

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

be respected by everyone. Table 1 shows the fitness criteria for recreational divers. The particular point is that sports (recreational) divers go diving because they want to and they accept responsibility for their actions. The safety concept however is based on the buddy principle, thus a fit diver has to be able to observe and to help his buddy.

TABLE 1
CRITERIA FOR FITNESS TO DIVE
FOR RECREATIONAL DIVERS

Ability to swim
Ability to communicate
Ability to manage self-responsibility
Exclusion of diseases that can provoke unconsciousness or disorientation
Exclusion of diseases that could provoke panic
Exclusion of diseases that could provoke barotrauma
Exclusion of diseases that may be worsened by diving

Persons with some disabilities do not usually fulfil these conditions. Are exceptions possible? Many physically disabled people have learned to dive and have improved their quality of life by enjoying the floating feeling of neutral buoyancy and the ease of movement under water. The question is not whether it is possible for the handicapped to dive, but what is the role of the medical examiner of divers for those people. As handicapped divers are not fit for unrestricted diving, the certificate must state that they may dive only when participating in a handicapped diving program.

The separate programs for different kinds of disabilities are shown in Table 2. From this analytical point of view children and diabetics also have to follow these guidelines, as their "disabilities" are insufficient management of self-responsibility in children and incomplete control of blood sugar level in diabetics (metabolic handicap).

Programs available

Several handicapped divers' organisations support training and diving activities of the handicapped. They usually offer a training program for instructors and helpers, a system of training adapted to the needs of divers and special certificates, as well as information and meeting points for interested persons.

In Europe the main organisations are the Handicapped Divers Association (HDA), the Handicapped Scuba Association (HSA; www.hsascuba.com), International Association for Handicapped Divers (IAHD www.iahd.org), but there are others which are locally based.

TABLE 2
SPECIFIC APPROACH TO
PARTICULAR HANDICAPS

IMPARED ABILITY TO

Swim

Physically handicapped program.

Communicate

Program for the deaf.

Program for the mentally handicapped?

Manage self-responsibility

Children's diving program.

Control blood sugar

Diabetics program.

All organisations distinguish three certification levels:

Level I Disabled persons who are difficult to train, but may reach, as end point, an independent autonomous diving capacity and being able to help their buddy.

Level II Disabled divers who are able to dive without help, but not in all water conditions. They are usually unable to help their buddy.

Level III Handicapped persons which need continuous assistance from helpers.

The situation in Switzerland, and probably in the neighbouring countries as well, is marked by highly motivated diving instructors training some disabled people to a particular level certificate, but then leaving the divers on their own. A level I diver will join the non-handicapped divers once he has got the normal certificate. Other disabled people, especially level III divers, will need competent helpers for every dive. However these are difficult to find. It is unfortunate that handicapped divers do not easily find help from other diving organisations. Because they assess their candidates themselves, medical examiners of divers have very little contact with the handicapped diving organisations. It remains to be established how far the liability of the diving doctor goes in these cases. Divers with a disability are dissatisfied with the current system and feel discriminated against by not having a normal certificate, which would enable them to hire equipment and participate in diving trips.

Practical solutions

DIABETIC DIVERS

The Swiss Society for Underwater and Hyperbaric Medicine (SUHMS) has defined an algorithm for defining

the conditions under which a diabetic person may dive.¹ Unstable diabetics on insulin and those with organic complications are unfit, while the rare maturity onset diabetes of the young allows unrestricted recreational diving activity. Diabetics, whether requiring insulin or not, with stable and uncomplicated diabetes may dive, but under special restrictions. The certificate contains a remark: "No decompression, less than 30 m, medically supervised log-book, next re-assessment in 3 months, supervised dives only".

TABLE 3**GUIDELINES FOR DIABETIC DIVERS**(adapted from Lerch)²**Reduce risk**

Regular diving practice
Skills and knowledge of specific procedures
(handicapped diving program for diabetics)

Prevent complications

Good hydration before diving
(minimum of 2 l of liquid in the 2 hours before a dive)
Raised blood sugar
(> 9 mmol/l [160 mg/dl])
Dive to less than 30 m
(Nitrogen narcosis mimics the hypoglycaemic state)
Dive within the no-decompression limits
(emergency ascent is always possible)

Enhance safety during the dive

Glucose paste and glucagon easily available under water
Equipment for normobaric, 100% oxygen at surface
Buddy must be an experienced diver, informed and trained in the emergency treatment of a diabetic diver

Monitoring/supervision

Blood sugar testing should be done at 60 and 30 minutes and, importantly, just before the dive. Testing should be done immediately after the dive and 12 hours later
Special logbook (monitor every dive!)
Annual fit to dive examination should include specific assessment of logbook contents

The prospective diver contacts a handicapped divers office, where he or she receives a brochure and a log-book and is directed to one of the trained medical examiners of divers of the SUHMS. The doctor introduces the diver to the medical aspects of the diabetics safety plan. The guidelines are set out in table 3. A more detailed version is available at www.suhms.org. The diver then undergoes a normal diving course, where the instructor has to be informed and introduced into the technical aspects of the diabetics safety plan.

The diver logs all relevant data according to the guidelines, being supervised by the instructor and by the doctor as required. After having achieved the diving certificate a consultation with the diving doctor is needed to check the logbook and assess the trainee's understanding of the guidelines. The reassessment interval is set to 12 months and diving with an informed buddy permitted.

DIVING FOR CHILDREN

An extensive risk assessment concerning children was performed by Ducassé and Izard in 1987 for the French Divers Federation (Fédération Française d'Études et de Sports Sous-Marins or FFESSM).³ A summary is given in table 4. The late maturation of the lungs and CNS are contraindications to using scuba gear in children under 8 years. Typical childish behaviour and insufficient ability to manage self-responsibility are the reasons for not attesting unrestricted fitness to dive. Between age 8-14 the following restrictions are written on the certificate: "only for introductory dives with an experienced buddy (children's training program)".

TABLE 4**SPECIFIC RISKS FOR CHILDREN**(From Ducassé and Izard 1987)³

Alveolar growth ends at about 8 years of age.
Lung compliance continues to develop until 18 years.
(Risk of barotrauma)
Risk of panting and inadequate ventilation leading to hypoxia at less than 8 years.
Frequent occurrence of otitis media.
Muscular function of Eustachian tube not fully developed in children.
(Risk of middle ear barotrauma)
High surface/weight ratio.
(Risk of hypothermia)
Limited ability to learn mathematics and physics before age of 8.
Emotional lability.
(Risk of sudden change of behaviour)
Searching behaviour.
(Risk of trying things out at inappropriate times)
Insufficient ability to face self-responsibility.
(Risk of not following instruction correctly)

The specialised training program of the FFESSM⁴ consists of a series of introductory dives with emphasis on communication and knowledge of fauna and flora. At the end of a diving week the child is evaluated by the instructor on the basis of his observations and may get a sticker in bronze, silver or gold according to the level of experience (table 5), and eventually a special qualification ("buddy

TABLE 5

FFESSM TRAINING LEVELS FOR CHILDREN'S DIVING

Bronze

Can dress and undress.
Can clear ears, use regulator, swim in the blue.
Knows how to approach surface, some animals, some underwater signs.

Silver

Can clear ears, take off and replace mask.
Orientation, can get back to starting point.
Knows how to surface in different conditions, more animals and algae, all underwater signs.

Gold

Can care for equipment and contribute to group security.
Has improved diving techniques.
Knows creatures and their behaviour, and some ecology.
Knows theory of buoyancy, why to clear ears, why to expire during ascent.

diver", "small boats", "big boats", "BC jacket"). There are no tests and no lectures.

The guidelines for safe practice are summarised in table 6. The key for good supervision is a personal diving passport and a medical "livret". The passport contains the medical certificate (initial and reassessments at 6-12 months), training certificate, certificate of special qualifications, the log of all dives with the instructor's comments. The "livret médical" includes the guidelines for fitness to dive assessment and the informed consent declarations for each training progression (signature of child, parent, instructor and doctor) valid for 6 months only. This is extended to 12 months from age 12).

A detailed study of the "sharpened" diving medical assessment of children shows that besides the usual examining standards the FFESSM added 4 points:

- 1 Determination of growth percentiles
- 2 A rather uncommon stress test (Ruffier)
- 3 An ENT special examination with audiogram and tympanogram and teaching of ear equilibration procedures
- 4 Estimation of psychological development (see Table 7).

ECG, X-rays and lung function tests are performed only for special indications.

The lower age limit for World Underwater Federation (Confédération Mondiale des Activités

TABLE 6

FFESSM (=CMAS) STANDARDS FOR CHILDREN'S DIVING

Reduce risk

"Sharpened" fitness to dive assessment
Informed consent (child, parents, physician, diving instructor)

Prevent problems by modifying equipment to fit

Snorkel
Cylinders
Buoyancy jackets, buttons, valves
Exposure suit
Regulator provides assisted breathing

Enhance safety during dive

No lectures and licence oriented training (stress)
Buddy with special training (M* to m5, M** to 10m)
Limited depth (immediate ascent possible)
Time limits
Temperature limits
< 12°C No diving
12°C Not more than 10 minutes
> 12°C Not more than 25 minutes
< 25°C must wear full wet suit

Monitoring/supervision

Special log book
Special medical record book

Note

M* CMAS One Star instructor,
M** CMAS Two star Instructor.

TABLE 7

PSYCHOLOGICAL ASSESSMENT OF CHILDREN (from "Livret médical")

Consideration should be given to

School history
General "impression" of the examining doctor
General "impression" of diving instructor (after the course is over)
General statement of Club doctor
Statement of parents

Subaquatiques or CMAS) basic diver training is 14 years, the age at which children may use motorised vehicles in traffic in many countries. Exceptionally children, who have obtained all the above mentioned diving experience and competencies, may do the basic course at the age of 12 if the child, parents, diving instructor and doctor approve.

PHYSICALLY HANDICAPPED

Unfortunately practical solutions are scarce for the physically handicapped. In the Swiss Paraplegics Centre diving is a part of the rehabilitation sports, but for other wheel chair-dependent divers there are no particular structures available. In the long term these divers must not be sequestered from the normal diving community, but integrated.

A good example is the diving section of the Sports University of Paderborn in Germany.⁵ Sports students train together with a few disabled people and take them for excursions to as far as the Spanish coast.

The physician's role is reduced to the fitness to dive assessment which should be adapted to the training possibilities of the disabled (see table 8). The training agencies have a diving doctor as a backup for unexpected new problems.

MENTALLY HANDICAPPED

There have been efforts in France⁶ and Germany⁷ to offer diving to this kind of disabled. However, we believe that there are absolute medical contraindications to this kind of diving (emotional instability, inability to understand theory, impaired communication). The behaviour of the mentally handicapped is much less foreseeable than in children.

DEAFNESS

Deaf people are physically and mentally fit, but extremely difficult to train. Once trained they have even better communication than non-handicapped divers if their buddy is also deaf. Their medical assessment needs special experience in the communication methods of the deaf.⁸

Conclusions

Diving doctors must be aware of their responsibility. They should avoid discriminating against handicapped persons as far as possible and also avoid the risk of provoking diving accidents by signing certifications as a favour.

We should establish a team approach, because each specialist has different experience and views, and many ideas are very provisional as they are not evidence based.

Underwater and Hyperbaric Medical Societies must use their authority and create centres of competence, or if possible excellence, in order to demonstrate a clear concept of minimal medical standards in spite of the different,

TABLE 8

HANDICAPPED DIVERS' FITNESS TO DIVE

Unfit

If locomotion, communication or self-control are not continuously assured
If there is a danger of drowning
If unable to understand instructions

Restricted fitness

Informed consent, handicapped divers have to be informed about their specific risks.
Novices start at level III and progress to their final level.
Level III "only for handicapped diving program"
Level II "only with experienced and specifically trained buddy"
Level I "time restrictions, avoid currents and exertion, special log book"

competing training organisations. An acknowledged monitoring system (logbook) should be part of the fitness to dive assessment.

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HEALTH STATUS OF RECREATIONAL SCUBA DIVERS IN WESTERN AUSTRALIA

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Key Words

Ascent, equipment, fitness to dive, medical conditions and problems, low air.

Abstract

Background

Scuba diving is a physically demanding activity. Physical fitness is required to meet the routine demands of the aquatic environment, and to cope with unexpected environmental or equipment related (technical) problems. "Fitness to dive" is currently assessed by pre-training medical screening and the achievement of a minimum swimming distance. The health and physical fitness of diving trainees, however, has not been well defined. Similarly, the prevalence of diving related health and technical problems is not known.

Aims

To characterise the general health and fitness of recreational scuba divers and to identify any diving related health or technical problems.

Methods

Detailed health and diving questionnaires were mailed to 63 experienced divers and to 919 randomly selected subjects who had recently completed a PADI accredited diving course.

Results

The overall questionnaire response rate was 55%. 72% of respondents were male and 28% female, with mean

age of 27 years (range 12-66). The divers' mean body mass index (BMI) was 23.5 (range 16-40), with 24% being overweight or obese (BMI>25). Current smokers made up 11.6% with 16.9% being ex-smokers. Most divers undertook regular exercise (88% >2 hours weekly), but only 26% swam regularly. Conditions which contraindicate diving (asthma, epilepsy or diabetes) were present in 10.4%. Minor dive related symptoms such as ear and headache were experienced by 52% of subjects. Dive-related technical problems (eg swimming difficulties, low-on-air, emergency ascent) had been experienced by 37% of respondents.

Discussion

While most recently trained divers are in good health, a significant proportion are either overweight and/or do not exercise regularly. Current medical screening is not effective at excluding people considered medically unfit for diving. Despite undertaking accredited training programs, many divers had experienced avoidable technical problems when diving. Given the prevalence of these problems, the relative lack of 'water fitness' of most divers is of particular concern.

Introduction

Scuba diving is a physically demanding activity. Diving fitness can be defined on a number of levels; strength, endurance and psychological factors.¹ Strength is very specific to the activity being undertaken and requires ongoing training to maintain. Regular swimming, preferably with scuba fins, is required to retain diving strength. Endurance is a cardiovascular phenomenon and relatively non-specific; i.e. it can be maintained by regular aerobic exercise of any form. Diving fitness also needs to consider both the physical demands of normal, comfort level diving and the sudden unanticipated demands that occasionally occur. Many divers have experienced unexpected changes in sea conditions or gear failures that suddenly necessitate a greater level of physical exertion to resolve. At the present time, scuba diving trainees undergo a simple swim test. They have to swim 200 m and they have to tread water for a couple of minutes. The energy requirement of different activities can be compared by a measure of workload, the metabolic equivalent (MET). To swim 200 m at one's own pace, requires only 6-7 METs. Treading water is more strenuous and requires 7-9 METs. Most people have to be moderately fit to achieve that, but certainly not very fit. In contrast, a diver in full gear requires a near-maximal exertion of 13 METs to swim at one knot.¹ Unless very fit, most people cannot exercise aerobically at this level. Anaerobic exercise can only be maintained for a minute or so before the diver becomes exhausted and slows down or stops.

A variety of medical conditions can also potentially affect diving fitness. In accordance with Australian Standard 4005.1,² all prospective scuba divers are required