Welcome to the first edition of the RCN Bulletin, a newsletter of the DAN Recompression Chamber Network.

We are sharing this publication with all the chambers that we engage with under the RCN and hope to be able to provide some valuable information to you all. We’d also like to hear back from you as to whether you find this interesting. If you would prefer not to receive these newsletters, please feel free to click unsubscribe at the bottom of the email sent to you and we will take you off this list.

Divers rely on your recompression chamber facilities, often in more remote or less-developed areas where some of the best dive sites are located, to provide them with essential treatments for diving injuries. We know that in some of your areas, supporting a chamber is a significant staffing, resource, financial and maintenance burden.

DAN launched an assistance program (the RCAP) back in 1993 to provide training, technical and safety advice, and other forms of essential support to chambers with such needs. Since then we have built an international network (150 chambers), many of them participating in the RCAP. It is our aim to use our resources to continue to give you appropriate support. We offer technical, safety and diving medicine symposiums, on-site training courses, education scholarships, site safety assessments and are available to answer your medical, technical, operational and safety questions. We are funded through our DAN members and supporters, which enables us to support you in the best ways we can.

In 2019 we will hold a technical and safety symposium, offered in Spanish in Cancun. This regular newsletter will contain interesting medical cases we have managed, new chambers that have been introduced into the network, technical and operational feature articles, relevant questions and answers taken from actual requests sent to us, and provide you with some resources, such as where you can find specific hyperbaric training courses.

Finally, this is intended to be your newsletter, providing useful information and providing a platform to share your experiences or the issues you face. We would love to hear back from you if you have anything of interest you’d like to share in forthcoming editions.

Enjoy reading and let us know if you’d like anything else to be showcased.

- Francois Burman and the DAN RCN Team.
WELCOME TO THE DAN RCN BULLETIN

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Incident Insight:

Underdiagnosed and Underinformed

Who:
A European couple went diving to a tropical island. They are both dive instructors but were diving on their own as a personal vacation.

The Dives:
They had been on the island for 10 days, the last five of which they did two to three dives per day. The last day of diving involved one dive to 136 feet for 52 minutes, followed by a 50-minute surface interval and a second dive to 100 feet for 50 minutes. The couple claimed that all dives were uneventful, on air, and within recreational no-deco limits.

The Injury:
The evening of the fifth day the 32 y.o. male diver complained of numbness in lower extremities. He had been out of the water for about 4 hours, and what started as a vague cutaneous sensation turned into clear numbness. Knowing this could be a case of DCS they went to the local hospital, which was walking distance from their AirBNB. Later on, the diver acknowledged that walking the last two blocks had become increasingly more challenging, as he could barely feel the ground.

At the local hospital the diver explained his symptoms and his concerns about the bends to the local doctor. The doctor asked him a few questions and after a basic physical examination, he concluded that it could be the bends and recommended recompression therapy. They contacted the local chamber, and the chamber tech informed them that they would be ready to treat the diver. The chamber was about 2.5 hours away, and the doctor inquired whether they had transportation. The couple said that they could drive, so after getting directions, they took off to the chamber. At the local hyperbaric chamber, the chamber tech received the diver and his fiancée at the parking lot. The patient needed assistance to get out of the vehicle and walk into the building where the chamber was located. The chamber was an older dual lock deck decompression chamber. DAN staff had visited the chamber and were aware of its limitations.

The chamber tech called DAN to inform us about the case as the patient was a DAN member. When the tech presented the case, the DAN medic soon realized that the description appeared consistent with a case of neurological DCS with spinal involvement and inquired about urinary function. The tech went to check; after a few minutes he returned stating that the patient had not urinated over the past 8 hours and seemed to be unable to. Upon further discussion with the tech, DAN staff determined that there were no Foley catheters available, nor was there a doctor available. DAN recommended that the patient needed a Foley catheter as a matter of urgency and that a doctor should be present during the treatment. Although the tech tried to have the local hospital send a doctor to the chamber, they ended up having to send the patient back to the hospital, place a urinary catheter, and then send the patient back with a doctor.

Analysis:
There are several things to dissect here. First, the divers understood that the symptoms were of sufficient concern to require medical evaluation. Perhaps being dive instructors meant they had a better understanding of the nuances of how DCI could present. They did well in seeking professional medical evaluation right away. However, it would have been better if they had called DAN much earlier in the situation, since this could have activated the chamber facility more quickly and prevented critical loss of time. Based on what we know now, the evaluation performed at the local hospital was suboptimal. Lower extremity paresthesia is usually suggestive of a spinal cord incident, particularly when the dive history is moderate to aggressive. We do not know if there was any degree of lower extremity weakness at the time, which would have been highly suggestive of spinal cord DCI. These cases usually develop urinary retention, so a Foley catheter and medical supervision during treatment were not a luxury but a medical necessity. It is not uncommon for small hospitals on small tropical islands to have no doctors trained in diving medicine, despite receiving injured divers on a regular basis. What is much more concerning is the chamber not being properly equipped. Although a team of technicians could be perfectly competent in successfully completing a recompression protocol, direct medical supervision is mandatory during a medical treatment. DAN has since assisted this facility to get up to speed with training and counseling. They now have a well-trained and well-equipped team of technicians, with two doctors covering to make sure that all cases will have direct medical supervision during treatments. This is now a facility that we do not hesitate sending patients to. As for the patient, luckily this strong young man had a good recovery despite the delay in the initial treatment. He required a series of treatments and ancillary medical support that he continued in his home country.
Chamber Profile:
ResortDoc, Silhouette, Seychelles

Chamber facilities in remote locations face unique challenges, but with DAN’s chamber course, attendants and operators can receive the best possible training in order to operate safely and efficiently. ResortDoc is a company that offers medical services to hotels and dive resorts in remote locations such as the Seychelles, Maldives and East Africa. Dr. Andreas Fichtner and Dr. Hendrik Liedtke have a team of German doctors which offers medical emergency services at their remote clinics. All the doctors are trained in dive medicine and are competent to treat divers in the chambers at the different facilities. The aim of ResortDoc is to improve medical services in remote locations and expose European doctors to the conditions in these locations. All the doctors have a trauma background and are mentally equipped to deal with any medical situation.

This article will focus on the Seychelles where ResortDoc has a medical and chamber facility on Silhouette Island (the third largest island in the Seychelles). Nestled between pristine shoreline and dense tropical forest, Labriz is a luxury Seychelles resort that offers guests a romantic and relaxing getaway. The island, only a 45-minute boat ride from the island Mahé (the largest island in the Seychelles), is rich in natural beauty and teeming with exotic wildlife. The medical facility on Silhouette is there to help the local island community as well as the guests at the hotel. The doctors at the facility are able to do general check-ups, dental work and even some minor surgical procedures in the small theatre available at the facility. What makes this place unique is the fact that it has a chamber available to treat divers with decompression sickness.

Not many dive resorts are lucky enough to have their own chamber available; however, this chamber is also accessible to divers from other resorts and can easily be reached by boat from all the islands in the Seychelles. The doctors at the facility are on call 24 hours a day and work closely with the DAN hotline. The chamber itself is a dual-lock recompression chamber and is capable of treating up to two injured divers comfortably. The chamber design makes it simple and easy to operate while minimizing potential errors. Safety and reliability is an important feature of any chamber design and this chamber is no exception. It is important to note that the chamber is air filled and has a high-pressure bank system available to pressurize the vessel. The chamber facility does not have any advanced medical support available but is able to provide the full range of oxygen treatment tables therapy to injured divers.

The chamber has two compartments: the main or treatment lock and the entry or transfer lock. Both locks are coated inside and outside with corrosion-resistant paint.

The working pressure is 5.5 bars (165 FSW) and the hull has a number of spare penetrators which allow additional systems to be installed in the future. The chamber also has a large medical or service lock, for the transfer of smaller items such as medications, medical equipment, fluids and waste into and out of the chamber when needed. There are two view ports which allow the operator to observe both compartments while the chamber is under pressure and maintain visual contact with the patient and the attendant at all times. Here’s a look inside the chamber:

- The main chamber is accessible through the entry lock and both locks have large diameter double-hinged doors.
- Both compartments have flat floorboards, also known as deck plates.
- The pressurization (inlet) and exhaust (outlet) air lines are protected by double hull or shell valves.
- The pressurization system is provided with adequate silencers to reduce noise to an acceptable level inside the chamber.
- The air exhaust or dump system has been constructed in such a way that it can’t be accidentally blocked by hands, clothes, etc.
- A hand-held, hyperbaric fire extinguisher is installed in the main lock in the highly unlikely event of a fire inside the chamber.
- Both locks have a built-in oxygen breathing system (known as the BIBS), with demand supply valves and over-board-dump masks. This means the exhaled oxygen is discharged outside the chamber to prevent a high oxygen level inside the chamber.
- A communication system is provided in both compartments. In case all else fails, a small hammer is available for communication by way of knocking signals.

As one might imagine, it is important to know how to operate a chamber to avoid further injury to a patient being treated. In the interest of providing quality training wherever needed, DAN has developed a chamber attendant and operator course, referred to as the ChAtt&ChOps course, specifically aimed at recompression chamber facilities in remote locations. The chamber facility receives custom-made manuals tailored to the specifications of that actual chamber. The training is done by one of the DAN chamber trainers under the supervision of the dive doctor at the facility. After the courses have been completed, each student receives a certificate specific to the training facility. The most important part of the training is the practical session — the students are required to demonstrate a high level of competence in these hands-on skills to pass the course.

DAN has trained six chamber attendants and operators at this ResortDoc medical facility to assist the doctor when recompression treatments are being done. The DAN chamber course is essential to ensuring the safety of the staff as well as the patient, and in addition offers knowledge on how to provide basic ongoing maintenance at a remote chamber facility. The main goal of the chamber training is to ensure that the remote chamber facility is safe and able to treat divers when needed.

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Chamber Profile:

Hyperbaric Medical Centre – Sharm El Sheikh

On March 10, 1993, the Hyperbaric Medical Centre in Sharm El Sheikh opened its doors. The chamber’s Medical Director, Dr. Adel Taher, was already one of the local diving pioneers. Since then, he has become one of the most (if not the most) experienced Diving Medical Specialists in the world, respected and well-known in both the international diving and diving medical communities.

Dr. Adel, and later his assistant, Dr. Ahmed Sakr, became a reference point for the Egyptian diving community. They were able to create a close relationship with the local government, emergency search and rescue services (the SAR) and dive centers in Sinai and promote diving safety in many ways.

Since 2004, the DAN Europe recompression chamber assistance and partnership (RCAPP*) team has visited this chamber several times and has provided technical assistance, the Chamber Assistant and Chamber Operator training program and essential parts for the chamber. It is a perfect example of what RCAPP can do and how we collaborate with chambers in remote locations.

The story of Dr. Adel and his chamber is unique and goes hand-in-hand with the growth of the diving industry in Sinai. A video (link below) highlights the 25th anniversary of the Hyperbaric Medical Centre, explaining both the story of the chamber and the development of the diving industry in Sinai.

In November 2018, to celebrate their anniversary, a free 3-day conference was organized for the local professional diving community. This was yet another occasion for Dr. Adel and his team to promote diving safety and nurture their relationship with the local dive operators. Diving medical, research and safety specialists from all over the world gave lectures, while Dr. Adel and his team made sure there was enough time for lecturers to discover the beauty of the Egyptian Sinai (both in and out of the water). DAN was privileged to be a part of this event. We provided several lecturers and hope many similar occasions will present themselves in the future.

Congratulations to the Hyperbaric Medical Centre in Sharm El Sheikh for their 25th anniversary and thanks for taking care of over 1700 divers in the last 25 years.

VIDEO: https://www.youtube.com/watch?v=kX7tr2F0FTw

* The DAN RCAP and RCAPP are the same program. The only difference was the name adopted in Europe to differentiate between the regions.
The Diver Recompression Chamber:

DAN Essential Service Providers

RCAP chambers are integral to everything that DAN does. Located in destinations around the world, these facilities are run by dedicated people with the unique qualities required to treat sick divers safely, responsibly and compassionately.

What makes an RCAP chamber, and what does DAN look for when deciding where to refer a diver with DCS or AGE, you might ask? We request that potential RCAP chambers fill out a form that will give a general idea of their level of preparedness and attention to safety and help us to determine where there is a need for assistance or information (please see attached). Following are aspects of chamber operations that are considered when referring an injured diver to a chamber.

Monoplace and multiplace chambers are both used for recompression of divers with DCI. It is a common misconception that divers can only be treated in a multiplace chamber. Monoplace chambers are used in many places in the world and can be adequate with adaptations to compensate for lack of accessibility to the patient. In many locations, a monoplace chamber is the only option.

Acute, unstable DCI patients may have to be transported to a hospital based chamber that can provide critical care inside the chamber, such as the need for a ventilator. Other cases need only basic medical care in the chamber, such as IV fluids and vital sign monitoring. Milder cases, such as some DCS type 1 patients, may need only a chamber capable of basic recompression. Chambers which are available 24/7 are greatly preferred — we have a special fondness for our 24/7 chambers. In emergency cases there is not usually time to call around to see whether chambers are open and available, so chambers that we know are always available will be our first call. This includes having a dive medicine doctor and trained chamber tenders/operators always available. This is no small undertaking and requires a significant time and financial commitment from the chamber’s owners and management. In many places 24/7 chambers are becoming ever scarcer, requiring more complex emergency planning and longer evacuation times.

Having capable and knowledgeable chamber operators and tenders is essential for safe operations. Training may consist of initial training for new staff or refresher training for current staff, or both. Training ranges from external certified training such as for a DMT (Dive Medical Technician), formal training such as an on- or off-site courses, and/or on-the-job training. Regardless of the type of training, the train-ee should have practical experience with the chamber they will be operating, and be rendered competent by the medical doctor, before being allowed to operate it with a patient inside. Having a record of the training is essential. It is usually more of a challenge for chambers with fewer patients to maintain their staff readiness.

Every chamber should have a nameplate that is somewhat like a birth certificate, saying when, where and by whom it was made, and according to which standards. It should also state the maximum working pressure. The viewports should carry similar identification, usually written along the edge of the viewport or in a separate document.

This documentation ensures their ability to withstand the pressure of a typical treatment table for DCS. For treating divers, a chamber should be able to be pressurized to at least 2.8 ATA (60 fsw), which is the depth for the most common initial treatment tables for divers — the USN TT6 & TT5. Some chambers may do deeper treatments, and/or use other treatment tables, but initial treat-ments for divers are usually 2.8 ATA.

Gas supplies (air and oxygen) for a diving chamber in more remote areas or on an island can be a challenge. Air for chamber pressurization must be supplied by compressors which need good maintenance to produce safe, breathing-quality air free from oil, carbon monoxide and excessive moisture and carbon dioxide. To be considered safe, a chamber should have a backup air-supply system to ensure that a treatment will not have to be aborted due to loss of power or compressor malfunction. This may consist of a secondary compressor or a bank of compressed air tanks. International breathing air standards such as CGA Grade E or EN 10201 should be tested for on a regular basis and the records available upon request. Oxygen should be certified by the manufacturer to USP standards of purity and be supplied in cylinders which are compliant with safety standards. There should be enough on hand to last until the next shipment, which in some cases, for example the Galápagos Islands, may be weeks away.

The danger of fire is of utmost concern in hyperbaric chamber operations due to the elevated levels of oxygen inside the chamber and restricted egress. An RCAP chamber should have a fire deluge and/or handheld water extinguishers, or both, which are maintained and tested at least every six months. Treatment locks in multiplace chambers should have oxygen analyzers to prevent the oxygen level from rising above 23.5 percent. Dedicated chamber clothing instead of a patient’s own clothing helps to prevent prohibited objects entering the chamber and sparks produced by synthetic fabrics. An emergency action plan with live, practiced drills for staff at least annually is essential. DAN can provide assistance with emergency action planning to RCAP chambers.

Recompression chambers located in popular diving regions are essential for injured divers, and safety is totally reliant on the commitment and practices of dedicated and well-trained staff. DAN supports these service providers as best we can under the RCAP initiative. It is through this dedicated partnership that we can both ensure that injured divers get the treatments they need when they most need it.
How long should a patient wait to fly after being treated for decompression sickness?

**A**: According to the U.S. Navy diving manual a waiting period of no less than 72 hours is given as a general guideline for patients who are completely recovered. Longer waiting periods are routinely prescribed in the Asia-Pacific region. A waiting period gives the diver time to recuperate before being exposed to the lower ambient pressure and partial pressure of oxygen found in commercial aircraft, which are usually pressurized to an altitude of between 2,000 and 8,000 feet, approximately 0.76 ATA. This does not mean that cabin pressure is always maintained at higher pressures. One study found that 10 percent of the commercial flights tested had cabin pressures exceeding 8,000 feet (Hampson et al. 2013).

Differences in flight conditions may need consideration, for example an 2-hour-long direct flight versus a long-haul flight with multiple stopovers. If the patient is not fully recuperated, and has residual symptoms, an extended waiting period may be prescribed by the treating doctor. In some cases, it may be up to a week or more to allow for further resolution of symptoms. If the patient is still in treatment and needs to be transferred by an aircraft pressurized to 1 atmosphere may be required, and the patient may still require 100 percent oxygen during the flight.

For further guidance on flying after recompression treatment, DAN medical staff are available on the DAN information line at +1 919 684 2948.

Since we rely on the local diving community to help us operate the chamber and our medical staff changes frequently over time, we have some problems in providing uniform training. Can RCAP help with this?

**A**: Having staff trained in a different way is a common problem when the doctor who provides training changes frequently. Training refers to operating the chamber and reacting in emergencies. When training is provided by several people using different materials and methods, there is always room for confusion, which can become a real problem in an emergency.

DAN can provide a Chamber Assistant & Chamber Operator course.

Is the in-line high pressure oxygen filter insert serviceable in the ultrasonic bath or do we replace it?

**A**: There are several aspects to this question:

- HP filter inserts or elements, strategically placed before high pressure regulators, may be found in separate in-line filters, or in some cases, a filter element is built into the inlet port to the regulator, or located inside the regulator itself.
- Most often these inserts are made of sintered metal: brass, bronze or stainless steel.
- Filter inserts should be inspected annually for the presence of any dirt such as metal particulates, oxidation products and dust.
- If clean, then they can simply be replaced.
- If dirty, or every few years (no more than 4 years), they should be removed so that they can be cleaned.
- Filter inserts can be cleaned either by placing in an ultrasonic agitating bath, using an oxygen cleaning agent, and/or by carefully blowing in the opposite direction using high pressure medical air (oxygen clean) or even oxygen.

We believe our obligation goes further than a standardized course. Personalized slides and manuals are made for the and these materials will remain at the chamber for any future training (or retraining) organized by the chamber. This way we are not only able to provide training, but make sure that when new staff arrives, they get trained in the same way, with manuals and slides that show exactly what they will see in their facility.

The DAN Chamber Assistant & Chamber Operator course has already been organized at several chambers all over the world and we will continue to do so as part of RCAP.

We were treating a diver that had Type I DCS. In conversation with this diver they wanted to understand what may have caused the injury. Other divers were certain that this individual was diving too soon after flying. Is this a potential risk?

**A**: There are concerns with diving after flying but they do not involve concerns with nitrogen or the reduced cabin pressure. The concerns are directly related to the diver’s physical condition on arrival at the dive destination. Long flights (8 hours or longer) do affect us physically through less than optimal hydration, nourishment and rest. Fatigue and lack of hydration have been suspected of contributing to the risk of DCS. They can at least confound the evaluation process and eventual diagnosis. Allowing enough time to properly rest, rehydrate and eat is essential. This could mean waiting at least 24 hours. The more time zones crossed the greater the adjustment. Our circadian rhythm is disrupted and that can affect our cognitive processes. The diver needs to make an objective and honest assessment of their physical condition before choosing to dive. You can also contact DAN for assistance and information.

Can RCAP help with this?
Frequently Asked Questions
The following are some of the frequently asked questions that DAN receives.

- Take care when opening and then removing these inserts: this will be a high-pressure line meaning that venting the line is required before starting to disassemble the filter housing or removing piping.
- When any parts in an oxygen system are disassembled, work must be done cleanly otherwise oxygen clean of the complete filter housing will be needed before reassembly.

What should we do when an injured diver presents for treatment at our facility, who has an implantable cardiac device (ICD) in place? Can we treat them?

A: The primary answer to this question does not lie with the device, but rather with the health of the diver.

The important question to ask is whether the diver was cleared to dive, by their cardiac specialist after the device was installed. If declared fit-to-dive with an ICD in place, then there is no reason not to treat this diver inside the chamber.

The secondary answers lie in the safety of the device and hence of the chamber.

There are no reports of any ICD having failed inside of any recompression that we are aware of. Most ICD manufactures have issued letter of confirmation that their devices are in fact safe to be used in a pressurized environment; this included devices powered by lithium-type batteries.

The concern that the device will be subjected to elevated oxygen levels is addressed in that being implanted, it is not exposed to the chamber operating environment.

Lastly, in most cases, an ICD is sterilized before leaving the factory using an autoclave. Saturated, hot steam at up to 3 ATA (20 MSW, 60 FSW, 29 psi) and typically 135°C (275°F) for between 4 – 60 minutes is used to destroy any microbes. This environment is much harsher than what is expected inside a recompression chamber.

Chamber Profile:
ResortDoc, Silhouette, Seychelles

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DAN will always strive to improve the safety of scuba diving and has taken this to the next step by improving the knowledge and safety at chamber facilities worldwide. Chamber doctors have access to diving medical assistance and advice via the DAN hotline at all times. With the development of the RCAP, the DAN team of doctors and medics have more confidence referring DAN members to remote chamber facilities. Proof once again that DAN is your buddy!