitalisation. The condition needs evaluation by a physician due to risk of over-distension of the trapped bowel and possible bursting, resulting in a serious infection of the abdomen (peritonitis).

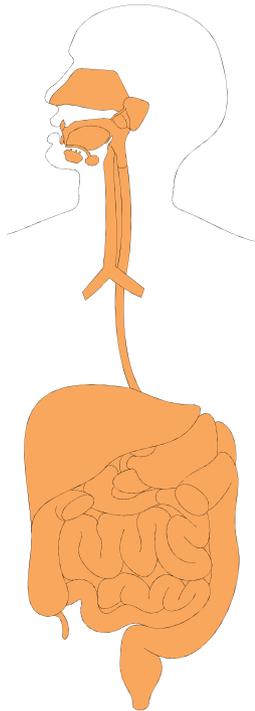
After remedies, such as surgery or antibiotics with an appropriate time for recovery, the individual may return to diving.

## COLOSTOMIES

Surgical intervention with regard to cancer of the large bowel or Crohn's disease (a chronic inflammatory disease), for example, may involve a colostomy. This involves cutting out the cancerous bowel. In order to allow the bowel to continue to empty its content, an opening or ostomy is opened on the abdomen. If the opening involves the small rather than large bowel, it is called an ileostomy. These then require fitting of a removable colostomy bag to remove bowel contents.

A concern would be that the bag might over expand and burst during a diver's ascent during air swallowing, etc. But this does not appear to be a problem. Another is the bag may be dislodged due to unusual movements of the diving equipment and the contents of the bag spilled. In either condition, this does not provide any danger to the diver.

With an ileostomy, another method is to insert a loop of the small bowel under the skin and is called a continent, moderate ileostomy or a Koch Pouch. To relieve the contents, a small nipple



valve is included that can be regularly emptied by means of a small rubber catheter. A possible problem, but more serious than with the bag, is that gas swallowed during a dive may expand on ascent and rupture the pouch and this could therefore be a contraindication to diving.

In most cases, a diver should still be able to dive. However, the diver would be wise to evaluate his or her particular situation both with the surgeon or physician involved and, whenever available, a physician experienced in diving medicine.

## CRAMPS

Painful spasms of the muscles, commonly of the calf of the legs or soles of the feet, are known as cramps. Other muscles, such as those of the thighs, upper limbs and even the abdomen, may be involved. The pain is often very strong, but temporary, and usually resolves after a short time with some residual soreness.

To assist relaxation of the muscles affected, passive extension and massaging is advised. Divers seem to be especially prone, perhaps because it seems to affect muscles not used to the heavy exercise involved. Clearly, severe pain while in or under water creates the danger of drowning. To mitigate the occurrence of cramps, divers or swimmers are advised to keep physically fit by exercising regularly, keep well hydrated with electrolyte-balanced drinks, have well-fitted (not over-tight) equipment, keep warm but not overheated or too cold and to eat a nutritious diet.

## GALLSTONES

Gallstones are found in the gallbladder and are made of cholesterol. One or more may be present and vary in size from very tiny to 2 ½ inches in diameter. Their presence may be found in association with other conditions such as pancreatitis, irritable bowel syndrome, kidney stones, etc. Symptoms may or may not be present, but are not life threatening.

The primary symptom is an acute intense pain in the upper right side of the body, possibly accompanied by nausea and vomiting. The treatment of choice, should symptoms occur, is surgical removal of the stones.

Some 600 000 individuals need surgery each year to remove gallstones. About 10% of people over the age of 40 have gallstones. In the past, surgical intervention involved laparotomy and access through a large abdominal incision. Today, laparoscopy access through only two or three small holes causes less pain and a quicker recovery.

For divers, the primary concern would be the occurrence of symptoms indicative of gallstones while on a live-aboard in a remote spot or similar remote dive sites. The diver would need to use all services available, such as the Divers Alert Network, to evacuate to a modern, experienced medical facility for potential treatment or surgery. After surgery and after the wounds have healed, the diver may return to diving without any problems.

## GASTROENTERITIS

When travelling abroad, it is not uncommon to contract gastroenteritis, which is often called food poisoning. The symptoms – nausea, vomiting and diarrhoea – can be very debilitating and is sometimes referred to as the influenza virus, which is incorrect.

There tends to be two kinds. One is due to bacteria contamination of the food supply, often affecting ground meat, poultry, eggs, fresh fruits, vegetables and salads. Common bacterial culprits are E. coli or Giardia or Salmonella.

The second is due to viruses, of which there are many. In recent years, these have appeared on cruise ships, nursing homes, college campuses, etc., where people are in close quarters, and are often due to the Norwalk virus. Symptoms include vomiting and watery diarrhoea, possibly with headache; increased temperature and abdominal cramping. These symptoms may continue for several days. The condition is also highly contagious. In severe cases, hospitalisation may be required.

Prevention involves good hygiene with frequent washing of the hands and decontamination of surrounding surfaces with antibacterial agents or chlorine bleaches. Contaminated clothing should be cleaned in boiling water. All food liable to spoilage should be refrigerated. Care should be taken when eating shell fish and especially raw fish.

The condition is found all over the world. Divers travelling to third world countries with low hygiene standards may be more prevalent. The major concern is dehydration. A physician may recommend specific rehydration solutions. In non-viral gastroenteritis, antibiotics such as Cipro may be of benefit. Over-the-counter drugs to help prevent diarrhoea, such as Pepto-Bismol or Lomotil, may be helpful in mild cases.

Since dehydration is believed to potentiate the possibility of decompression sickness when diving, divers may need to wait for a few days after recovery, and rehydration has occurred, before returning to diving.



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*Divers seem to be especially prone, perhaps because it seems to affect muscles not used to the heavy exercise involved.*

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## HEARTBURN

Heartburn is the non-medical name for gastroesophageal reflux disease (GERD). It is caused by an abnormal reflux or backflow of the stomach acid and contents. Symptoms include a burning sensation or pain behind the breastbone and may be accompanied by a sour taste or even regurgitation of food or a sense of bloating and nausea. Commonly, it occurs after eating (especially spicy foods) or overeating. It may last for several hours and lying down or bending over will make it worse.

The condition occurs in 20% of adults at least once per month, especially in those over the age of 45. Severe heartburn may occur in 5-15% of individuals and it is present in 80% of pregnant women. Drinking alcohol and smoking will exacerbate heartburn, as will having a stomach ulcer or hiatal hernia (see Hernias).

The latter, especially during descent when diving, may precipitate heartburn. During ascent, due to expansion of air swallowed during the dive, reflux may also cause regurgitation of stomach contents. During diving, this involves the added risk of reflux of the stomach contents into the regulator or into the lungs which may be fatal.

Mild heartburn is usually treated with over-the-counter antacids. More severe cases with frequent episodes may require stronger prescription medications or even surgery.

Those divers with frequent, chronic heartburn should seriously consider the risks of diving with this condition.

## HERNIAS

A hernia is caused by a weakness of the abdominal wall which allows the soft tissues beneath to cause a bulge. Inguinal hernias are the most common and occur in the groin region. Femoral hernias may be confused with inguinal but are due to bulges from the lower abdomen into the upper thigh. Incisional hernias can occur after abdominal surgery. Umbilical hernias develop around the navel and epigastric hernias develop in the middle of the abdomen. Hiatal hernias occur when part of the stomach bulges out of the abdomen into the chest cavity.

The symptoms associated with inguinal hernias include tenderness or severe pain in the groin or heaviness, swelling and a tugging or burning sensation in the groin, scrotum or inner thigh. This may be relieved only when lying down. It is possible that a bulge may be caused without any pain.

Hiatal hernias may involve heartburn or esophageal reflux. Sometimes there may be no symptoms at all.

Treatment commonly involves surgical repair of the hernia. There are some 750 000 carried out each year in the United States alone. If not treated, there is a danger of trapping a piece of the bowel in the hernia. Such an obstruction, "incarceration" or strangulation can be fatal due to the blood supply to that loop of intestine being cut off, killing the tissue. There is a small (less than 10%) risk of a further hernia after surgery. Trusses are not generally advised as they do not prevent trapping.

The risk to the diver is that the trapped loop of bowel containing air will expand during ascent and cause a rupture. Surgical repair of a hiatal hernia can result in "gas-bloat" syndrome resulting in distension of the stomach with gas due to an inability to belch. This, too, may result in a rupture of the stomach on ascent.

For these reasons, it is best to have a hernia surgically repaired before diving. Prevention of a hernia or its recurrence can be assisted through plenty of exercise and avoiding obesity or sudden weight loss. Chronic, heavy coughing, straining at bowel and urine relief and lifting heavy weights improperly should be avoided.

## INFLAMMATORY BOWEL DISEASE (IBD)

IBD is a chronic condition that causes inflammation and sometimes ulceration of the bowel and affects some 600 000 people in the United States. The two most well-known forms are ulcerative colitis and Crohn's disease, but it can also affect the joints, eyes and skin. Symptoms include bloody diarrhoea or constipation, nausea, vomiting, acute abdominal pain, fever and loss of weight. Although not life threatening, these can be very debilitating and may involve an accompanying depression. There is also an increased risk of colon cancer.

The disease may start with intermittent attacks followed by more prolonged attacks, accompanied by anaemia, electrolyte disturbances, dehydration, poor absorption of fluids, liver disease and a generalised fatigue.

Treatment in the mild cases with only occasional symptoms may involve medications such as corticosteroids, but severe cases may involve surgical removal of the colon.

Divers often travel to isolated dive sites or on live-aboards where an acute attack may be difficult to treat. Divers with active symptoms of IBD should not dive. However, divers under medication with good control of the inflammation are fit to dive.



“  
*Divers with active symptoms of IBD should not dive. However, divers under medication with good control of the inflammation are fit to dive.*  
 ”

## PANCREATITIS

Pancreatitis is due to inflammation of the pancreas in the abdomen. The condition may be either acute or chronic.

Acute pancreatitis is serious and life threatening. It is associated with severe pain and distension in the middle of the abdomen, which may also be felt in the back. It may occur after a heavy meal or drinking alcohol. Other signs or symptoms may be nausea or vomiting, fever and a rapid pulse. More prolonged and chronic pancreatitis is similar, with the following symptoms: bouts of long-lasting, severe abdominal pain and distension; loss of weight and bad-smelling, large faeces. There is a possibility of developing diabetes if the pancreas is too severely affected or becomes calcified.

Treatment will initially focus on controlling the severe pain but requires intervention by a physician and hospitalisation. Not uncommonly, pancreatitis may be initiated by gallstones which obstruct the pancreatic duct. In this case, surgery (most likely endoscopic surgery) may be required to remove the blockage or even the whole gallbladder with the gallstones (refer to Gallstones). Chronic pancreatitis will involve avoiding fatty foods and alcohol and taking medications prescribed by a doctor.

For those who may be diving on a live-aboard or remote island far from experienced medical assistance or hospitals, acute pancreatitis should be regarded as unwise for divers and evacuation to appropriate medical facilities instituted as soon as possible. Those with chronic pancreatitis who are not under medication for pain, not fatigued and have a normal diet can probably dive with the permission of their physician.

## PEPTIC ULCERS

It is estimated that 5 to 10% of the general population may develop a peptic ulcer. It is due to a sore on the lining of the stomach or duodenum (first section of the small intestine). Those in the stomach are called peptic ulcers and those in the upper small intestine, duodenal ulcers.

The most common causes are irritation of the stomach lining due to higher acidity produced by aspirin or non-steroidal, anti-inflammatory (NSAID) drugs or infection by *H. pylori* bacteria. Treatment is by antacids or antibiotics for infections.

Symptoms may include upper left abdominal pain (often relieved by antacids), loss of appetite, weight loss, general fatigue, bleeding and possible perforation, bloating and nausea after eating, vomiting after meals and black, tar-like stools due to the bleeding.

Left untreated, ulcers may heal, however, at least half such cases will recur. Today, medications are most effective in treatment and surgery is rarely necessary.

In divers it is probably best that they not dive if they have a peptic ulcer. The symptoms of such an ulcer can come on rapidly and be severe and disabling. Once the ulcer is cured by medication or surgery, and there have been no further symptoms, then diving should be possible.

## VOMITING

Vomiting may be caused by many possible factors: sea sickness, overeating, gastroenteritis or gastrointestinal disease. In most cases, it will be due to inflammation of the stomach and intestines from viruses or *Salmonella* bacteria. It is quite common in countries with poor sanitation and health control. The symptoms of vomiting – abdominal cramps, diarrhoea, fever, headache – may last for several days. Viral gastroenteritis is contagious so it can easily spread through a group of divers.

The most important treatment for all such vomiting, especially in divers, is to prevent the acute loss of fluids and dehydration which may potentiate susceptibility to decompression sickness.

Vomiting from sea sickness affects some divers and, again, can be treated by medications. Its occurrence underwater is a particular problem and danger. Not everybody can vomit through the regulator and nor, perhaps, should they. Advice, on the other hand, to take out the regulator to vomit is equally difficult as the large inhalation after vomiting may come before the regulator is restored and therefore, drowning may occur. Medications to control sea sickness often cause drowsiness and other side effects and need to be tested by the diver at least 24 hours before diving to ensure these will not be a problem.

Prolonged and uncontrolled vomiting may require hospitalisation to ensure adequate rehydration.

Prevention is the best treatment. Ensure that food is adequately refrigerated and hygienically prepared. Wash hands frequently and cook all meat and chicken to a temperature likely to kill bacteria (see Gastroenteritis). 

“  
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# DAN Research Updates

## The latest analysis, data and discoveries

By Dr Richard Vann

**DAN's mission is recreational diving safety. The Research Department supports this mission through field, epidemiological and experimental studies that seek to shed light on the issues related to fatalities, injuries and the risks of decompression illness (DCI). Here are the findings from some of our recent projects.**

### DIVE FATALITIES RESEARCH

DAN Research maintains an active surveillance programme for dive fatalities. A recent investigation of 947 diving-related deaths from 1992 to 2003 found that the principal injuries preceding death were asphyxia (33%), arterial gas embolism or AGE (29%) and cardiac incidents (26%) (Ref 1). Deaths due to asphyxia and AGE were associated with entrapment, insufficient gas, rapid ascent and equipment trouble. For cardiac incidents, associated factors were age and a history of cardiovascular disease.

A review of fatalities among insured DAN members also provided some interesting insights, particularly regarding associations with the age of the diver (Ref 2). Annual death rates for insured DAN members were stable from 2000 to 2006, with a mean of 16.4 deaths per 100 000 members. Fatality rates increased dramatically with age. Among divers 15–25 years of age, the fatality rate was less than 10 per 100 000 members but increased to 30 per 100 000 among divers 65 years of age and older.

Women under the age of 55 were much less likely to die while diving than men were, but among divers 65 years of age and older, there was no difference in the death rate between the sexes.

To better understand the specific role of age in these deaths, we went back to the associated injury data and this time looked at the trends by dividing members into two age groups: over 50 and under 50. In this analysis, we found that older divers were three times more likely to die from asphyxia, four times more likely to die from AGE and 13 times more likely to die from cardiac events, in comparison to the under-50 dive group.

The high association of cardiac incidents with older divers is of particular concern since the general diving population is aging. As a result of our findings, DAN Research has planned a two-and-a-half-day workshop for April 2010 to discuss the question of dive fatalities.

### HIGH-RISK DIVING GROUPS

DAN fatality surveillance also tracks small, high-risk recreational diving populations such as cave and rebreather divers. Cave diving deaths decreased during 1969–2007 and now account for only about 5% of annual U.S. and Canadian fatalities reported to DAN. Rebreather fatalities, however, have increased since 2000 and now account for about 6% of known deaths.

### ANALYSIS OF DCS CASES

Helping divers understand, avoid and find proper treatment for DCI was the primary reason for DAN's founding. DCI is a broad category of pressure-related injuries that includes both AGE and decompression sickness (DCS), with DCS (or the bends) being the most common malady. DAN is notified of about 1 000 U.S. and Canadian DCI cases per year and processes insurance claims for approximately one-third of these.

Analysis of the DCS claims among DAN members from 2000 to 2007 found an average rate of 217 cases per 100 000 insured members, with an annual decrease in claims of approximately 12 cases per 100 000 members during the period. The claims rate was very low for divers in their early teens, rose to 350–400 cases per 100 000 members for divers in their 20s and declined with age thereafter. For women, the claims rate was lower than those by men, by about 60 DCS cases per 100 000 members.

In future editions, we plan to bring you updates from ongoing DCI/DCS research projects including:

- A joint effort between DAN Research and DAN Medical Services to investigate first aid and therapy options that provide the best long-term outcomes for divers affected by DCI.
- The collection of depth-time profiles from recreational and technical divers to study the overall DCS incidence and identify profiles with the highest DCS probability.
- The establishment of a centre of excellence for DCS probability modelling, in co-operation with Duke University's mechanical engineering department and the U.S. Navy.

### EXPERIMENTAL DIVING RESEARCH

Also, look for updates on the experimental diving research under way in the chambers of the Duke Center for Hyperbaric Medicine and Environmental Physiology. Projects include:

- How immersion and exercise affects the DCS risks of flying after diving.
- How elevated oxygen partial pressures affect carbon dioxide narcosis.
- A recently completed study that found the prescription drug Cialis increased the risk of CNS oxygen toxicity in rats (Ref 3). **AD**

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3. Demchenko I, Ruehle A, Allen B, Vann R, Piantadosi C. "Phosphodiesterase-5 inhibitors oppose hyperoxic vasoconstriction and accelerate seizure development in rats exposed to hyperbaric oxygen." *J Appl Physiol.* 2009; 106:1234-42.



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# DAN Products

## OXYGEN UNITS



### DAN DUAL RESCUE PACK EXTENDED CARE

Includes: Two Luxfer Jumbo-D cylinders, 1600 Pelican waterproof case, brass multifunction regulator, demand valve with hose, oronasal resuscitation mask (DAN pocket mask), hand-wheel with chain, non-rebreather mask, silicone Tru-Fit mask. Dimensions: 61.6 cm X 49.3 cm X 22 cm; Weight: approximately 6.4 kg (case only); Delivery time: 120 minutes.



### DAN RESCUE PACK

Ideal for shore-based diving and training activities. Includes: 1450 Pelican waterproof case, brass multifunction regulator, demand valve with hose, Luxfer M9 cylinder (248.22 l), oronasal resuscitation mask (DAN pocket mask), silicone Tru-Fit mask, hand-wheel with chain and a non-rebreather mask. Dimensions: approximately 40.6 cm X 33 cm X 17.4 cm; Delivery time: 20 minutes.

### DAN SOFT-SIDED OXYGEN UNIT

The Soft-Sided Oxygen Unit uses a compact, water-resistant nylon case, which was exclusively designed for the unit. New from DAN, the Soft-Sided Oxygen Unit was created for divers and professionals who do not require a waterproof case for their oxygen unit. It contains the same components as the standard Rescue Pack Extended Care. The case includes a front pocket and a zippered top lid for easy access to the cylinder. An adjustable shoulder strap and top haul loop provide two easy carry options, and a nylon daisy chain runs down the back of the case, making it simple to secure in your vehicle or boat.



### DAN RESCUE PACK EXTENDED CARE

Ideal for dive sites and larger dive boats. Includes: 1600 Pelican waterproof case, brass multifunction regulator, demand valve with hose, Luxfer Jumbo-D cylinder, oronasal resuscitation mask (DAN pocket mask), hand-wheel with chain, non-rebreather mask, silicone Tru-Fit mask. Dimensions: 61.6 cm X 49.3 cm X 22 cm; Weight: approximately 6.4 kg (case only); Delivery time: 60 minutes.

## FIRST AID KITS

### DAN POCKET GUARDIAN FIRST AID KIT

The perfect, compact, personal first aid kit, whether you're on or around the water. Packaged in a zippered nylon pouch with a waterproof inner bag.



## BOOKS AND GAMES



### SCUBA DIVERS SIGN LANGUAGE MANUAL

This illustrated manual provides a visual record of underwater communications and shows how the signs are made to help the reader remember them.

By James P. Smith;  
103 pgs; hard cover © 2000

### SCUBA-OPOLY

Scuba-Opoly is a board game designed for divers and non-divers who enjoy the marine environment. The artwork of artist Rogest gives you beautiful and colourful sea creatures to enjoy while playing.

Buy property, collect research dives, go to exotic places... sounds easy enough... but add a shark cage, lost weight belts and typhoons and it becomes a little more difficult and a lot more fun!

Scuba-Opoly is part of the DAN fundraising programme. Proceeds from the sale of Scuba-Opoly support the DAN Research Internship Programme.



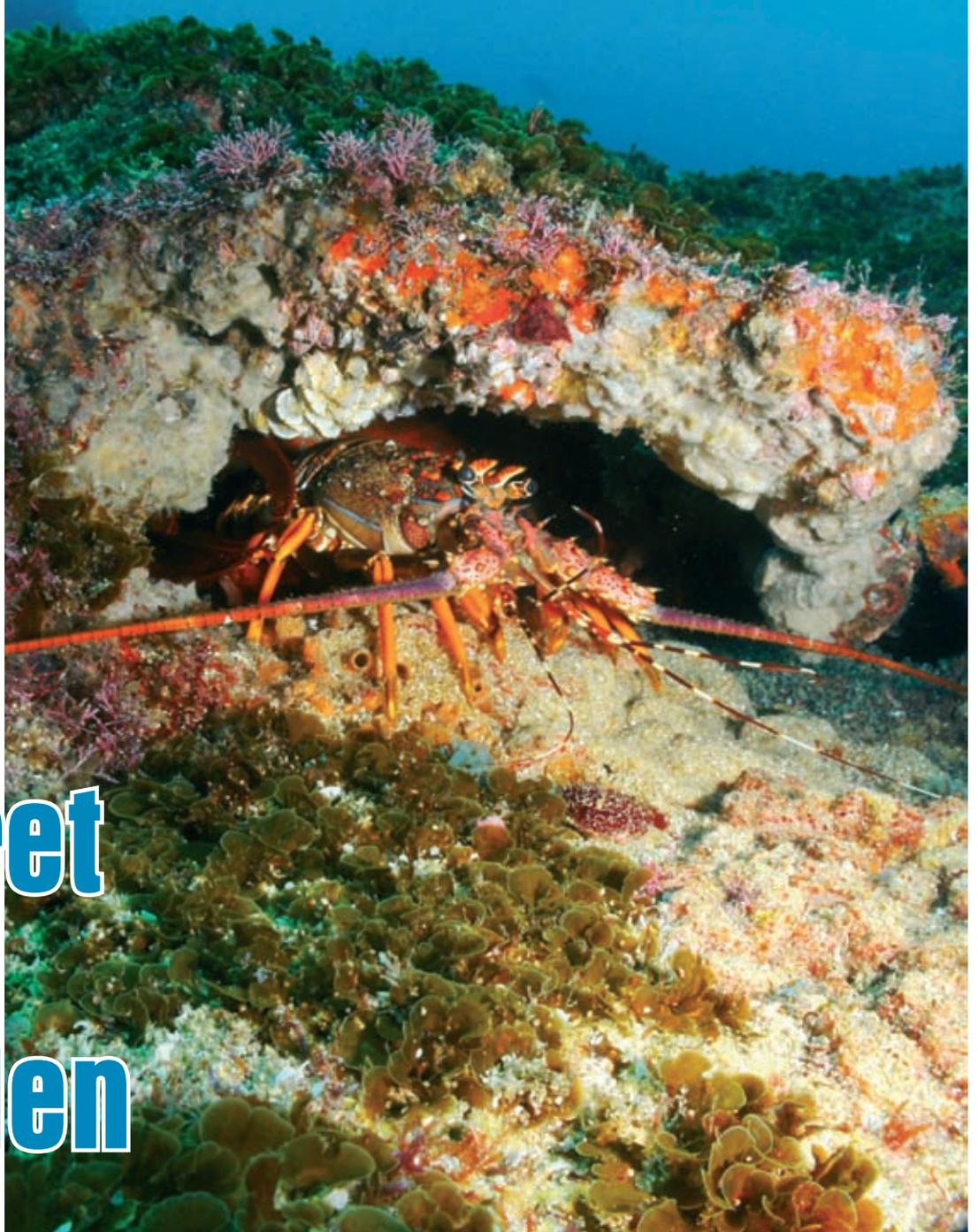
## ACCESSORIES

### KEYRING DISPOSABLE BARRIER

Keyring pouch containing a pair of gloves and a disposable mouth-to-mouth barrier with one-way valve, which is ideal for training sessions.



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# The Secret Sea Garden

**DAN** member Vladimir Lymar submitted this edition's Parting Shot. This is his story...

“

I took a trip down to Umkomaas at the beginning of December last year and as is the usual case with any dive trip, I took my trusty camera (Sealife DC 1000 with external flash) with me to add to my ever-increasing “critters” folder. I love sharing my underwater shots with non-diving friends and family members.

My first dive at *The Channel* presented this interesting photo opportunity. It seems like the crayfish is overlooking the lawn of its magical front garden (all that's missing is a little “welcome home” mat in front of the cave's entrance). My friends and I loved this shot so I thought I'd share it with you.

”

**Parting Shot gives you a chance to share your interesting dive stories and images with us.**

Have you encountered a rare or exciting activity underwater and captured it? Has an underwater event just added that something extra to your dive and you have a photo? If so, all you have to do is send through your high resolution image (300 DPI) along with your story (including a brief description of your creature, location of dive site and pertinent photo information) and contact details to [partingshot@dansa.org](mailto:partingshot@dansa.org) and your submission could appear in the next edition of *Alert Diver!*

All images submitted for the *Parting Shot* become the property of DAN.



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