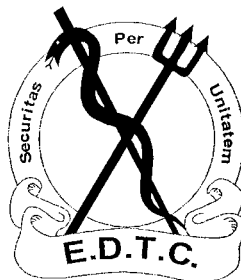


Fitness to Dive Standards

Guidelines for Medical Assessment of Working Divers



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1. Foreword

Commercial divers, being highly specialised professionals are often working in international waters or inshore in foreign countries. Different regulations result in complications of mutual recognition of certifications. Until now, no European or international standard has been in use and the British Health and Safety Executive has abandoned a practice of evaluating foreign certifications that eventually were considered equivalent to the British HSE Standards. The European Diving Technology Committee has pointed out the need for international standards for the fitness to dive assessment of divers in the "Goal-Setting Principles for Harmonised diving Standards in Europe". In 1999 EDTC has decided to elaborate European fitness to dive standards for working divers, in order to fill this gap. Furthermore these standards should be a basis of working safety also for the many working divers that are not controlled by national regulations.

The medical subcommittee of EDTC has concluded that these new standards should be based on evidence and modern clinical practice and that there was no need to synthesise the many national existing checklists that generally were originally navy born.

The main change that we want to achieve is to abandon the prescribed way of assessment with pass-fail-checklists, but enable the medical examiners of divers to do a descretional assessment. This needs a higher competence of the doctor in order to get a judgement of fitness to dive taking into account the technique of diving and the specific environmental conditions of the worksite. This approach shall be enabled on the base of the following three conditions:

1. International acknowledged guidelines
2. Standardised training for diving medicine
3. A handbook as desktop reference for the medical examiner of divers

The training standards for diving and hyperbaric medicine being already available (joint consensus of EDTC and European Committee for Hyperbaric Medicine 1999), with this document we represent the guidelines for fitness to dive assessment (approved by EDTC March 2003). In a next step the authors from the Medical Subcommittee of EDTC will compile a desktop reference with these guidelines as a core module incorporated (fall 2003).

These guidelines were produced in a consensus procedure of all EDTC medical representatives of the 17 member countries. During several special meetings and e-mail discussions we came to a draft solution, that was presented in a workshop for medical examiner of divers (biomedical seminars 2001, Amsterdam, directed by David Elliott). After final editing, this is the approved version. The rate of progress in the detection and management of medical conditions is such that this document will remain under continuing review.

The fitness to dive standards may be adequate to use for tunnel and other workers in raised environmental pressure but not working in water. Modern tunnelling techniques now include mixed gas and saturation exposure.

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2. Introductory remarks

Legal aspects

The medical, mental and physical fitness of all commercial divers is important for the safety of the work operations they participate in. Lack of medical fitness represents a hazard for the diver as well as for the other members of the crew.

The importance of safety in diving operations is reflected in the regulations and guidance laid down by European governments which are similar in general. Health and safety aspects are two different entities which are not always covered by the national regulations in an identical way (see resume diving). Regulations provide national fitness standards that are largely similar. It is the purpose of this document to offer harmonised standards for working divers that can be adopted throughout Europe.

Maintaining appropriate standards of medical fitness imposes responsibilities on various parties. The employer has responsibility for the safety of all employees as well as for completion of the work contract. The diver has a responsibility to report a complete and accurate medical history to his/her diving medical examiner at the time of medical assessment and also a responsibility to report temporary unfitness to his/her employer as a result of illness or injury occurring between medical examinations. Regulations define which doctors may become officially recognised (accredited) to sign fitness to dive certificates for working divers. However, the variation in recognition arrangements results in a situation where not all doctors have equivalent training and competence to make an appropriate medical assessment.

Recognising this situation, the EDTC has adopted a standard describing appropriate training objectives for diving and hyperbaric medicine physicians in Europe. The goal of these EDTC and ECHM standards is that the examining doctors throughout Europe have equivalent training at the appropriate level (see annex of this manual). Further, the accredited doctor can refer the candidate to a diving medicine specialist for an in-depth examination.

Where someone is found to be unfit to dive (or fit to dive only with limitations) the person should be informed in general terms the reason for this conclusion.

The examiner has to respect the medical confidentiality of the candidate. Thus the result of the assessment has to be entered on a form which does not contain any medical details, but it must clearly state whether the fitness to dive is unrestricted or must provide a precise definition of any restriction. The certificate should state the type of assessment performed (in depth or annual routine) and the date of the next assessment. A copy of the examination record, which remains in the hands of the medical examiner, should be given to the diver who needs to retain it for scrutiny by his next medical examiner.

The assessment record, together with details of any restriction, should be signed by the examining doctor AND the candidate. Not only does this demonstrate informed consent but this may be important later if the diver has denied a medical problem which may affect safe diving.

If someone is found to be unfit, or fit with a restriction, the person should be advised of their right to a review by the supervising body (as arranged by the national Health and Safety authority). The diver may have to apply in writing to that office within a certain time interval for a review of their case, normally by a diving medicine specialist and a specialist in the relevant medical field. These procedures differ from nation to nation.

General criteria of fitness for commercial diving

Although the hazards of diving are principally the same for sports divers, diving instructors, scientific divers, fishing divers, police divers or commercial inshore or offshore divers, the risks may vary according to the different diving procedures (see chapter 6). These are reduced by appropriate training, skills and the equipment of the diver. The following table gives an overview of the essential criteria for safe diving:

Criteria for Fitness to Dive
➤ No known medical conditions that limits the ability to do the job as diver (swim, communicate, manage responsibility, mental fitness)
➤ No known medical conditions that will jeopardise the safety of the diver or the team (e.g. loss of consciousness, orientation, panic attack)
➤ No known medical condition that might get worse as an effect of diving (e.g. conditions leading to barotrauma)
➤ No known medical condition that predisposes the diver for diving or occupational illness (e.g. presence of PFO after an episode of DCI)

The examining doctor has the task of excluding any person with a contraindication for diving, based on his appropriate training in diving medicine and using the acknowledged standards for fitness to dive. This judgement will depend to some extent on the diving technique and task of the professional diver.

This manual contains a checklist for the assessment of the history and physical examination as proposed by the EDTC. The following chapter contains a list of some possible contraindications and temporary restrictions. The list is NOT complete but may help in planning further specialist examinations and referrals. The recommendations need not be followed dogmatically if the particular working conditions of an individual permits a deviation from these guide-lines. The guide-lines represent the current scientific state of the art and the opinion of the medical subcommittee of the EDTC. Further development and refinement is to be expected.

The assessment procedure

In several regards the examination of a working diver, like that of any occupational assessment, differs from a routine clinical consultation that is characterised by a patient seeking help from a physician. The medical examination of working divers is prescribed by the national regulations concerning diving and the diver is not likely to know his medical examiner initially. Although the diver may be free to choose his medical examiner, it is recommended that the same examiner continues to perform the follow-up assessments for as long as possible.

The EDTC Medical Sub-committee strongly recommends that the questionnaire on the diver's history is completed by the examining doctor and the diver together, in order to ensure that the candidate has understood the questions properly. This also gives the examining doctor a chance to study the behaviour, mental state and ability to communicate of the candidate. If there are symptoms or a diagnosis in the history-taking session which are clearly incompatible with safe diving, the physical examination may be omitted.

Apart from that, all the examinations to be found on the checklist must be performed if the final certificate is to state that the assessment has been performed in conformity with the EDTC standards for the medical assessment of professional divers. Any examination that cannot be performed by the examining doctor may be delegated to an appropriate specialist. How to proceed in such cases can be found later in this manual.

The referral letter for specialist consultations must contain precise questions which need to be defined by the medical examiner using the appropriate chapters of this manual. The specialist will perform supplementary examinations and respond, leaving the final decision concerning the fitness to dive to the medical examiner of divers.

In difficult cases diving medicine experts may be contacted (usually other diving medicine examiners or designated diving medical advisors appointed by the according authority).

Frequency of assessments

The EDTC standards distinguish 3 types of assessments: in depth assessments, annual routine re-assessments and special re-assessments after injury or decompression illness.

Initial medical examination

The first medical examination of a potential diver is particularly important for determining future safety underwater. It must also attempt to determine if the candidate, who is about to spend considerable time and money in training, is likely to remain fit for a worthwhile career. He or she should be advised accordingly. The medical history and examination of a candidate before entry into training for a career as a working diver should be especially stringent because, at this stage, the consequences of rejection are relatively straight forward. In contrast, medical disqualification during or after training implies financial penalties for the individual.

Annual assessments

The concept of major routine medical examinations at annual intervals has been abandoned by the EDTC. Instead it is intended that an in depth medical examination is carried out only in intervals of several years and that the annual medical requirement takes the form of a monitoring of the functional auto-assessment of the diver at work. These annual assessments are clinical reviews based on face to face interviews¹ with a medical examiner of divers supplemented by further investigations if indicated (see form "Routine annual medical assessment").

The periodical in depth assessment

Besides this annual assessment, a periodical in-depth assessment (almost as complete as the initial one) is needed at variable intervals. The recommended interval for young healthy divers working under regular conditions is 5 years. This interval has to be with increasing age (normally above 45 years as judged by the doctor at each assessment).

Re-assessment after illness, injury or decompression illness

The purpose of assessment for fitness to return to diving after illness, surgery or injury is primarily to determine any factors which may affect subsequent in-water safety. The assessment of this follows conventional principals but with some additional considerations. A hand injury, for example, may affect a bell-man's ability to handle another diver's hose in an

¹ Exceptionnaly, in countries with very remote access to a medical examiner of divers, an equivalent procedure can be organised, combining a physical visit to a local occupational medicine doctor and a phone call with the diving medicine specialist

emergency. The doctor must know the tasks which the diver is expected to perform and the hazards to be met after his return to diving. If there is any doubt then the doctor should seek advice from someone like a diving supervisor. A restricted certificate of fitness might then be an appropriate option but too often, it seems, the restriction is made in terms of a maximum depth limit, which is rarely meaningful. This kind of assessment, if after DCI or pneumothorax, should be performed by the diving medicine physician (advanced training level according to the EDTC/ECHM training standards, see annex).

The EDTC forms

The checklists and forms found below should be a help for the examining doctor. They represent a consensus proposal by the national representatives of the Medical Sub-committee of the EDTC, and may be incorporated into the existing routine procedures of each country.

There are up to now no plans for a unique European certification. However, the national certifications for fitness to dive may state that the assessment was performed in accordance with the European standards of the EDTC (see sample).

The examining protocol (record) is a checklist relating to any signs and symptoms as well as containing the comments of the examiner, but the certificate contains only the conclusion of whether the candidate is fit or unfit (or fit with a particular restriction as to a diving technique or procedure). The certificate also contains the doctor's full address (print) and medical licence number and the date of the next examination. The privacy of the candidate's medical information has to be remembered when completing the certificate.

The record of any fitness to dive assessment must be filed and traceable within the doctors office at least 10 years.²

² In countries where the physicians do not have any personal licence numbers, the certifying body and year of certificate must be indicated instead of personal licence number.



STANDARD RECORD FORMS FOR MEDICAL ASSESSMENT OF WORKING DIVER

Family name / First name: _____
Date of birth: _____
Street address: _____
Postal code / City / Country: _____
Telephone: _____
Occupation / type of diving: _____
Company (employer) / Diving training agency: _____

Photo

IN DEPTH ASSESSMENT: HISTORY (preliminary and periodical)

The history has to be taken by the examining doctor together with the diver in order to make sure that the candidate has understood the questions properly and to give the examining doctor a chance to study the behaviour and mental state of the candidate during the consultation. An adapted divers questionnaire for self-assessment may be handed to the diver before the interview. On completion the diver's signature should be witnessed.

1. Diving history / motivation for diving (previous diving experience, training level, type of diving, professional goals), previous diving related illness [check the logbook]
2. Sports activities, frequency of training, previous sports medical assessments. Any incapacity for work in the past 3 years (more than 3 weeks), any incapacity for military service
3. All hospitalisations, surgical interventions, accidents
4. Medical consultations, medical treatment since last in-depth assessment [ask for examining physician and date]
5. Weight, height, any changes during last year
6. Medications (previous or current)
7. Smoking, alcohol, drugs
8. Allergies, conjunctivitis, rhinitis, asthma, eczema
9. Ear problems, middle-ear inflammation, rupture of eardrum, hearing difficulties (even unilateral), audiograms
10. Dizziness, unconsciousness
11. Sinus problems
12. Dental problems, prostheses
13. Respiratory problems (dyspnoea, coughing, phlegm, pneumothorax, asthma)
14. Previous or current cardiovascular problems (heart-rhythm disturbances, blood pressure)
15. Diabetes mellitus, other metabolic or endocrinological diseases
16. Musculo-skeletal (back or joint pain, rheumatism, arthritis, injuries)
17. Vision (possibly with contact lenses), colour vision
18. Epileptic fits (seizure, absences, hyperventilation fits)
19. Psychiatric or psychological problems, i.e. anxiety, depression, panic disorders, claustrophobia; treatments)
20. Pregnancy
21. Family history

Remarks:



STANDARD RECORD FORMS FOR MEDICAL ASSESSMENT OF WORKING DIVER

IN DEPTH ASSESSMENT (CONTINUATION): EXAMINATION

These examinations represent a minimum. If in doubt or when history or signs might represent a contraindication, further evaluation is necessary (see list of contraindications).

1. Height, weight, body mass index (BMI)
2. Otoscopy with Valsalva-test (or Toynbee, eardrum mobility or scarring) simple hearing test (if in doubt ear microscopy and tympano- +/- Audiogram).
3. Examination of throat and teeth
4. Neurology /locomotion system: Nystagmus (spontaneous and after head movement), sharpened Romberg test, sensitivity and motor function, gait, grasping small objects, reflexes (patella and Achilles, etc.), cranial nerves
5. Lung and heart auscultation, blood pressure, heart rate (for any unusual sign and BP > 140/90, see contraindications pages)
6. If age 45 and more years: stress ECG (by cardiologist)
7. Lung function including FEV₁, FVC, flow-volume-curve (or peak-flow if curve not available). If not within 80% of normal values, see contraindications pages
8. Submaximal stress-test for aerobic capacity (give reference, examples see annex A). If VO₂ max. extrapolation from tables is below expected maximal workload, see contraindications pages
9. Laboratory: complete blood picture count, haematocrit, blood-sugar. Sickle cell disease to be excluded (only for subjects who could be affected). Urine: strip
10. Examination of abdomen (hernia, scars, resistance)
11. Psychological judgement (see introductory remarks and contraindications pages)
12. Additional examinations:
 - if assessment of lung structure is thought to be indicated perform chest x-ray and spiral CT scan of lungs (to exclude emphysema/bullae)
 - screening for long term effects (bone necrosis): only for divers who average 20 hours of diving per week and diving over 30m: MR imaging (or x-ray of hips AP, shoulders AP), blood-test for lipids.
 - any consultations of specialists or diving medicine experts:
 - audiogram if required for hearing conservation program.

Conclusions and comments (informed consent), remarks for the diver

Date/City:

Signature of examining physician:

Signature of candidate

Stamp, address of Doctor

No. of medical license



STANDARD RECORD FORMS FOR MEDICAL ASSESSMENT OF WORKING DIVER

Family name/First name: _____
Date of birth: _____
Street address: _____
Postal code/City / Country: _____
Telephone: _____
Occupation / type of diving: _____
Company (employer) / Diving training agency: _____

ANNUAL MEDICAL ASSESSMENT

History (interview to be completed by the physician):

1. Date of the last previous examination, by which physician?
2. Accidents, diseases, or hospitalization, other health problems or medical consultations since last examination
3. Incapacity for work for more than 3 weeks
4. Personal habits (sports, nicotin, alcohol)
5. Medications
6. Changes in body weight
7. Diving experience: (professional and recreational)
 - hours in water [check logbook]
 - number of different kinds of dives (sat, bounce air, nitrox, mixed gas, hard hat)
8. Diving incidents/accidents
9. Any symptoms or problems while diving: transient alterations of sensation (numbness, paraesthesia), muscle- or joint-pain, headache, skin symptoms (rushes, itching, subcutaneous emphysema), pressure equilibration problems, dizziness, vertigo, depth-euphoria, exhaustion, panic reaction, other (sinus, teeth, abdominal)

Status: (if indicated after interview or wished by the diver)

1. Otoscopy with Valsalva
2. Heart and lung auscultation, blood pressure, heart-rate, sharpened Romberg test

As in the case of in depth examinations, further clarification is necessary whenever any doubt or questions arise in the history or any marked findings are observed.

Additional examinations:

Specialists consulted:

Judgment / Comments: (informed consent)

Date/City:

Signature of medical examiner of divers:

Signature of candidate (optional):

Stamp, address of Doctor

No. of medical license



STANDARD RECORD FORMS FOR MEDICAL ASSESSMENT OF WORKING DIVER

Family name/First name: _____
Date of birth: _____
Street address: _____
Postal code/City: _____
Telephone: _____
Occupation / type of diving: _____
Company (employer) / Diving training agency: _____

ASSESSMENT TO RESUME DIVING

Description and date of incident / reason for incapacity

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Assessment (to be defined by the diving medicine specialist):

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Conclusions / Comments: (informed consent)

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Date/City:

Signature of examining physician:
(should be higher qualification than medical examiner of divers)

Signature of candidate:

Stamp, address of Doctor
No. of medical license:

4. General Guidelines

Cardio-vascular assessment

The function of the cardiovascular system should be such that the diver is able to sustain strenuous muscle activity at depth. There should not be an increased risk of loss of consciousness or incapacitation.

Electrocardiogram is generally not required, but stress ECG (with measured maximal exercise) is needed over age 45 or if considerable risk factors are present.

If a stress ECG is considered to be necessary, it should be done by a specialist (where appropriate resuscitation facilities exist).

Contraindications:

Any organic heart disease is a cause for rejection unless considered by a cardiologist to be haemodynamically unimportant. That includes all types of cardiomyopathy, ischaemic heart disease, haemodynamically important valvular disease, cyanotic heart disease and other shunts.

● **Ischaemic Heart Disease**

At the preliminary examination an individual found incidentally to have ischaemic heart disease should be declared unfit.

Symptomatic ischaemic heart disease is incompatible with diving. The requirement for medication to control a cardiac condition is a contraindication as well.

An individual who is symptom free following coronary bypass surgery remains unfit to dive. An individual who has had percutaneous transluminal coronary angioplasty might be considered fit if 6 months after the procedure:

- the procedure has been demonstrated to produce revascularisation;
- he or she remains symptom free;
- has a normal stress ECG test and can meet the physical requirements.

Such individuals will require careful assessment by a cardiologist, and if considered fit will require careful follow up. At an annual assessment, full specialist evaluation, including exercise testing and further investigation when considered appropriate (eg. angiography), is required to assess the risk of an acute event occurring during diving.

● **Dysrhythmias**

Disorders of cardiac rhythm, except for sinus arrhythmia and infrequent ventricular extrasystoles, require specialist evaluation and are likely to be a cause for rejection, particularly at the preliminary medical examination.

Any dysrhythmia that might cause incapacity in water will disqualify.

- **Pacemaker**

In most cases the indication for pacing is likely to be a contraindication to diving. Careful assessment of the type of diving and type of pacemaker involved will be required and, if necessary, will require specialist cardiological advice.

- **Patent Foramen Ovale**

Examination for the presence of an intracardiac shunt is not a requirement for either the preliminary examination or the annual assessment. A patent foramen ovale (PFO) is a natural condition that can be found in a significant number of divers who never have and never will suffer decompression illness.

However, examination for right-to-left-shunt can be justified in a diver who has suffered neurological decompression illness, particularly where the dive profile was not obviously contributory since it may contribute to an assessment of the overall risk to the diver of continuing to dive. A positive finding is not necessarily a reason for a finding of unfitness. However, a diving medicine specialist's opinion is recommended.

- **Valvular Heart Disease**

Auscultation of the heart should be normal. Murmurs are acceptable only if deemed to be physiological. Where doubt exists referral for specialist opinion or further investigation such as echocardiography should be considered.

Atrial or ventricular septal defects, aortic or mitral stenosis are contraindications to diving. Coarctation is a contraindication. Other valvular conditions, including bicuspid aortic valve, mitral valve prolapse would require cardiac evaluation. Cardiac function in terms of exercise capacity should be normal.

- **Blood Pressure**

At the preliminary examination the resting blood pressure for a young diving candidate should not exceed 140 mmHg systolic or 90 mmHg diastolic, using the fifth phase as an indicator and with the patient supine. For older candidates the effect of age should be taken into account. The possible impact of a rise in blood pressure during a diver's potential career should be considered.

At subsequent annual assessments, mild hypertension (not exceeding 160 syst or 100 diast) would not be a contraindication provided that:

- either no medication was required or the medication taken had no implications for diving safety; and
- there was no evidence of end organ damage.

More detailed evaluation by the standardised Tilt Table Test³ only if indicated.

Where doubt exists consult a cardiologist with a knowledge of diving medicine.

³ Tilt Table Test (reference): A. Natale, Efficiency of different treatment strategies for neurocardiogenic syncope, *Pace*, Vol 18 (1995) and
E. Braunwald, *Heart diseases, A textbook of cardiovascular medicine*, 6th edition 2001

● **Peripheral circulation and microcirculation**

The peripheral circulation should be capable of providing adequate peripheral perfusion even in cold conditions. Clinical evidence of impaired circulation will require further evaluation. Peripheral vascular disease may predispose to cold injury. Contraindications are:

- varicose veins associated with circulatory impairment (for example, varicose eczema); and
- conditions known to be associated with impaired organ perfusion.

Airway assessment

The nasal airway should be free from signs of obstruction. There should be no evidence of chronic sinus disease. Clinical examination of the respiratory system should be normal. There should be no evidence of gross anatomical abnormality, no evidence of obstructive or restrictive lung or of impaired ventilatory capacity. There should be no history of respiratory disease suggesting impaired structural integrity or gas exchange capacity of the lung. The presence of abnormalities as described above requires specialist evaluation.

Spirometry: The forced vital capacity (FVC) and forced expired volume in one second (FEV₁) should be recorded but the use of the FEV₁/FVC ratio to provide a numerical threshold for pass/fail is inappropriate, although it remains an important indicator for specialist referral. The shape of the maximal flow volume loop is another important consideration. From a series of examinations, the examining doctor must look for individual trends, particularly those which are still within the range of normality for the general population, but which are revealed as significant only by comparison with that individual's previous records.

European Community Coal and Steel Industry predicted normal equations are recommended as reference values for caucasian people. Other norms should be consulted for other ethnic groups.

There is no indication for routine measurement of maximal minute volume.

Radiology: A Spiral CT scan of the lung at first assessment is the appropriate screening tool to search for bullae, air trapping and other structural lung pathologies. However due to the facts that barotrauma is rare in commercial diving and that in the general population small bullae are a common finding in spiral CT examination, excluding all candidates with an abnormality would be ethically unacceptable. The actual consensus only recommends the CT scan if there is a positive clinical indication. In this situation standard chest x-ray is inappropriate for this screening. No further x-rays of thorax are needed unless indicated, but the requirement for x-ray can vary geographically according to the local prevalence of tuberculosis that is becoming more common in some urban areas.⁴

Further investigations will need specialist referral: direct measurement of max O₂-uptake, blood gases, spiroergometry, extended lung function with total body plethysmography, helium uptake etc. Diffusion capacity is difficult to assess and is generally not necessary.

⁴ In Italy chest x-ray and hyperbaric oxygen challenge test are compulsory every year.
In Portugal chest x-ray are compulsory every year.

Contraindications

- acute respiratory illness;
- chronic lung disease which results in a reduction of exercise capacity;
- chronic obstructive airways disease; and
- previous spontaneous pneumothorax;
- the presence of bullous lung disease;
- chest injury, particularly penetrating injury resulting in pleural adhesions or pulmonary scarring (excl. uncomplicated rib fractures).

Conditions requiring careful evaluation

- Pneumothorax, not spontaneous but provoked by unusual respiratory stress or following surgery, since when there has been at least 3 months for the rupture to heal: a detailed investigation by a specialist laboratory must show normal lung function and no evidence of local or generalised airflow obstruction.
- Where a diver has had chest surgery but is clinically fit, an opinion should be sought from a diving medicine specialist as to fitness to dive.

Asthma

A history of asthma or broncho-constriction after early childhood remains controversial. Contrary to theoretical predictions, there appears to be no firm evidence that asthma predisposes to pulmonary barotrauma and gas embolism. Stable asthmatics who are not triggered by provocation testing could be considered fit. Indeed it was suggested that the use of inhaled steroids to maintain stability in a person with good peak flow was not per se an absolute contraindication to diving. The "Americans with Disabilities Act" and similar legislation in other countries would now suggest that 'asthmatics' must be allowed to dive professionally. However, if allowed to do so because there is no data to show that this would be unsafe, there must be a meticulous collection and analysis of relevant evidence to confirm the wisdom of this change in policy.

Individuals with asthma require careful additional assessment. That is likely to include bronchial provocation testing using histamine or metacholine, cold or hypertonic saline and exercise. They should demonstrate less than a 20% reduction of peak flow or FEV₁ after 6 minutes of hard exercise.

The pulmonary fitness criteria should be applied more strictly at the preliminary medical examination than to a fully trained diver who develops late onset asthma.

Specialist referral is necessary at initial assessment but later only as required.

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.

Ear, Nose and Throat Assessment

The individual must be able to equalise pressure in both ears. Visual confirmation of eustachian function should be obtained. The ear canal should be free from obstruction and evidence of infection. Exostoses are common and unless they occlude the canal are not a

contraindication to diving. There should be no increased susceptibility to infection. The tympanic membrane should be intact and not atrophic. Vestibular function should be normal. Hearing should be of a level which permits normal conversation to be understood.

Audiometry is not systematically required. An audiogram should however be performed after an episode of aural barotrauma. In addition audiograms should be carried out according to a hearing conservation programme, where hazardous noise levels have been identified⁵.

While this may be common in some types of work, many divers are not exposed to this risk.

The tympanic membranes should be examined annually as an individual may perforate an eardrum and be unaware of it. Limited fitness may be attested for those with a problematic tympanic membrane if not at risk from water ingress, e.g. using a helmet.

Contraindications:

- Ninety-five per cent of traumatic tympanic perforations heal spontaneously and, for the rest, repair of the drum can be performed which does not preclude an individual from diving. However the presence of attic or posterior marginal perforations of the drum indicate middle ear disease and contraindicate diving. Complications of otitis media such as glue ear, deafness, perforation and persistent discharge are causes for rejection.
- Atticotomy also debars but a simple mastoidectomy does not. Other cases need specialist advice.
- Chronic otitis media contraindicates diving.
- Stapes surgery is a contraindication to diving because barotrauma may drive the prosthesis inwards causing total deafness, but individual advice from a specialist is recommended.
- Meniere's disease is incompatible with diving.
- After successful repair of a round window rupture, the diver may resume diving, but the opinion of the ENT specialist involved should always be sought.
- Nasal septal deformity may result in difficulties in eustachian tube function. Many cases could be rectified easily by a simple operative intervention.

Dental

The diver requires a high standard of dental health. It is necessary to retain a mouthpiece and the presence of cavities may be associated with barotrauma. Unattached dentures should be removed during any diving activity. Partial dentures can be worn if secured to the remaining teeth.

The diver should attend a dentist regularly and the dentist should be aware that the individual is a diver. Where doubt exists a certificate of dental fitness should be obtained.

⁵ In France and Italy audiograms are necessary for first assessment as a baseline to prove further eventual deterioration.

In Sweden audiograms are performed at each in depth assessment

In Portugal audiograms are compulsory every year.

Neurological assessment

Central nervous system

The central nervous system should be clinically and functionally normal.

Assessment of central nervous function includes both physical and psychological aspects. The diver must be psychologically capable of undertaking diving activity. The diver's manner, attitude, verbal and intellectual response form part of the examination. Where doubt exists specialist clinical psychological assessment might be required.

Predisposition to impairment of consciousness, convulsions, disturbances of speech, vision or motor control or disturbances of orientation and balance is incompatible with diving. Conditions which may mimic decompression illness or jeopardise safety must be sought and excluded.

The examination of the cranial nerves, motor system, sensation, reflexes and co-ordination should be detailed performing the in-depth assessments and a permanent record of the examination needs to be retained as a baseline.

Equilibrium and control of positioning should be examined by performing the sharpened Romberg procedure, as described in Lee 1998⁶.

Neuro-psychiatric Assessment

Individuals should be free from psychiatric illness and cognitive impairment. They should not be suffering from psychological or personality problems that would interfere with their in-water safety or that of others.

Assessing the mental fitness the primary considerations in all cases must include the risk to the individual's safety and/or that of those around him or her; and the risk of recurrence of psychiatric or psychological disorders. Special consideration should include the various stresses associated with the type of work, remote location and risks involved.

Contraindications:

- claustrophobia
- severe motion sickness.
- migraine if accompanied by visual, motor or sensory disturbance and excessive daytime somnolence.
- any unprovoked loss of consciousness, recurring fainting episodes other than febrile convulsions occurring up to the age of five years.
- Any form of epilepsy is a contraindication to diving. However, in certain circumstances where a diver has been fit free for ten years without treatment they may be considered for fitness to dive. Expert assessment will be required.
- A history of any intracranial surgical procedure, depressed skull fracture or penetrating head injury needs careful assessment because of the increased risk of subsequent epilepsy,

⁶ C-T. Lee, Sharpening the sharpened Romberg, SPUMS Journal; 28: 125-132 (1998)

especially in the following year. A history of head injury is acceptable if there has been loss of consciousness of less than 30 minutes without focal localising signs, if the period of post traumatic amnesia (defined as the time to the restoration of continuous memory) is less than 1 hour. Minor linear skull fractures are acceptable if the criteria above are met. Other cases of mild to moderate head injury, especially if recurrent, require full neurological and psychometric assessment.

- Major intracranial tumor surgery is disqualifying while minor surgical procedures (some meningiomas) might be compatible with professional diving if risk of seizures is not elevated.

Psychiatric disorders which, while quiescent, still exclude passing an individual as fit to dive:

- schizophrenia;
- bipolar affective disorder;
- unipolar affective disorder;
- disorders asymptomatic due to treatment.

Disorders which, if resolved, may allow passing an individual as fit to dive:

- adjustment reactions;
- parasuicide;
- pre-menstrual dysphoric disorder;
- phobias;
- isolated psychotic episodes.

Inner Organs

Endocrine System

Diving results in numerous neurological reflexes and hormonal responses. It is unlikely that those suffering from endocrine conditions leading to impaired thermoregulation, cardiac or muscular insufficiency would be found fit. A proven or suspected abnormality will require detailed assessment. So each individual with an endocrinological disorder must be assessed for fitness jointly by an endocrinologist and a diving medical specialist

- Gross thyroid disease is one obvious contraindication to diving but, on replacement therapy, hypothyroidism can be compatible with professional diving even when a dose or two of thyroxine is missed. Similarly, although thyrotoxicosis may be a bar for diving, after treatment with radioiodine and on replacement therapy, their fitness should be considered favourably, though beware the retrosternal goitre.
- Hypopituitarism on replacement therapy might be thought to follow the same principle, but when injured or stressed those on cortisol replacement may collapse, making it a certain contraindication.

Diabetes mellitus

If any form of diabetes is found at the time of initial assessment before diver training, the individual should not become a professional diver because of the certainty of later disqualification due to complications. Diabetics should not become professional divers,

however, under special conditions they might be trained under medical supervision and then become divers for limited diving operations.

Once diabetes is diagnosed in a working diver, an automatic disqualification may seem wise, but is no longer acceptable. The two factors are the nature of the work and the degree of control achieved by treatment. What is appropriate for a scientist working in a laboratory wave tank may not be appropriate for a construction diver at sea. Note that those on oral anti-diabetics who become hypoglycaemic may be more difficult to manage than those who become so on insulin.

In addition to the acute problems of diabetics, it is the complications which are of concern and should disqualify: atherosclerosis, cardiomyopathy, retinal changes, peripheral vascular disease, diabetic foot syndrome, nephropathy and neuropathy.

Genito-urinary system

Dipstick urinalysis for blood, protein and glucose should be undertaken routinely.

A history of renal disease or of urinary tract infection needs careful assessment.

- Divers with active genito-urinary infections including herpes should not dive until adequately treated and symptom-free. A patient with recurrent herpes infection might be advised against saturation diving.
- The presence of genito-urinary disease or renal tract disease associated with abnormal renal function is usually a cause for rejection. Cases of renal stones or colic should be judged on an individual basis after specialist investigation.

Gastro-intestinal conditions

Gastro-intestinal function should be normal with no increased tendency to vomiting, dyspepsia, reflux, bleeding, perforation, diarrhoea or pain. Hepatic and pancreatic function should be clinically normal.

- Dyspepsia will require investigation and the association of reflux oesophagitis with a predisposition for duodenal ulceration could compromise in-water safety.
- Symptomatic hiatus hernia and active peptic ulceration (including cases where the condition is under treatment) will disqualify an individual from diving until the patient has been symptom-free for at least one year. Elective peptic ulcer surgery, the former gold standard, has now been replaced by a continuation therapy with proton pump antagonist. This would therefore be an acceptable basis after careful consideration and an adequate symptoms free interval (also for saturation divers). A past history of peptic ulceration leading to bleeding, perforation or requiring emergency surgical treatment may however disqualify.
- Recurring episodes of abdominal pain should be investigated and probably disqualify because of the likelihood of confusion of the diagnosis when a hazard of diving illness is present. Chronic inflammatory intestinal disease would be cause for rejection. Acute distal colitis or proctitis should await the outcome of investigation and treatment.
- The presence of an intestinal stoma does not affect safety and for short duration diving should not disqualify. In saturation diving the problem may be social acceptance and disqualification on medical grounds is not appropriate.

- Symptomatic haemorrhoids should lead to referral for surgical treatment and should contraindicate diving only until successfully treated.
- Abdominal wall herniation must be a cause for temporary disqualification until repaired because of the risk of encapsulation, particularly during decompression.
- Evidence of acute hepatic disease and pancreatitis would render a diver unfit. Once a diver with hepatitis has recovered from acute illness and is symptom free and stable, then he or she may return to diving. Individuals with evidence of chronic hepatic disease require specialist assessment. Regardless of known hepatic disease, all divers must be trained to have immaculate personal and environmental hygiene at all times, particularly for the close confines of a diving chamber.

Haematology

Any disorder leading to significantly impaired ability to transport oxygen is likely to be a contraindication to diving, especially when exercise capacity is impaired.

Blood tests: full blood count including red cell indices, haematocrit, blood sugar. Sickle cell disease to be excluded (sickle cell test or haemoglobin electrophoresis mandatory only for subjects which could be affected).

Normal ranges for haemoglobin for males are 13-18 g/dl and for females 11.5-16.5 g/dl. A haematocrit of 0.4 SI units and a haemoglobin of 12 g.dl⁻¹ in men and 10.5 g.dl⁻¹ in women are the minimum acceptable levels.

- Sickle cell disease or thalassaemia major is a contraindication. Carriers of the sickle cell and thalassaemia traits are not believed to be at a significantly increased risk during diving. So for these divers there is no cause for rejection, but testing for thalassaemia minor may be judged appropriate in Mediterranean candidates.

Assessment of musculo-skeletal system

For a novice diving candidate the standards are much tougher than those in somebody who has ten years experience, has a good work record and for whom the standards can become much more pragmatic. To become a working diver, the candidate must have unimpeded mobility and dexterity and must be sufficiently physically robust to meet the demands of the proposed work. In particular, for the safety of self and others, all joints should have a normal range of functional mobility.

- Divers with a history of back pain should be carefully assessed, bearing in mind the heavy lifting a diver may be required to do when out of the water. Recurrent episodes of incapacitating back pain need careful assessment and can be a cause for medical disqualification. Successful surgery for spinal lesions is acceptable if neurological examination is normal and full agility is regained.
- Some disabilities after injury of the locomotary system may be compatible with some forms of diving. A restricted fitness may therefore be appropriate.

Bone necrosis

Dysbaric osteonecrosis is the one well-established occupational health hazard of diving. It can occur in persons who have dived only within the safety of accepted tables and who have

never had a decompression disorder. Thus it is a disease which deserves compensation in some way but is not, on its own, evidence of employer negligence. It is commoner in those with a record of treatment for decompression illness and can follow a single exposure to pressure. It is unknown in those who stay within the no-stop range and very rare in those who dive within the limits of the USN and similar compressed air tables. It is more prevalent in those who dive deeper than 30 metres (100 fsw) and increasingly so in saturation divers with deeper experience.

Radiological assessment and screening: As a standard, screening is needed only for divers with more than 20 hours per week under water or diving of over 30 m. Bone x-rays of hips a-p, shoulders a-p were standard for many years, but they will be replaced in the future by MR imaging as this technique allows screening without the use of ionising radiation, which makes it ethically more acceptable (in spite of the increased costs). MRI is able to detect bone necrosis – while it may produce some false positives, i.e. some lesions probably heal without leaving a necrotic infarct, it can be readily repeated.

There are fishermen-divers who dive for several hours per day, some as shallow as 20 metres (66 fsw) without using appropriate decompression stops and in them the condition is very common. Even so it is very slow to develop. Delay from the date of known first exposure to the first x-ray change is 10 months. The use of scintigraphy and MRI may show earlier changes but a number of these turn out to be false positives which then disappear.

For this reason all new entrants on graduating should be considered for baseline long-bone imaging. For those who become, for example, police divers further imaging should not be necessary, but would be for those working for the offshore oil and gas industry. These records must be stored longer than the lifetime career of the diver. Routine health surveillance is then recommended for those diving regularly more than 30 metres and under pressure for more than 4 hours (deep air, mixed gas and saturation divers). It should be considered also for those with clinical symptoms referable to a joint and for those who have had a decompression illness.

Those found to have bone necrosis are not necessarily unfit for diving. If the lesion is in the shaft of a bone (B lesion), the diver is not at risk from joint collapse and the condition has no effect on underwater safety. A juxta-articular lesion is more serious but, again, is unlikely to affect underwater safety and so medical disqualification cannot be for that reason alone. The strong advice to give up diving is based on the need for the individual to avoid excessive weight bearing at that joint.

For the prevention of osteonecrosis, there is still a need for epidemiological investigation of the possible causative factors. To achieve this, the central reporting of the MR-imaging or x-ray results and the availability of a detailed record of each individual's occupational exposure to pressure remain a high priority.

Vision

The diver should be able to see well enough to accomplish his functions and a person who can read a car number plate at 15 metres probably has adequate vision for diving. The diver should also be able to read diving tables, gauges and watches accurately and so corrected vision should be adequate for reading.

- To accomplish this modern gas-permeable contact lenses are acceptable for diving. Divers requiring optical correction can also use a prescription faceplate if using a facemask. There

is a risk of infection with all contact lenses and it may be difficult to maintain sterility in a saturation environment. The use of disposable lenses may reduce this risk.

- The assessment of colour vision should be made at the initial medical examination and any deficiency communicated to the diver. Even though colour vision is not essential for diving safety, colour vision may be a vocational requirement in some diving skills such as non-destructive testing. Visual acuity and colour vision may be essential for other tasks such as boat navigation, especially at night.
- The risks associated with diving after ophthalmic surgery require careful evaluation and individual assessment in conjunction with the surgeon. The orb is incompressible and so there should be no reason why corneal laser or any other surgery on the eye should be a contraindication to diving once any gas pocket retained in the eye after surgery has been resorbed and scar formation is finished and visual acuity is stable.

Diverse Conditions

Malignancy

A malignant condition should be assessed on an individual basis and will require information from the doctor responsible for the patient's care. Any such person found fit to dive is likely to require regular review.

Communicable diseases:

The medical examiner should be satisfied that the individual is not suffering from a communicable disease. If there is any doubt as to the person's fitness after such an illness, the certificate of diving fitness should be withheld until the doctor involved in the initial care of the patient has been consulted.

Recreational diving instructors with active communicable disease are not allowed to teach buddy breathing practically.

Drugs

Medication: Medical fitness to dive under medication is dependent on:

- the effects of medication on fitness to dive.
- the consequences of its abrupt cessation if complications were to arise during diving.
- the type of diving;
- the underlying pathology;

The assessment must include that of the underlying condition for which medication is being taken and which may be the most important consideration. The assessment should also consider the length of time that an individual can safely be without medication in the event of its loss. Consideration should be given to the potential for unexpected side effects as a result of interaction with pressure or resulting from the particular working situation. Every situation needs to be judged on an individual basis.

- **Smoking:** Divers should be discouraged from smoking.
- **Alcohol, drug or substance abuse** is incompatible with diving. With any history of this there must be doubt about fitness for diving. A lengthy period of stability without any medication should be sought as a minimum.

Skin disorders

The skin is very vulnerable to the repeated and, at times, constant wetness experienced by divers and also to the high humidity and reduced temperature tolerance experienced in the closed environment of saturation chambers.

Skin diseases in relation to diving may be divided into those in which the integument is compromised and those in which there is some disorder of thermoregulation. Some diseases such as eczema can fall within either category.

Those of the first group include eczema, psoriasis, pityriasis rosea and lichen planus.

The disorders which can affect thermoregulation can be divided into those in which there is a haemodynamically based disturbance (severe eczema/psoriasis, urticaria, mastocytosis) and those in which there is a disturbance of the sweat gland apparatus. This can be occlusive such as psoriasis, destructive such as scleroderma, or congenital such as ichthyosis. Neurological causes of impaired sweating also occur.

- Urticaria is a transient condition, but provided that it affects only the skin and never the mucous membranes, would not appear to be a contraindication though it may cause confusion with cutaneous DCI especially if triggered by cold or pressure.
- Any acute or chronic skin infections, whether fungal, monilial, bacterial, parasitic or viral must be controlled before diving is allowed. Recurrent herpes simplex constitutes very little risk to others and no risk to the diver. Hand warts would not be a contraindication to diving. On the grounds of hygiene, verrucae probably should be, but it would be difficult to prevent the person diving.
- There are also the occupationally acquired skin diseases which need to be considered. Neoprene contains antioxidants and the glues used for the nylon backing can contain allergens. Drilling muds are a complex material with many varied constituents but do not appear to constitute a major sensitisation problem. The alkalis are primary irritants and can give rise to serious skin reaction. The oil-based muds are also irritants. Occasionally reactions to the tannins and chromium have been reported. Those identified by suffering from allergic contact dermatitis must avoid all future contact with that allergen, but the majority of persons will be found to have an irritant dermatitis which should respond in time to rest and thereafter that person can return to diving.

Obesity

Obesity is reputed to predispose to decompression illness, but certainly is inversely related to fitness. Body mass index is relatively arbitrary. Some degree of fatness can protect against the cold but, as an indicator of fitness, exercise tolerance testing would seem to be more appropriate (see above)

Gender

In general the same fitness criteria apply to both male and female divers.

The major difference between female and male divers relates to possible harmful effects that exposure to increased pressure may have on a foetus. Consequently a diver who is pregnant or who suspects that she may be pregnant should not dive.

Resumption of diving after a decompression injury

In anything other than a case of simple decompression illness the review should be carried out by a diving medicine specialist, or at least in consultation with one. Further advice including names of diving medicine specialists can be obtained from the national Health and Safety authorities (see address list in Annex).

Specialist examination to look for the presence of factors which may predispose to DCI should be considered, particularly after "undeserved" episodes of neurological decompression illness especially if associated with cutaneous manifestations. Investigations should include contrast sinography with strain to seek right-to-left-shunt (i.e. PFO, other intracardiac shunt or intrapulmonary shunt). Extended lung function tests including measurement of static lung volumes or closing volume should also be considered.

There is a perceived need to assess the effect of any diving incident upon the diver's subsequent health. If there are residua, do they affect only safety or health also?

Until recently little distinction was made between these two. It was proposed by one European government department that the safety of divers is a matter for government control but that their health is not. Health is a matter between the diver and his employer. Though this distinction is not spelt out in the regulations, it is a useful exercise in assessing of fitness to resume diving. With a threat to the diver's safety there must be no compromise concerning disqualification but, when the threat is to future health, the doctor should only advise. The decision to return to diving or to quit should be made by an informed diver⁷: it is his, or her, life and livelihood. This is supported by the advent of legislation for the disabled in many countries which now protects an individual's right to work unless personal safety is affected. Any question of diminished working effectiveness after a period of unfitness is a separate issue.

Recommended times away from diving:

The recommended **minimum time until medical reassessment** after successful treatment with no sequelae are:

- **Simple DCI** with limb pain, skin "bend", lymphatic swelling, headache, fatigue etc and
 - Uncomplicated recovery: 24 hours
 - Recurrence/relapse requiring further recompression: 7 days
- **Neurological DCI** with
 - Altered sensation in limbs only: 7 days
 - Other - for example audiovestibular, motor, pulmonary etc: 28 days

However, it is recommended that because of the nature of their diving patterns and profiles and the lack of supervision, the time away from diving for persons diving at work in the recreational sector should be longer.

⁷ France: actually not possible according to the French regulations for diving at work (only in recreational diving)

Portugal: actually not possible to apply integrally this General Guidelines according to the Portuguese regulations for diving at work, dated of 30/09/1994 (only in recreational diving)]

Reliable tests of physical fitness

Diving is a strenuous activity. A commercial diver must be able to meet the physical requirements of the task to be performed. That includes the ability to rescue a stricken diver and to effect a rapid recovery.

The difficulties begin when one tries to take age and experience into account in a standard of physical fitness. The ability to undertake physical work declines markedly between the ages of 18 and 65¹ and maintaining the necessary physical fitness becomes more difficult. Any diver may need to call upon all his reserves of effort in a life-threatening emergency. The required duration for that effort is unpredictable. This makes it difficult to specify a required level of physical fitness. Functional goals should be independent of age and gender and would allow for the fact that the experience of older divers may make them more effective than younger divers. Medical examiners must satisfy themselves beyond reasonable doubt that the candidate is adequately fit.

An assessment of exercise capacity must be carried out at each in-depth assessment. For practical reasons an indirect method to measure VO_2max may be applied and a reference to the method should be provided. The result is to be noted as millilitre O_2 per kilo bodyweight/per minute (for more detailed description see ref.²), which allows comparison of different results produced using different test protocols.

Simple tests such as a cycle ergometer test provide an adequate means of fitness. The majority of divers will be able to achieve an exercise level equivalent to 12 MET's or 40 ml/kg/min oxygen consumption. The results of the test should be considered together with other aspects such as blood pressure, obesity, and lung function. At subsequent examinations repetition of the same test is valuable to assess any alteration of fitness status. Measurement of peak expiratory flow rate (PEFR) before, 5 and 10 minutes after the exercise test (other than swimming) provides a useful screening for exercise induced wheeze.

Acceptable (referenced) exercise-testing protocols

Submaximal stress tests:

A problem is that the different tests recommended are not easily comparable. Of value is the use of a bicycle or treadmill ergometer where heart rate can be monitored against a defined exercise load and can thus provide an indirect measure of aerobic capacity.

- Astrand Ryming Cycle ergometer test³. Pedalling 50-60 rpm for 5-7 min with workload of 50-100 Watt until steady state is attained. Stress should result in heart-rate of 120-170 beats (normally 2 steps approach is used). Evaluation by using the Astrand Ryming nomogram. VO_2 max. estimate has a standard error of 10% in relatively well-trained individuals, 15% or more in other groups.
- Lactates based submaximal test on cycle ergometer (Toni Held, 1998⁴). 2-3 steps on cycle ergometer in submaximal range for 3 minutes each, recording lactate levels in capillary blood during steady state. Results give estimation for VO_2 max. from a nomogram.

Maximal exercise stress tests:

If the rate of oxygen uptake can be monitored, a more accurate direct measurement of aerobic capacity can be done on an ergometer. The direct methods of measuring oxygen consumption are possibly too complex or costly to be considered as a routine. When testing maximal loads, ECG monitoring should be done and resuscitation material must be available.

There is also merit in considering a more functional test, such as the time taken to swim one kilometre, as an annual measure of continuing fitness but, in practice, this could not be verified by an examining doctor easily (not standardised).

- The stage 1 test, developed by N.L. Jones⁵, uses increasing multiple steps to the maximum work-load. $VO_2 \text{ max.}$ is estimated as $3,5 \times (\text{body weight/kg}) + 10.98 \times \text{Watt reached}$.
- The 12 min run test, developed by K.H. Cooper⁶, measures the maximum distance run in 12 min. as a maximal effort, while estimating $VO_2 \text{ max.}$ as $(\text{numbers of meters covered}/100 \times 2) - 5$.
Very useful is to combine these stress-tests with a monitoring of the perceived exhaustion, using a standardised scale like Borg GAV 1982⁷.

Further investigations will need specialist referral: direct measurement of max O_2 -uptake, blood gases, spiroergometry, extended lung function.

References:

- ¹ B.E. Ainsworth, et al., Compendium of Physical Activities: classification of energy costs of human physical activities. *Med Sci Ports Exerc* 25: 71-80, 1993
- ² ACSM's Guidelines for Exercise Testing and Prescription (6th edition), American College of Sports Medicine, Lippincott Williams & Wilkins, Philadelphia, 2002, page 77, (data from the Institute for Aerobics Research, Dallas TX, 1994)
- ³ P.O. Astrand, K. Rodahl, Textbook of Work Physiology, McGraw-Hill, New York, 1977
- ⁴ T. Held, et al., A lactate-based submaximal test on cycle ergometer for estimation of endurance capacity. *Schweizerische Zeitschrift für "Sportmedizin und Sporttraumatologie"* 46 (4), 144-149, 1998
- ⁵ N.L. Jones, Clinical Exercise Testing (4th edition), Saunders, Philadelphia, 1997
- ⁶ K.H. Cooper, A Means of Assessing Maximal Oxygen Intake, *JAMA* 203: 135-138, 1968
- ⁷ G.A.V. Borg, Psychophysical bases of perceived exertion. *Med Sci Exerc* 14:377, 1982

Guidelines for medical training

Training standards for diving and hyperbaric medicine Prepared by the Joint Medical Subcommittee of ECHM and EDTC

1. Introduction:

These training standards are the result of some years of international discussion which began prior the 1st European Consensus Conference on Hyperbaric Medicine, Lille, in September 1994 where one session was devoted to "Personnel education and training policies". A comprehensive paper by J. Desola MD and the subsequent debate defined the 5 different personnel categories ideally involved in the staff of a Centre of Hyperbaric Medicine:

- the medical doctors,(including the Medical Director),
- the nurses,
- the attendants,
- the chamber operators, and the
- technicians.

The definition, functions, background, academic requirements, dedication, and the continuous education, of each category were agreed. (This full document is reproduced in the Appendix 1). A working group being formed to define the requirements for medical doctors in the fields of diving and hyperbaric medicine. An important feature of this project was the collaboration between the European Committee for Hyperbaric Medicine (ECHM), which is primarily a medical committee, and the European Diving Technology Committee (EDTC) which is a 15-nation committee with not only government, industry and trades union representatives but also with a doctor nominated from each member country. The Goal-setting Principles for Harmonised diving Standards in Europe was published by the EDTC in 1997 and includes a section on the "Qualifications, education and training of medical doctors" (appendix 2).

The work presented here has been done by the Joint Medical Subcommittee of these two main committees and, from time to time, reports by this Subcommittee have been submitted to and approved by each of the two parent bodies.

It is the purpose of this paper to summarise what has been accomplished and to look at the future tasks of a Joint Medical Subcommittee of the ECHM & EDTC.

2. Definition of jobs:

Before any consideration of a training programme, the training objectives of each job need to be defined in relation to the competencies that are expected from the incumbent. A number of the jobs in diving and hyperbaric medicine have tasks and objectives in common and so it is possible to optimise the efficiency of the educational program and avoid too much overlap by adopting a modular structure. Thus the first task was to prepare the job definitions which are compatible with EDTC and ECHM:

I. "Medical examiner of divers"

- Competent to perform the periodic "Fitness to dive assessments" of working and recreational divers and compressed air workers, except the initial assessment of novice professional divers.

IIa. "Diving medicine physician"

- Competent to perform the initial and all other assessments of working and recreational divers or compressed air workers.
- Can manage diving accidents and advise diving contractors and others on diving medicine and physiology* (with the back-up of a hyperbaric expert or consultant).
- Should have knowledge in relevant aspects of occupational health. (He or she does not need to be certified specialist in occupational medicine to be in accordance with the standards).

IIb. "Hyperbaric oxygen physician"

- Responsible for HBO sessions at the treatment site (with backup of a hyperbaric expert or consultant)
- Should have appropriate experience in anaesthesia and intensive care in order to manage the HBO patients (he or she does not need to be certified specialist in anaesthesia to be in accordance with the standards)
- Competent to assess and manage clinical patients for HBO treatment

III "Hyperbaric expert or consultant (hyperbaric and diving medicine)"

- Competent as chief of a hyperbaric facility (HBO centre) and/or to manage the medical and physiological aspects of complex diving activities* .
- Competent to manage research programs.
- Competent to supervise his team (HBO doctors and personnel, health professionals and others).
- Competent to teach relevant aspects of hyperbaric medicine and physiology to all members of staff.

IV. "Associated specialists"

This title is not a job qualification, but rather a function. It covers experts, consultants and specialists of other clinical specialities who can be nominated as competent to advise within their own speciality upon specific problems in the diving and hyperbaric field.

* optional additional qualification for bell diving (saturation, mostly off-shore)

3. Contents of Modules

Levels of competence:
a - basic
b - need to know
c - must be expert

Modules of formation and subjects

	Jobs:	I	IIa	IIb	III
1	Physiology & pathology of diving and hyperbaric exposure:				
1	Hyperbaric physics	b	c	c	c
2	Diving related physiology I (functional anatomy, respiration, hearing and equilibrium control, thermoregulation)	b	c	b	c
3	Hyperbaric pathophysiology (Immersioneffect, blackout mechanism incl apnea, psychology, working performance/endurance under water)	b	c	a	c
4	Hyperbaric pathophysiology (decompression theories, bubbles)	b	c	b	c
5	acute Dysbaric disorders, DCI (Barotrauma, DCS)	b	c	b	c
6	chronical Dysbaric disorders (Long term effects)	b	c	a	b/c
7	HBO-Basics (effects of hyperbaric oxygen)	-	b	c	c
8	O2 Intoxication	a	c	c	c
9	Inertgas-effects (Narcosis/HPNS)	a	c	a	c
10	medicaments under pressure	b	c	c	c
11	non-dysbaric diving pathologies (Hypothermia, near drowning, fauna&flora effects, injuries and accidents in water, the sick diver)	a	c	-	c
12	diving fatalities	a	a	-	b/c
2	Diving technology and safety:				
1	diving procedures (Bell diving)	b ¹	b ¹	-	a /c
2	Diving procedures (SCUBA, surface supplied, bell, TUP, SURD, O2-Deco, mixed gas diving)	b	c	a	a/ c
3	Divers (Recreational SCUBAdiving, technical and deep diving, Apnea-diving, professional diving: offshore, inshore, scientific, media, recreational divinginstructor, Caissonwork, astronauts)	b	b	a	a/c
4	Diving gear (SCUBA, SSUBA, mixed gas, rebreathers, monitoring equipment, working tools, suits)	b	b	a	a/c
5	Diving tables and computers (incl altitude and interval)	b	b	b	a/c
6	Regulations and standards for diving	b	b	-	a/c
7	Safety planning / management (monitoring)	b	b	-	a/c
3	Fitness to dive				
1	Fitness to dive criteria and contrindications (for divers, tunnel workers and HBOT patients and chamber personel)	c	c	c	c
2	Fitness to dive assessment (diagnostics)	c	c	c	c
3	Fitness to dive standards and regulations (prof and recreational d.)	c	c	b	c

¹ as required

4	Diving accidents:				
1	Diving accidents / incidents (assessment and preclinical treatment incl. ORL, barotraumas, CPR)	a	c	a	c
2	Diving accident management clinical (Diagnostics, patient care, followup)	-	c	c	c
3	Diving accident management: Differential diagnosis	a	c	c	c
4	HBO-T for diving accidents (Tables and strategies)	a	c	c	c
5	Rehabilitation of disabled divers	-	a	a	b/c
5	Clinical HBO:				
1	Chamber technique (multiplace, monoplace, transportchambers, wet recompression)	-	b	c	c
2	HBO: Mandatory Indications	-	a	c	c
3	HBO: Recommended Indications	-	-	c	c
4	HBO: experimental and anecdotal Indications	-	-	b	c
5	Data collection / statistics / evaluation	-	b	b	c
6	general basic treatment (nursing)	-	b	c	c
7	Diagnostic, monitoring and therapeutical devices in Chambers	-	c	c	c
8	Risk assessment, incidents monitoring and safety plan in HBO-Chambers	-	b	c	c
9	Safety regulations	-	c	c	c
6	Diverse:				
1	Research standards	-	a	a	c
2	Paramedics teaching program	-	b	a	c
3	Management /Organisation of HBO facility	-	a	a	c
7	Practical training:				
1	Fitness for chamber-dive test (of the course participants)	-	+	+	+
2	CPR	-	+	+	+
3	Practice in field first aid (diving accidents)	-	+	-	+
4	practical training FTD exam (skills)	+	+	+	+
5	Demo : professional diving	+	+	-	+
6	Demo : HBO-T	-	+	+	+
7	Introduction to (wet)-Diving	(+) ²	+ ⁴	-	+
8	Practice in HBO-T (including pressure test)	-	+	+	+
9	Practice in paramedics teaching	-	+ ³	-	+

² recommended

⁴ exceptions possible, if important reasons of unfitness to dive

³ as required

4. Standards for course organisation and certification

Teaching courses

In order to comply with this EDTC/ECHM standard the person responsible for the professional contents of the course must be a hyperbaric medical expert or consultant (job type III)

1. The course curriculum should be declared as being "in conformity with the ECHM/EDTC standards" and the educational objective (jobs I and IIa, IIb) stated.
2. The course organisers are invited to send a copy of the curriculum to the joint medical subcommittee of ECHM/EDTC (through the national co-ordinator).
3. The final tests for individual evaluation are mandatory, and should cover all the taught subjects (see list) at the level of competence required for each subject.

The standards do not prescribe the status of the teaching institution but it is strongly recommended that courses are university based, are approved for such training courses by national health authorities, speciality training boards or are under the auspices of the national scientific society for diving medicine and/or hyperbaric medicine.

How a course is to be organised is not prescribed in these standards. Evenings, week-ends or full weeks are possible. For clinical teaching, an internship or residency may be appropriate. The acknowledgement of a high teaching standard is based on a credible final test of the candidates.

Modules and course organisation

The actual organisation and conduct of the modules will be influenced by local factors and so it is proposed that these details can be decided on a national basis and probably left to the individual course directors. The following proposal indicates the total teaching hours considered necessary to achieve appropriate competencies in the following jobs.

I	Medical examiner of divers	25 lecture hours + 3 hours practical
IIa	Diving medicine physician	The above + 30 additional lectures + 10 hours practical
IIb	Hyperbaric medicine physician	60 hours + a practical phase (5 different types of clinical cases with different indications for treatment)
III	Diving and hyperbaric medicine expert or consultant	This needs further review (see below)

The proposal serves as a guideline and is not mandatory. When one of these teaching programmes includes topics covered elsewhere a reduction in the number of lecture hours may be justifiable.

Recognition of an expert

The experience needed to become an expert cannot be learned from a course. The essentials have already been described in general terms. The candidate should already be an accredited specialist or equivalent.

Except in those countries where some equivalent or higher standards already exist, those who wish to be acknowledged as experts or consultants in the fields of diving and hyperbaric medicine should send their curriculum to their national co-ordinator (representing the Joint Medical Subcommittee or to that subcommittee itself if that nation has no co-ordinator) who may decide on the basis of the agreed standards. The Joint Medical Subcommittee will be informed by the national co-ordinator and can issue a list of experts if required. In the future the verification of achieved qualifications will be done by a national health authority or a scientific body (EU legislation). The aim is to achieve a recognition of the standards by those so that they automatically could take over the role of the national co-ordinator.

5. Continuous Education (Quality Control and Competency)

In most countries, the conditions for maintaining the active status of an individual are defined by some system of continuous medical education credit points (CME, as introduced in the USA some time ago). The ECHM & EDTC need to define the minimum requirement for this in a flexible way that provides enough freedom for the national bodies to establish a more detailed system. It is expected that these national requirements will be compatible with our guidance.

Our proposals are the following:

Job I:

A minimal activity of 10 medical assessments of divers fitness per year is needed plus attendance at one refresher course (usually 2-days) in two years. Reactivation after a lapse needs participation in two 2-day refresher courses or a repeat of the full basic course.

Job IIa:

Continuing experience in the field of professional diving (e.g. advising a professional diving contractor or some equivalent activity) and participation in a course or congress previously approved by the national co-ordinator. Reactivation after a lapse should be on the basis of a specifically approved course. Where this cannot be achieved, the candidate should submit an alternative training programme to the national co-ordinator for approval.

Job IIb:

Active employment in an HBO facility (or equivalent activity) and attendance at one national and/or international congress on hyperbaric medicine per year. Reactivation after a lapse needs a 10 working days in a HBO facility and attendance at two congresses in two years.

Job III:

Will rely on the decision of the national co-ordinator

The refresher seminars can serve to update the participants in order to confirm their active status and to reactivate those who temporarily have not maintained their required activity. They can also serve as an introduction to doctors of other specialities who may also gain CME credits in their own specialities. This not only can help the financing of a course but can be a chance for promoting HBO to those who would not attend the HBO scientific congresses.

6. The Joint Medical Subcommittee of ECHM and EDTC

This committee will operate on the basis of the tasks outlined above.

The members are the two chairmen of the education and training subcommittee of the ECHM and of the medical subcommittee of the EDTC respectively. Further two to three members are nominated by the chairmen on the basis of their special competence and experience in one of the relevant topics. As the chairmen each represent a specific subcommittee, any major changes or decisions must be discussed within these subcommittees before going to the meetings of the EDTC or ECHM respectively.

Each country interested in educational courses recognised by EDTC/ECHM should be represented by a member who has been acknowledged by the national hyperbaric medicine authority (or of all such authorities if there are more than one such authority in a country). Normally this would be either the national member of ECHM or the national medical representative on the EDTC. If not the same individual, both could attend if appropriate.

The EDTC and ECHM representatives of each country should nominate a national co-ordinator of teaching programmes, who could be the joint subcommittee member himself or who could delegate for that purpose (for instance to the national health and safety authority or any representative scientific body covering all aspects of hyperbaric medicine). The national co-ordinator will have the duty to supervise the national programs, the certification procedures and the status of the course directors.

In order to enhance credibility of certification and to help those who do not yet have the experience necessary to establish a good validation system, the Joint Medical Subcommittee will create a pool of multiple choice questions with an evaluation grid, in the main European languages. This will be available for all members. Evaluation of the answers should be done by an international group nominated by the Joint Medical Subcommittee. This Subcommittee may also certify a national teaching syllabus or educational course if desired by its organisers, thus helping the national societies or other authorities in getting accepted by their governmental health and safety department or by their speciality boards.

For the Joint Medical Subcommittee of ECHM and EDTC :

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National references

(These references represent the actual state of investigation. Any further information or clarifications are welcome)

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