

dive shops are really quite keen on that. So people in Australia are advised to see a diving doctor. Even with the PADI questionnaire.

Mike Davis, Christchurch

What sort of permissive discretionary approach do you take Vanessa? In particular, which form and what approach to permission and clearance for recreational diving do you take? Do you take the discretionary one that is our Society's policy or do you take PADI's.

Vanessa Haller (Victoria)

I use the medical form in the Australian Standard, AS4005.1 Training and Certification of Recreational Divers Part1. But it is very similar to the one in AS2299 Occupational Diving. There is not a lot of difference between them. The AS4005.1 form has probably got more in it.

John Knight, Melbourne.

For those who do not live in Australia, it is composed of a number of States which do not have exactly the same laws, it is a Federation. Australian Standards exist for States to put into their legislation if they want to. The only State that has put AS4005.1 into its legislation is Queensland and the law in Queensland requires somebody who wants to learn to scuba dive for recreational reasons to go to a doctor with special training. Training as laid down by the Censors of the South Pacific Underwater Medicine Society. In the rest of Australia, there is no compulsion but most of the training organisations are keen on getting their trainees medically examined, as this will shift the liability for taking somebody who does something unhealthy, like having a fit underwater, off their shoulders and onto the doctor.

Chris Coxon (Cairns)

It appears that PADI and the other training organisations are developing a proliferation of shorter courses than entry level certification courses. I understand these have lowered the previous age limits and some of them can be used later to shorten the basic certification course. Could Drew Richardson explain what these courses are and how the RSTC medical screening process fits in? I raise the matter, because I could not see any age reference in the whole document.

Drew Richardson

For *Discover Scubas*, and other non-certificate courses, the battery of questions is adapted for the screening element. If someone answers in the affirmative, they are referred to the full document. But there is no lower age at the moment (May 2000). However we are under revision right now.

Henrik Staunstrup, Denmark.

I agree that at least 10 years ago this medical statement was great for a lot of areas in the world. But in

those 10 years an awful lot of diving doctors have been educated. I think that this RSTC statement should reflect that we have a different world now. That there are many areas filled with approved diving doctors who can do good dive medicals. I think you should really emphasise that the RSTC statement can be used, but in areas where there are plenty of diving doctors it is advised that one should have a medical examination. What is the policy of RSTC, to have this all over the world or to try and develop dive medicals and diving medicine?

Drew Richardson

I disagree with the suggestion that we now have a proliferation of physicians with expertise in diving medicine that we did not have ten years ago. I believe that the number is probably flat or declining. Look at the UHMS. Its focus now is much less on diving medicine. It is going into other hyperbarics. So I think there are actually fewer and fewer diving doctors. The number of divers has increased significantly. So, although the number of doctors probably is keeping up with society's needs, the number of diving doctors is falling behind its user group. I believe there is even more of a demand for diving doctors than there used to be. However we do, generally in Australia and New Zealand, make the recommendation to see a diving doctor.

FIT FOR WHAT? WHAT DIVING CAN BE DONE BY SOMEONE WHO IS NOT PERFECT?

David Elliott

Key Words

Diving medicals, fitness to dive, medical conditions and problems, recreational diving, standards.

Introduction

If we are to endorse good medical standards, set pass/fail criteria or provide doctors with well-considered guidance, are these to be identical for *all* divers? For example, does the vacationer in a tropical resort who wants to try his or her first "diving experience", need the same medical screening as an experienced North Sea oxy-helium saturation diver? For some things, yes (neither should have a pneumothorax), in other things, no (screening a novice for dysbaric osteonecrosis is certainly not necessary) but in other ways, the novice should have a greater level of screening (consider the potential for a panic attack in a first-ever dive). So, not all fitness assessments are the same. Now, primarily for lack of time, we should put aside all the different varieties of working divers and, in doing so,

acknowledge that in many countries the instructors of recreational divers are recognised as working divers and required to have annual health checks. This may be simply in accordance with regulations, but is also advised because their underwater responsibilities extend to the safety of the novices whom they train. This needs to be more widely known because a number of competent US/Caribbean recreational instructors have found themselves medically disqualified when seeking employment in the UK.

The recreational envelope

In this context we are concerned with fitness for open water *unrestricted* diving within the recreational envelope (whatever that may be). This does not include those who are disabled and dive only with prescribed restrictions.

Many recreational divers in North America would interpret the recreational envelope as being repetitive no-stop diving to a maximum of around 130 fsw (40 m) but many Europeans would routinely include decompression dives. So is there any international definition for this? Certainly the various definitions as applied by different training agencies and by DAN (para 3.2) are incompatible.¹ Perhaps SPUMS could consider, at least for accident analysis purposes, something along the lines of:

Recreational diving, PADI-style, is repetitive no-stop diving to a maximum of around 130 fsw (40 m) although it would be reasonable to extend the depth to 140 fsw (43 m), the maximum depth of their tables or perhaps a little deeper still for diver-rescue by an instructor. This category of recreational diving can include scuba nitrox as a sub-variety because when dived as taught it is safe.

Extreme air diving should be defined as scuba diving somewhere below 50 m, because it is not reasonable for the few crazy extremists (certified or not) to contaminate the good record of the majority of divers. For compatibility with PADI and similar agencies, the threshold depth could be any diving beyond the agreed recreational depth limits. Alas, there is no medical screening test for stupidity and overconfidence.

Advanced recreational diving, using air or nitrox scuba, covers wreck, cave and virtual overhead diving. The term "*virtual overhead diving*" is one used by DAN that neatly covers those who cannot return to the surface without complying with decompression stops.¹ Dived as taught, overhead diving is also relatively safe.

Technical diving, as Bill Hamilton put forward at the SPUMS meeting in 1996, is diving with a change of breathing gas during the dive. This covers recreational divers who carry several tanks so that they can switch gas mixtures during deep dives and it also covers those who use rebreathers. These rebreathers are usually either closed

circuit with a constant PO₂ system (i.e., implying a percentage change of inspired gas during changes of depth) or one of the premix nitrox semi-closed rebreathers (implying a change of O₂% during changes of work rate). These dives may be intended to be safe but do carry increased risk.

Restricted diving is for those who are not fit to dive like others within the recreational diving envelope of depth and exposure time but who, for medical reasons as will be discussed tomorrow, have prescribed limits that are likely to be procedural rather than restrictions of depth or time. There is also the issue of unknown fitness among those who take a resort course or just a diving experience "try dive". Fatalities do occur. These dives are under supervision in clear water and so, fit or not, they are not making unrestricted dives.

So dives in these unrestricted categories that are not "for reward" together define the boundaries of the recreational envelope and within that envelope the medical standards should be the same.

Should the physical fitness standards be the same also? A strong adverse current can affect anyone, a life-threatening crisis underwater can occur at any time and who would not try to rescue an unconscious buddy in a rough sea? All divers should be physically fit but only professional divers are assessed. Physical fitness needs to be emphasised in training courses but without setting any standards.

Unrestricted diving

Disability and diving restrictions, is it right to link these two phrases? A disability can be mental, medical or physical. Procedures for those with a motor impairment are provided in the PADI training manual but not, it seems, for those with another physical impairment, significant hearing loss, even though those who use sign language underwater may have some advantage over the "fit" diver.

The loss of a few fingers is a physical impairment that may make life difficult but for diving may cause no significant loss of functional capability, no physical disability.

In contrast, paraplegia following spinal trauma is an impairment that is also a disability that must restrict diving. Nevertheless, one working diver, a marine scientist who became paraplegic from a car accident about 20 years ago, has continued to dive regularly while accepting some appropriate operational conditions. Though restricted by the routine need for a dedicated buddy to protect his lower limbs from scrapes and to help with safe egress from the water, he points out cheerfully that he has less risk of spinal decompression sickness than others have.

For other reasons, diving restrictions may apply to those with a medical disability, but there are some with an impairment who can make unrestricted dives. This is partly a matter of semantics. Divers with medical disabilities that require their diving to be modified or restricted will be discussed tomorrow but there are others who may have a different type of medical disability that also questions their fitness to dive. Included in this group are persons who would fail the self-declaration form but whom, on assessment by a doctor, are considered to be fit for *unrestricted* diving. One example that will be detailed later is a stable asthmatic even though his or her fitness should be time-limited and depend on the absence of deterioration. These persons when fit require no special in-water support and need no limitations upon their activity.

Assessment after head injury

Slightly different is the example of the person with a history of head injury. In this case restricted diving would be inappropriate and the choice should be all-or-none, simply either fit or unfit for unrestricted diving. But when is that transformation?

Assessment of recovery from head injury is not an easy process but is a good illustration of an assessment that could result in unrestricted diving. Obviously that assessment must include other factors such as neurological impairment and post-concussion syndrome. The latter includes headache, dizziness, poor memory, poor concentration and irritability, which are all symptoms similar to those expressed by some divers after decompression illness. One of the reasons persons should not dive after a significant head injury is the risk of subsequent epilepsy, an absolute disqualification from diving.

As reviewed by Dick the severity of a head injury is measured historically by the length of coma, the clinical state on arrival and the duration of post traumatic amnesia (PTA).² The depth of coma can be measured using the Glasgow coma scale but the best indicator of the severity is PTA. This is the time from the head injury until the time

the patient begins to lay down a *continuous memory*. Islands of memory *do not* represent the end of amnesia. PTA does not shrink with the passage of time. This is in contrast to retrograde amnesia, the amnesia of incidents leading up to the injury. PTA is always longer than the interval from the injury until when speech starts. PTA may correlate well with the degree of damage shown on magnetic resonance imaging.

Post traumatic epilepsy can follow head injury. In 5% it occurs in the first week and there is an increased risk of this with depressed skull fracture, intracranial haematoma, prolonged PTA and focal neurological signs. Late epilepsy can occur in 5% and there is an increased risk if there is an intracranial haematoma (31%), early epilepsy (25%) or a depressed skull fracture (15%). With none of these, the risk is 1%. Sixty per cent of the first post-traumatic fits occur within 1 year, 24% in 1-4 years and 16% after 4 years. The occurrence of fits is dependant on the severity of the head injury as shown in Table 1.

Rather than pursue this debate along a well-trodden track of scientific citations, let us take a brief look at summaries of how guidance is presented by some different diving Authorities.

HEALTH & SAFETY EXECUTIVE (FOR WORKING DIVERS)

There are inherent dangers in diving if there has been significant brain damage or if there is a risk of post traumatic epilepsy. After head injury where there has been any of:

- a depressed skull fracture;
- intracranial haematoma;
- unconsciousness or post traumatic amnesia greater than 30 minutes; or
- focal neurological signs

there is a significant risk of post-traumatic epilepsy and the person should be rejected.

More minor episodes of head injury (less than 30 minutes unconsciousness or PTA) are a reason for

TABLE 1

HEAD INJURY CLASSIFICATION AND OCCURRENCE OF FITS IN APPROXIMATELY 3,000 PATIENTS

Head injury	Fits within 1 year	Fits within 5 years
Severe		
Confusion, haematoma, > 24 hours coma, amnesia	7.1%	11.5%
Moderate		
Skull fracture with 30 min to 24 hours unconsciousness	0.7%	1.6%
Mild		
< 30 min unconsciousness or amnesia	0.1%	0.6%

temporary unfit for a period of 4 weeks subject to review by a medical examiner. However, minor head injuries can cause cognitive dysfunction.

UK SPORT DIVING MEDICAL COMMITTEE (UKSDMC)

Because head injury may be followed by epilepsy, the fitness of divers who have sustained this type of injury needs to be carefully considered. The following guidelines are suggested.³

The length of post traumatic amnesia (PTA) including any period of unconsciousness may be used as an index to the severity of injury. Where PTA has been less than one hour, there should be a three week layoff from diving. With PTA of an hour to 24 hours, there should be a two month layoff. Where the period of PTA exceeds 24 hours, there inevitably has been severe brain damage and there is considerable likelihood of subsequent epilepsy and impaired mental functioning. A minimum period off diving of three months is suggested and cerebral function should have returned to normal.

Where enquiries are being made about an incident in the past, the individual sometimes has difficulty in recalling the period of PTA and in such cases the period of unconsciousness may be doubled as a rough guide.

If epilepsy should have developed as a result of injury then further diving is banned unless it was an isolated fit occurring at the time of injury. Likewise, if anticonvulsant medication is being taken as a prophylactic measure, diving should be banned, but may be resumed three months after this is withdrawn if the individual never had a fit.

THE SPUMS DIVING MEDICAL

Candidates with a history of head injury involving significant unconsciousness or concussion associated with repeated headaches, or intra-cranial surgery, should be individually assessed by a neurologist.

THE RSTC GUIDELINES

Neurologic abnormalities that affect a diver's ability to perform exercise should be assessed individually based on the degree of compromise involved.

Relative Contraindications:

- History of head injury with sequelae other than seizure
- History of spinal cord or brain injury without residual neurologic deficit.

Absolute Contraindications:

- History of seizures other than childhood febrile.

Assessment of asthma

Asthma is another example of a disability in a diver that, like recovery from a head injury, means only either disqualification or unrestricted diving. Restrictions are not appropriate though a fitness certificate may be time-limited. There is no logic in a fit asthmatic diver being restricted to shallow diving (which is just where Boyle's Law is most active), nor can one ask an asthmatic to avoid life-threatening situations. However, unlike head injury that can only improve, there is a need for the asthmatic to monitor for any deterioration over time. In the meanwhile, if they can dive, they should dive without any medically-imposed restriction.

The difficulty lies in deciding just whether or not a particular individual can dive. What follows is not a comprehensive review but a distillation from two relevant meetings.^{4,5} In simplistic terms, the main problem of a candidate who has some history of asthma is determined by pulmonary function, can he or she exercise adequately when in the water? The diver will have normal lung function when he is not suffering from the acute effects of his condition, but can one ensure that they will not get into any difficulty when in the water, especially when breathing cold gas that, with some regulators, might also be a sea-water aerosol.

Those who have significant broncho-constriction on exercise should not dive. Beware of sports divers who have quite marked impairment on exercise and yet who claim never to have problems in the water because they probably never achieve the level of ventilation necessary to trigger exercise-induced asthma. However it might arise in a life-threatening situation.

The exercise test is therefore an essential step. Divers can be considered fit provided that they demonstrate less than a 20% reduction of peak flow or FEV₁ after about 6 minutes of hard exercise. Indeed it has been suggested that the use of steroids to maintain stability in a working diver with good peak flow is not per se a contraindication to diving.

Other challenge tests are said to be less useful. In a few persons the response to inhalation of nebulised normal saline is sufficient to convince them that hang gliding might be a more attractive pursuit. Bronchial hyperactivity in response to a histamine challenge does not add any useful information.

The controversy about asthmatics diving tends to focus on the risks of pulmonary barotrauma and gas embolism. Asthma may be associated with a mucus plug in

an airway or, occasionally, the spontaneous collapse of a lobe but contrary to theoretical predictions, there appears to be no firm evidence that asthma predisposes to barotrauma.

Again, rather than continue with a review of published medical wisdom, it may be more profitable to summarise the guidance offered by some diving Authorities. There is little disagreement.

THE UK HEALTH & SAFETY EXECUTIVE (FOR WORKING DIVERS)

Asthma is normally a contraindication to diving. A requirement for regular bronchodilator therapy is a contraindication to diving. However, individuals with mild asthma:

whose lung function remains normal for most of the time and there is no reduction of exercise capacity or evidence of exercise or cold-induced bronchospasm;
and they have been asymptomatic for a considerable period of time;

may be considered fit to dive even if they require regular prophylactic medication to control symptoms.

Individuals with asthma require specialist referral. That is likely to include bronchial testing using cold, exercise or hypertonic saline. Persons assessed with a possible diagnosis of asthma are likely to be found either fully fit or unfit. It is unlikely that a certificate of fitness with a restriction on diving activity (for example depth) would be appropriate.

UK SPORT DIVING MEDICAL COMMITTEE (UKSDMC)

There is little if any evidence that the mild controlled asthmatic who follows the guidelines below is at more risk. Asthmatics may dive if they have allergic asthma but not if they have cold, exercise or emotion induced asthma. Only well-controlled asthmatics may dive. Asthmatics should not dive if he or she has needed a therapeutic bronchodilator in the last 48 hours or has had any other chest symptoms.

The asthmatic should not need more than occasional bronchodilators, i.e. daily usage would be a disqualifying factor, but inhaled steroids/cromoglycate/nedocromil are permissible. During the diving season he or she should take twice daily peak flows. A deviation of 10% from best values should exclude diving until within 10% of best values for at least 48 hours before diving. A β_2 agonist may be taken before diving as a preventative but not to relieve bronchospasm at the time.

The medical examiner should perform an exercise test such as the 18 in (43 cm) step test for three minutes, or running outside (not a bicycle ergometer) to increase the heart rate to 80% (210 minus age). A decrease in PEFV (peak expiratory flow rate) of 15% at three minutes post-exercise should be taken as evidence of exercise-induced bronchoconstriction and hence disbars. The patient should be off all bronchodilators for 24 hours before the test.

THE SPUMS DIVING MEDICAL

Any abnormal findings should be fully investigated. Such investigations should include provocation testing if any doubt concerning the possibility of bronchial hyperreactivity exists. Particular attention must be paid to any condition that might cause retention and trapping of expanding gas in any part of the lungs during decompression (e.g. asthma).

The following conditions may disqualify: (iv) Any evidence of obstructive airways disease e.g. current asthma, chronic bronchitis, allergic bronchospasm.

In cases of doubt, specialist medical opinion should be sought. Such opinion should include provocation testing if any doubt concerning the possibility of bronchial hyperreactivity exists.

THE RSTC GUIDELINES

Any process or lesion that impedes airflow from the lung places the diver at risk for pulmonary overinflation with alveolar rupture and the possibility of cerebral air embolisation. Asthma (reactive airway disease), COPD (chronic obstructive pulmonary disease) cystic or cavitating lung diseases all may lead to air trapping. Spirometry, provocative tests such as methacholine challenge and other studies to detect air trapping should be carried out to establish to the examining physician's satisfaction that the diver is not at risk.

Relative Contraindications:

History of prior asthma or reactive airway disease (RAD)*.

History of exercise/cold induced bronchospasm (EIB)*.

Restrictive Disease**.

Absolute Contraindications:

Active RAD (asthma), EIB, COPD or history of them and abnormal PFTs (Pulmonary function tests) or positive challenge.

Restrictive diseases with exercise impairment.

Note

* Air Trapping must be excluded.

** Exercise Testing necessary

THE CALIFORNIA THORACIC SOCIETY

Until better data are available, the following guidelines should be considered. Prospective dive applicants should be screened for the presence of asthma by history and physical examination.

A remote past history of asthma alone should not preclude an individual from diving.

Candidates with a more recent history of asthma or those with intermittent asthma should be required to have normal spirometry at rest and in response to exercise before being certified to dive.

Candidates with mild persistent asthma on medications should be required to have normal spirometry at rest and in response to exercise.

The patient has to assume responsibility to refrain from diving when asthma symptoms are present.

Conclusions

On the whole these various approaches are reasonably similar to those of the UK Sport Diving Medical Committee (and I have no association with them) which provides the most practical guidance. But could it be universally accepted?

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AUDIENCE PARTICIPATION

Cathy Meehan (Cairns)

Do you have a protocol for the exercise challenge test? In Cairns, it has been my practice to do an exercise challenge test and then follow that with a hypertonic saline challenge. Do you think there is any point in doing that? Do you think exercise will pick up everyone or do you think that the two is a good way to test for everything?

David Elliott

I know nothing about the hypertonic saline challenge test. However there is nothing to stop you doing it as an extra. After you have sufficient numbers who have done both tests you would be able to tell me the answer. Exercise is not meant to be absolutely gut-busting. As far as I am concerned climbing stairs or a quick walk around the block is suitable. I would like Jürg Wendling, who has the responsibility of pulling this together for all the European countries, to give his comments.

Jürg Wendling (Switzerland)

I think it is an unresolved question because there are so many ideas that there is no consensus yet. The European Diving Technology Committee, which is a 17 nation committee, has tried to define, for the European Standards, a submaximal exercise test. We want to avoid a direct measurement of VO_2max and use an indirect calculation of the VO_2max . Any test running around the block will not be acceptable. However any other test which has a reference to VO_2max can be used. The result should be written down in the VO_2max space and indicate the reference of that particular test. The Standard will be published on the Web when we have finished at the end of the year, so it will be readily accessible to everybody.

David Elliott

Jürg, how many minutes after exercise do you test lung function? And did you say that the Step test was not acceptable?

Jürg Wendling (Switzerland)

Most of the doctors I know use a step test as doing some steps and then when the candidate is tired, they take the measurements. I do not think that acceptable. However a standardised step test, such as the British Army Step test is acceptable.¹

David Elliott

The problem with exercise, is that there are three reasons for doing exercise in a medical assessment. One is obviously cardiological, one is for testing people with asthma and the third one is for physical fitness. And we naively thought when we got together in Edinburgh in 1994, we might be able to bring all these exercise tests together.² But no, I think each particular question has to have its own exercise, but yes, there is a standardised step test under the physical assessment of fitness. But in the UK we tend to

use VO_2 for commercial divers, as being the appropriate assessment.

Jürg Wendling (Switzerland)

The agency prescription of assessment, with a peak flow measurement immediately after six minutes exercise, repeated every five minutes, is a standard largely accepted by pneumonologists. In Switzerland they say that they would prefer to have full spirometry, not just the peak flow. Full spirometry gives more appropriate size measurements but the peak flow is easier to take.

David Elliott

Can I add one sobering thought to all this. Who pays? The trouble is, most working divers are actually self employed so they do not want to have all the wonderful tests which we would like them to have. If the working diver is in salaried employment, that is alright as the employer will pay. This really does need to be part of our thoughts.

Bill Brogan (Perth)

David, in your definition of recreational diving you mentioned that diving below 40 m is not permitted, and those that did so were idiots. Then you went on to mention wreck diving. Now what do you mean by wreck diving? Is there a depth limit on wreck diving?

David Elliott

I do know that a lot of people do it successfully, but one has to draw a borderline somewhere when you are collecting statistics. As far as wreck diving is concerned, or overhead diving, there are training programs and that is well defined. The first part of your question was whether or not 40 m is an appropriate depth. As far as the working diver is concerned, 50 m is the maximum depth, at least in Europe, with I think still the exception of France where they go to 55 or 60 m on compressed air. In the Royal Navy, we used to do 180 foot (54 m) dives routinely and 240 foot (72 m) dives occasionally on air. A trained person, who has worked up to it, can do it, but we are talking about the recreational field. Recreational divers have died on deep air dives, even those with adequate air. Usually they have not dived to those depths before. Those are the people I am worried about. Some people want to go into wrecks, others want to look at fish and some want to do these things below 50 m. Unfortunately some are merely going for the badge "I've dived deeper than you". They are the people one has got to beware of.

Bill Brogan (Perth)

I disagree with that, because I have done about 400 odd dives to depths between 40 and 60 m in the last 11 years at places like Truk Lagoon and Bikini and in New Guinea, and so have many thousands of other people who have derived great pleasure from their deep dives. I have not had a problem nor have I seen other people have

problems and it is quite a large group, if you take that number of dives. I have had problems with cold water, rough conditions on the surface and stupidity, mine and other people's, but not pure depth.

David Elliott

230 feet is approximately 70 m and I have certainly seen people go unconscious when swimming at that depth. I have actually watched them with my own eyes. Not everybody is as experienced as you are. There are idiots who merely want to beat everybody else in the depth and more of them will be lost.

Bill Brogan (Perth)

I know, but I am talking at a specific group which is a very big industry in the Pacific and it has always concerned me a bit that SPUMS seems to ban them.

David Elliott

Well there are other ways of doing those kinds of dives. If you use Heliox or Trimix then you would not have the narcosis problem and should not have the CO_2 build up problems and things like that. So I think, Bill, that you should move on from being a compressed air diver.

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PRACTICAL SOLUTIONS FOR DIVERS WITH RESTRICTED FITNESS TO DIVE

Jürg Wendling

Key Words

Children, disabled diver, fitness to dive, medical conditions and problems, standards.

Introduction

The medical assessment of fitness to dive is a preventive action with the idea of improving the safety of diving. For different diving practices the criteria may vary to some degree, but there are common risks which have to