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PANEL DISCUSSION ON THE TREATMENT OF DECOMPRESSION ILLNESS

Moderator Dr Chris Acott

Panellists
Drs Michael Bennett, Alf Brubakk, Richard Moon and Robyn Walker.
(with audience participation)

Key Words
Decompression illness, treatment.

Moderator (Chris Acott)
What symptoms would the panel treat?

Alf Brubakk

With minor symptoms which do not progress, I do not think there has been anybody who has shown that not treating with recompression leads to serious damage. As we have shown ourselves, non-treatment does, however, lead to mild CNS symptoms. I think there is a considerable under-reporting, minor symptoms are in many cases not treated today. However, if someone has neurological symptoms, these should be treated. I believe that if we insist that everybody should be treated with the standard procedure, a large number of patients will not come forward. I admit that this is perhaps a dangerous statement.

Richard Moon

I think that anyone with symptoms that could be attributable to decompression illness should receive recompression treatment. That would include classical, well defined instances of pain not attributable to other causes, and neurological symptoms. Occasionally it may be worthwhile to treat someone complaining of extreme fatigue.

Mike Bennett

I am pretty much in agreement with Richard Moon there. As many people in this audience are aware, and as we have heard several times over the past few days, the experience of what exactly is decompression illness and who presents can be vastly different in different settings. In most of our recreational diving settings, the patients are, in the vast majority, not extremely seriously bent, in a sense of having dramatic symptoms and signs. Most of them have some subtle signs, but mainly they are complaining of fairly non-specific symptomatology. When we see such people who have not been treated, and we often, perhaps a dozen times a year, see people several weeks after their last dive who have been feeling this way for that time, their lifestyle is seriously affected. They are not happy people. The question of whether, after several weeks, it is worth recompressing them, is not really my point. Actually most of the time we end up recompressing them as an act of desperation as much as anything else. But those people who have apparently fairly trivial signs in our opinion need to be compressed, otherwise they end up with ongoing minor illness, which actually takes up most of their attention, and they do not work well. They continually ring us up to complain about their performance at work and so on. While some sort of one atmosphere oxygen immediately after the dive might have been adequate treatment for their symptoms, we seldom see that situation. When people get to a facility with a recompression chamber and complain that they have had symptoms since diving, then I think they should all be taken seriously.

Robyn Walker

I agree with the others.

Richard Moon

I would like to comment on what Mike Bennett just said. It has been said that only a small proportion of patients who have been treated for decompression illness have long term sequelae, and that most of these are minor. In my experience, the anxiety that is induced by even minor symptoms is extremely important. Divers with ambiguous or minor symptoms may not need to be treated, and if they are treated, the degree of improvement after recompression may be similarly ambiguous. But the fact of their having received the ultimate in treatment, such as a Table 6, means that the patient can be reassured that the bubbles that may have been causing their symptoms, have now gone. This goes a long way toward relieving anxiety.

Chris Acott

It has always appeared slightly illogical to me that we have the same treatment table for a disease which presents in so many different ways, but also from so many different gas loads and diving profiles. However I think Table 6 has been the only table with any data to support using it.

Moderator (Chris Acott)

Does the panel think that in the future we will be able to go towards a strategy of treating a particular illness or gas load with a particular table, or do you think we will just stick with Table 6?

Alf Brubakk

It is a difficult question to answer, because I believe, like you do, that different treatments should probably be used for different patients, or different gas loads, or different symptomatologies. But it is a very difficult job to work out exactly how these differences should be modelled, and the exact procedures to be followed. It would require a lengthy research project to try and find out how to do this. It may be that the results may be marginal; that one would not find firm experimental evidence that actually one procedure is better than another. I think that is particularly likely when the time between the symptoms starting and the start of the treatment is long. In fact I think that the time to treatment may be more important than the procedure used. The damage goes back to a common pathway. The search will be very interesting, but I am not sure that it will result in a very different treatment protocol.

Richard Moon

I think in the very early treatment of decompression illness, it might be possible that the treatment table will be affected by the dive profile preceding it. Consider, for example, a diver on a oil rig who has spent some considerable time at a depth of say 100 m, and then due to a procedural problem, blows up to the surface. For that diver Table 6 may not prevent continuing evolution of inert gas, and for adequate treatment probably a deeper table would be required. But I would submit that after a few hours, at which point the inert gas partial pressures in the tissues and bubble may have reached some quasi-equilibrium, then the major effect of recompression is the pharmacological effect of hyperbaric oxygen, rather than compression of bubbles.

Mike Bennett

I absolutely agree with Richard Moon's and Alf Brubakk's remarks. We think we are giving the same treatment in giving the same table. But of course in many ways the dosage of oxygen we are giving is dependant on the body build of the person. Big people dose themselves up with larger quantities of oxygen by dint of their higher lung volumes. So it is not true that everybody is getting exactly the same. However, if we think of it in terms of partial pressures they are. I think the most important point is that we are dealing with late changes, and bubbles are bubbles and they produce the kind of changes that Richard Moon waxed so eloquently about the other day.

Robyn Walker

One of the interesting clinical cases that I have seen, and I still do not understand, is why someone who presents after embolising in a swimming pool at a depth of 2 m, and is in the chamber within 35 minutes, does not have any recovery of a paralysed limb. Yet, the people who present with lots of these vague but constitutional symptoms, even two weeks afterwards, get a fabulous improvement. I still do not think we have the answers about what we are treating, or the question of what it is that we are treating, to be able to work out what is the most appropriate table.

Moderator (Chris Acott)

To digress a little bit, earlier Alf Brubakk was speaking of teaching diving and physiology. On our boat this week there has been some discussion other than what we saw on the dive. We discussed whether it would be better to teach divers how to read a particular table or whether we should teach them diving physiology, and in particular decompression physiology, so that they could then go and look at a table and have a good understanding of how to read the table or of what their computer can do, and dive accordingly. Would you like to comment on that Terry?

Terry Cummins

One of the things that we have noticed on the boat that we were on, and I assume it was much the same on the other boats, was the general lack of comparing a dive table with the computer. This stimulated some discussion on our boat. From a training agency perspective, we really would like to see the divers checking the computer against the table more regularly than we do. We sampled our boat, and there were only two people who had a table with them on the trip. I think that this is an appropriate observation. We are very solidly into promoting the use of the dive planner with PADI. We also think people are relying too heavily on computers without understanding the physiology and decompression theory.

Robyn Walker

Terry, can I just say that there are a lot of people who do have experience with tables, and to plan a multi-level dive using standard tables can be very difficult. I think a lot of people have, in the back of their mind, that square wave profile, and they know and have an understanding of where they are in relation to a particular a square dive profile. I hope they do.

Unidentified speaker

I think I have seen published guidelines for diving with a dive computer. One sees people diving with a computer, who seem to disregard normal diving practice. They are following what the computer says, but going deeper at the end of a dive, or doing essentially what we used to call two or three dives. Without quite breaking the surface, they will start deep and work their way up and then go deep again. It is probably something for which guidelines should be more widely published, for what you do if you are going to do computer assisted diving. There are some typical, normal things, such as starting deeper and progressively going shallower, which one does if one learns tables, but perhaps forget once the computer is strapped on.

Moderator (Chris Acott)

Yes, a lot of divers that I have seen have done it. I have spent some time in Outpatients discussing their dives. It is quite important to ask why they did a shallow dive first, followed by a lot deeper dive and then a shallow dive later. The usual response is "My computer lets me do it". There is no understanding of what they are actually theoretically doing. Mike, would you like to comment?

Mike Bennett

The first comment that I would like to make is that it is a quirk of statistical fate that both these sets of tables were on the same boat. I did not see any tables on mine.

I approach our divers in the same way as Chris. One gets some extraordinary responses. The impression I get is that whatever people are taught about diving physiology and tables in courses is going to be forgotten soon after a computer is bought. "The computer told me I could do it so I should not be here" is the usual response.

Alf Brubakk

We are working in our laboratory on different models that we can give students and people who dive so that they can actually see some of the consequences of all the different types of tables and behaviour on bubble formation. I think a thing like that, if developed, would be very useful, as then one can demonstrate graphically some of the consequences of a particular type of behaviour. A lot of the teaching of divers is too theoretical. One needs to be able to visualise the lessons in a better way. We need some better teaching tools.

Unidentified speaker

One of my dive buddies and I were writing a dive plan. He has dive planning software for trimix diving. The program included bubble evolution and a graphical display. We were both quite surprised when we put in some poor diving practice, like doing a shallow and then a deep dive, to see how it affected the bubbles on the graphical display. It may not mean anything, but shallow dive followed by a deep one shows a lot more bubble formation than a deep dive followed by a shallow one. As Alf Brubakk suggested, seeing the graphics on the screen, even though we understood the physics, made us believe it a bit better.

Richard Moon

The suggestion to place ultrasound machines on dive boats is a good one. It would be an excellent way of bringing home to divers the message that bubbles do form even after routine, uneventful dives. Perhaps that might in some way influence their behaviour.

Alf Brubakk

It would probably scare them !

Drew Richardson

Just a few comments. In terms of published recommendations, there are several sources for recommendation in terms of diving with a computer which have been out for a number of years. DAN have them; PADI and other training groups have them. Every computer manufacturer puts them in the instruction manual. But reading and acting on them is a different matter.

Using a community or peer approach would be a way to address this topic in the future. If the diving community itself, and on the boat, in discreet ways could take each other aside and say "Look, I wouldn't have done what you did. Did you realise?" Maybe that is a way to keep diving safety in their minds. This is the top of the drawer here in this room. Some have expressed concern about what was observed this week. In public education it is difficult to get people to make the right choices. The question is whether it is because of ignorance or intention. One never hears anybody talking about what they did during the dive. We all speak about what we saw. The divers' desire to see or chase an animal seems to overpower the intelligence needed to decrease risks. I just throw that out in terms of perhaps more community interaction over the course of a diver's career.

Moderator (Chris Acott)

If we perhaps put in more preventative measures, we would not have to talk about treatment. Perhaps SPUMS will do that at another time.

About training divers in first aid and recognition of the problems associated with diving. At the Royal Adelaide Hospital we are one of the few courses in the world recognised by the Health and Safety Executive of the UK (HSE) for the training of Diver Medical Technicians (DMTs) for the commercial diving industry.

To answer some of Dr Brubakk's questions from my clinical experience. Can we train them to clinically recognise that they have a problem? I think we can, very much so. Can we train them to evaluate an outcome? I am not sure of that. Handling complications? I would say no. The use of drugs and intravenous fluids? Yes. As you know, DMTs are our eyes and ears on the diving platform. Perhaps we really should be looking at training the majority of diving instructors up to the DMT levels. Maybe that is a pie in the sky. Alf, would you like to comment on that?

Alf Brubakk

It is quite obvious that your suggestion would be an improvement. I do not know if that would be possible or practical. It would need a change of attitude and acceptance that medically unqualified people will have to do work that is normally regarded as requiring medical qualifications. Because there are not enough doctors to do it. It is our responsibility to train them to a level where they can do this safely and feel confident enough to do the right thing. Confidence is important, because in many cases people dare not do the right thing because they simply have not been trained to feel that it is right.

Richard Moon

I think the primary responsibility should be in prevention. Our data suggest that a large percentage of individuals with decompression illness have had some problem with their diving procedures, such as ascent rate.

It would be fantastic if we could train our diving instructors to DMT level.

Robyn Walker

Unfortunately it is difficult to obtain continuing education for them. It is not good practice to have people do a course and then not have regular follow up or regular exposure or updating of that experience.

Moderator (Chris Acott)

In the commercial industry, the DMTs are required to have a refresher course every 3 years. In our courses we teach the first timers and use the same time to refresher the others. They spend a week upgrading their practical skills in our Hospital. Unfortunately, we have been unable to persuade any other hospitals in Australia to follow our example.

John Knight

Robyn has said most of what I wanted to say. We are dealing with a relatively infrequent occurrence and very few people in a short while, say a year, will see more than perhaps, if they are very unlucky, 3 or 4 cases. The reason that the MICA ambulance people are so good at their job, is they see those cases every day, and they can keep their skills up. We should be offering to teach these people the skills. We will just have to hope that their memory is about as good as the junior doctor's memory, and when something that they have never seen before but have been told about comes up, there is about a 60-70% chance that they will do the right thing.

Moderator (Chris Acott)

In closing, Alf and Richard have covered quite a lot of the things which will appear in the SPUMS Journal at a later date. Table 1 shows some conclusions we have agreed upon about the acceptibility of various treatments.

Alf Brubakk

USN Table 6 is the only one that has had reasonable clinical testing so it is the basis of all treatment procedures.

Moderator (Chris Acott)

If one has a patient on Table 6, who has not got better, or deteriorates during decompression, is going deeper the answer? Or should say he got better at 18 m, so let us keep him there and saturate him? Or should one continue decompressing and hope that extra treatments in the following days will do the job?

Alf Brubakk

I do not think there is enough data to support one over the other. In this case there is no standard treatment.

TABLE 1

TOPICS DISCUSSED BY THE PANEL AND AUDIENCE

Accepted treatments	Possibly efficacy	Not accepted
Recompression using USN TT6 is the only definitive treatment with enough data to support routine use.	IV administration of lignocaine in "cardiac" doses in severe neurological DCI (where appropriate equipment/monitoring exists).	Breathing air at 1 ATA.
		In-water air recompression
There is consensus for the administration of fluids to restore hydration.	Recompression procedures other than USN TT6, e.g. deeper schedule, heliox.	
	Saturation recompression schedules (but require special facilities)	
There is consensus for keeping the patient flat in the supine or lateral position prior to recompression in early onset neurological cases.		High-dose steroid administration
	Non-steroidal anti-inflammatory drugs including aspirin	
Data supports the use of surface oxygen (as close to 100% as possible) .	On-site recompression in a chamber (Accepted by some)	In-water oxygen recompression (Accepted by some)

When one has to tackle those who do not respond or who get worse, then it depends on the experience of the people at the treatment centre. Sometimes they will try going deeper, sometimes saturation.

Richard Moon

I agree. All of these possibilities are legitimate options. Under various circumstances, one might choose any one of them. For example, if you are on a remote island with only a small deck recompression chamber, surfacing may be the only viable option. On the other hand if you have all of the facilities available in Adelaide, you might want to institute saturation. It is difficult to insert too many details into guidelines, without taking into consideration the wide variety of circumstances under which they may be used. However, it is reasonable to elucidate the various options.

Moderator (Chris Acott)

It all comes back to clinical "I've been there, done that" as to what works.

Mike Bennett

I would suggest that in our statement, our policy, we do mention all those options, exactly the framework that Richard suggests. We all agree fluids are extremely important, and there is adequate data to support that, whether it be intravenous or oral.

I know Richard is in favour of steroids, but whenever steroids are used it reminds me of what one of my teachers in medical school used to say: "If you do not know how to treat it, use steroids".

Richard Moon

I would not like to leave the wrong impression. My feeling on steroids is that I would personally use them, knowing full well that they will, in some patients, induce hyperglycaemia. There are many divers with glucose intolerance, and there is strong evidence that in the setting of CNS injury, hyperglycaemia is bad. If the diver is under medical care within 8 hours, and it is possible to monitor glucose on a frequent basis, then the use of corticosteroids is an option for the diver with serious spinal cord bends. However, other than anecdotal cases, at present there are no data supporting the use of steroids for spinal bends.

Robyn Walker

The only thing in the teaching I received was that no one should be allowed to die before being given steroids. I do not use them routinely.

Mike Bennett

Non-steroidal anti-inflammatories are strictly question mark territory. It was a common practice for some patients when I arrived in Sydney. The patients who did not respond to recompression very well, who had residual symptoms after the first one or 2 recompressions, were often given non-steroidals and told they would feel better. And they often did, but whether that was a placebo effect, we are not sure. So we are doing a controlled trial which will be finished in about a year. We are wondering whether we can break the cycle of minor irritating symptoms which people focus so much on and become so anxious about. Perhaps we can stop the symptoms, perhaps not even modifying the basic disease process very much, but just convincing them that they are going to feel better.

Alf Brubakk

There is some quite interesting experimental evidence which indicates that it might help. That has been done a long time ago. But a question mark, yes.

Moderator (Chris Acott)

Unfortunately I was not here for the first session today, when on-site recompression was discussed. Can the panel enlighten me?

Mike Bennett

As a neutral, I do not think we came to any consensus. The question of on-site recompression became a little bit bound up in whether we are talking about in-water or a chamber. I think we were a little bit more disposed to consider on-site chamber treatment than in-water treatment, as a group, which is why it is in the middle column instead of on the end.

Robyn Walker

I think it depends on the level of equipment. There is a whole range of chambers that one could have on-site. It depends on the level of expertise. It depends on the clinical condition of the patient. In some circumstances, it may be a useful option.

Richard Moon

The question regarding on-site treatment versus later hospital based treatment really depends, exactly as Robyn says, on what kind of on-site treatment one is talking about. Some people are reluctant to recommend in-water recompression, but there should be no reluctance on anybody's part to recommend recompression if one has an on-site diving doctor, plenty of oxygen and at least a 4 foot (1.2 m) diameter deck recompression chamber of sufficient size to accommodate the diver and a skilled tender. Now, between the water and a traditional chamber we have a relatively new option, the one man chamber. Before recommending the use of that device, adequate procedures for dealing with both treatment and complications have to be written. How does one deal with a convulsion? How does one deal with somebody who is hypotensive? All of these issues need to be thought out very carefully before recommending the use of such a chamber.

Alf Brubakk

I fully support that, and I agree that there is a lot of work to be done. It needs proper documentation and procedures in order to make sure one knows what one is doing. Of course, one of the advantages of these simple solutions is that the consequences if something goes wrong are much less dangerous than they are if someone is convulsing in the water. It is an option that can be useful as an alternative to the in-water treatment, which, as I understand it, is done quite a bit. I know, at least in the technical diving community, a lot of in-water treatment is done today. I feel that if it is possible to do something on land, it is a better option.

Unidentified speaker

One of the great advantages of on-site treatment is, for example what has happened here, that one does not have to worry about getting a pressurised aeroplane or making sure that the aeroplane flies below 1,000 feet. One can just shove the patient in a bag and keep them at one atmosphere, and take the plane to whatever height, and they are breathing oxygen. I like that idea.

Moderator (Chris Acott)

We dealt with saturation earlier in the week and deeper tables, when we were talking about US Table 6. What about using heliox?

Alf Brubakk

My personal opinion is that different gases belong in the question mark area. There are some people who swear by heliox treatment for decompression sickness caused by air bubbles. It is not very well documented that it works. There is no doubt that it works at times, as there are single cases where there have been dramatic improvements in very seriously ill patients. It has to be an option and it is in the US Navy Diving Manual as an option.

Moderator (Chris Acott)

In the 'Not Accepted' column we have; air, 1 at one bar; in-water air recompression; high dose steroids; and in-water oxygen (which is accepted by some).

Pauline Whyte

My first question is, if RN 62 is the only treatment table with enough data to truly support its use, is there any role for a shorter treatment table as a trial of pressure in equivocal cases where the diagnosis of DCI is uncertain? The second question is, with divers who require 2nd and 3rd treatments, is there any role for 80/60/30s, or should they again receive RN 62s?

Richard Moon

I do not think that a "test of pressure" is a very useful concept. Consider the rate of resolution of symptoms of decompression illness treated after a significant delay. Sometimes relief is immediate, but more typically the response may not occur until after two or more oxygen cycles. Therefore one cannot use the response to a short oxygen exposure, or test of pressure, as a diagnostic test for bends. I believe that after clinical evaluation, if decompression illness is believed to be a possibility, then a complete treatment should be administered, irrespective of the response within the first few minutes.

Pauline Whyte

I thought I read in Alert Diver a recommendation for a shorter treatment table in equivocal cases, maybe six months ago.

Richard Moon

There have been articles in the Alert Diver referring to use of USN Table 5.[1-2] In the USN, if the medical officer feels most strongly that the diagnosis is musculoskeletal trauma, rather than bends, but is not entirely sure, and no improvement in symptoms occurs after two oxygen cycles at 18 m, decompression may then be initiated using USN Table 5.

Whether shorter or shallower treatment tables are ever appropriate is a worthy question. Alf has proposed that shorter or shallower tables may be sufficient for some types of bends, but before accepting their routine use, I think more information is needed.

Regarding follow up treatments, the question is entirely open. Operational concerns of the hyperbaric facility usually override any specific recommendation regarding the appropriate table, particularly in view of the relative absence of data. The only information that I know of regarding the choice of follow up treatment table comes from the Alfred Hospital in Melbourne, and was presented at the 1989 UHMS meeting. Their conclusion, using retrospective data, was that after an 18 m follow up table the relapse rate was lower than after a 14 m table.

Unidentified speaker

As David Elliott has said, "a trial of pressure is Table 62".

Moderator (Chris Acott)

That is right. There is certainly a tendency in my unit, and I suspect at other places, for this concept to creep in. We try and squash it every time we hear somebody use the term. We do not do tests of pressure. However, having said that, there are times when there is an election made to treat with a Table RN 61, or US Table 5, for someone with mild pain only symptoms. Again, that is not my personal practice, but some of the other physicians do, and I do not have any data with which to beat them over the head. That is still written in the US Navy Manual.

Richard Moon

There are data supporting the efficacy of US Navy Table 5. Green and colleagues published a paper[3] showing that when used according to US Navy Guidelines, that is to say for pain only, skin or lymphatic bends in which the symptoms resolve within 10 minutes at 18 m, the outcomes after USN Tables 5 and 6 are statistically indistinguishable.

Mike Bennett

I am not convinced that there is such a thing as non-neurological DCI.

Moderator (Chris Acott)

Bob Green, your article was looking at various Tables. You pointed out that USN Table 5 was used inappropriately in quite a number of cases.[4]

Bob Green

Reviewing the RN data, I fully agree that USN 5, if used appropriately, has good results. But in a large number of cases it was used inappropriately. When it is used to treat neurological DCS it has very poor results. My personal feeling is that one should use USN Table 6, and forget about Table 5 because if it is available, it will be used inappropriately from time to time.

Alf Brubakk

That is probably correct. On the other hand, with on-site recompression in remote locations, there might be limited amounts of treatment gas and limited possibilities of running a full Table 6. Should we take into account Kindwall's, and some of the other data which exists, and try to design some protocols to give options for treatment when a full Table 6, which is perhaps the best that we can have, is not possible? Should the patient stay at 18 m as long as possible and then come up, after all the ascent was designed for the tender's safety, or would it be better to go to 9 m or even shallower, and stay longer, because that would save gas and be better than surface oxygen?

Mike Bennett

I would not accept treatment in an on-site recompression chamber if it had not got enough oxygen to complete a Table 6. I would be calling for the nearest plane, as obviously they do not know their job.

Richard Moon

I agree. I think the effort should be convincing people to buy enough oxygen rather than designing tables to get around the system. Just one comment about altering the USN Tables. Remember that the stop at 30 feet/9 m, was designed not for the diver, but for the tender. If the chamber is quickly decompressed to the surface after a prolonged stay at 18 m one may create another case.

Robyn Walker

The only time the RAN would consider using Table 5 is in mass casualties. If one is faced with 40 survivors, who have escaped from a submarine, all with decompression illness, giving a short Table 5 to treat as many people as fast as possible may be better than completing a formal Table 6 and making people wait a considerable time for a place in the chamber.

Michael Loxton

Please confirm that these recommendations are for sport diving only. We are not making any comments relating to commercial or military diving?

Moderator (Chris Acott)

We are only discussing the treatment of recreational divers.

I would like to, on behalf of the Society, thank Alf Brubaak and Richard Moon for some interesting discussions, and Robyn Walker and Michael Bennett for participating in the panel discussions in this session. Thank you very much.

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Speakers who were not mentioned after earlier papers in this section are mentioned below.

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