Fitness to Dive Standards

Medical assessment for work under pressure

Contents

Preface

Commercial divers, being highly specialised professionals, are often working in international waters or inshore in foreign countries. This similarly became routine in compressed air tunnelling work as well. Differing regulations make mutual recognition of certifications difficult. The European Diving Technology Committee (EDTC) 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". To fill this gap, the EDTC decided in 1999 to elaborate European fitness to dive standards for working divers. Additionally, these standards should also become a basis for the safety of the many working divers who are not controlled by national regulations. The new fitness to dive standards are, thanks to a cooperation with the BTS CAWG, designed to be used as well for tunnel and other workers in raised environmental pressure but not working in water. Modern tunnelling techniques now include mixed gas and saturation exposure.

The medical subcommittee of the EDTC concluded that the medical fitness standards should be based on the available medical evidence and modern clinical practice and that there was no need to amalgamate and synthesise the numerous existing national checklists that were originally navy born in general. Despite this, we recognise that national regulations may differ from our recommendations and that these must be respected in their respective jurisdictions.

The main goal we aimed to achieve, was to abandon the previous rigid manner of examination with pass-fail checklists and to give the medical assessors a competence to perform a differentiated risk evaluation according to a given task and type of diving or hyperbaric work. The physician evaluating the needed fitness must be able to include the technique of diving or hyperbaric work and the specific environmental conditions at the worksite into his judgement. Implicit in the assessment is a knowledge and understanding of the inherent requirements of the working environment the individual will be working in.

Following three conditions shall facilitate this approach:

1. Internationally acknowledged guidelines
2. Standardised training objectives for diving and hyperbaric medicine physicians
3. Desktop reference handbook for the medical assessor of hyperbaric workers

The training standards for diving and hyperbaric medicine have been realised by a joint consensus of the EDTC and the European Committee for Hyperbaric Medicine (ECHM) in 1999, revised and updated in 2011 and 2025. The first recommendations for the assessment of fitness to dive by the EDTC resulted from a workshop with large international participation, chaired by David Elliott 1994. Guidelines and a desktop reference for fitness to dive were published by the EDTC in March 2003. The Medical Subcommittee of EDTC and the international collaborators of the HYMEPRO workgroup revised and updated the standards in October 2022.

In late 2024 we could finally publish the revised manual, a desktop reference for medical examiners of divers and hyperbaric workers, with financial support by IMCA.

The HYMEPRO Workgroup: Our revision process took ten years and involved 115 specialists from all continents covering the relevant medical specialities, discussing and contributing in a virtual meeting room. Members of the HYMEPRO workgroup, which was initiated by the EDTC, are listed in Appendix D.

Chapter 4 contains recommended literature, links, and relevant contact addresses in the European and some overseas countries that will enable the physician to find out more about specific conditions and regulations.

Two appendices will help doctors to perform their assessments:

- Appendix A contains a list of documented submaximal ergometric tests enabling the examiner to calculate the exercise capacity in units of oxygen consumption like METs or VO_2max.
- Appendix B is a checklist for return-to-work assessments after DCI or diving emergencies (separate download)
- Appendix E presents forms for medical fitness examinations and for physical fitness tests (separate download)

These standards reflect the current state of the art and a general consensus whenever this was possible to achieve. In some instances, important minority views are mentioned. The rate of progress in the detection and management of medical conditions is such that this document will remain under continuing review.

The manual (paperback of 350 pages)[1] contains a reference section, which is a guideline for medical assessors, describing in detail the risks, diagnostic categories, diagnostic steps and possible concerns for hyperbaric exposures, covering a great number of health disorders, each on a single page. The book is also available as e-book, downloadable via EDTC or directly from the DAN Europe website www.daneurope.org. As our guidance for medical examinations is a result of continued experience and ongoing published evidence, readers are invited to give us feedback and are advised to check the website www.edtc.org for possible updates of the e-book.

Many thanks to the co-editors of the manual, Jack Meintjes, Jean-Louis Méliet, and Roland Vanden Eede, as well as the numerous experts of the HYMEPRO group for their valuable contributions and dedication.

Jürg Wendling, Chairman of the
Medical Subcommittee of the European Diving Technology Committee

April 2024

[1] Wendling J, vanden Eede R, Elliott DH, Meintjes J, Méliet J-L, Nome T (editors). Medical assessment for work under pressure – EDTC Fitness to dive standards, 2nd ed. 350p. International Marine Contractors Association, London, UK (2024). ISBN-13: 987-3-9522284-3-2. Available from: https://www.imca-int.com/resources/logbooks/diving/edtc-medical-assessment-of-working-divers-2024-edition/

The principles of assessment

Legal aspects

Regulations vs Standards

Safety at work is depends significantly on the medical, mental and physical fitness of participating hyperbaric workers – be they commercial divers or compressed air workers. Lack of medical fitness represents a hazard not just for the individual hyperbaric worker, but also for the other members of the crew.

The importance of safety in hyperbaric operations is reflected in the regulations laid down by European (and other) governments and which are generally quite similar. Health and safety aspects are however two different entities, which are not always separately covered by the national regulations in an identical manner (see “periodical in depth assessments”). Regulations providing national fitness standards are largely similar. They differ however quite considerably in the way they prescribe the medical assessment procedure. The assessments range from checking a candidate’s health status against a list of contraindications pre-defined by the regulators to a discretional assessment by a specially trained and competent occupational medical physician.

The purpose of this document is to offer harmonised standards for all hyperbaric workers, be they working divers or compressed air workers, that can be adopted throughout Europe and as far as agreed by others internationally. Harmonisation however does not mean to define the lowest common denominator of existing legislation. The aim of our standard is to provide recommendations for good practice to doctors knowledgeable and competent in health and safety aspects of hyperbaric work. Consequently, our recommendations are exclusively based on scientific evidence and expert experience, which means that they may not always be in line with the legally prescribed procedures of a particular country. Legislation however has priority over scientific standards. Our standards are in accordance with the "Technical and ethical guidelines for workers' health surveillance", published in 1998 by the International Labour Organisation[1].

Maintaining appropriate standards of medical fitness imposes responsibilities on various parties. The employer has a responsibility for the safety of all employees as well as for the completion of the work contract. The hyperbaric worker has a responsibility to give a complete and accurate medical history to the doctor undertaking his/her 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. For diving or compressed air work with special risks (remoteness, saturation, etc.) the employer can further prescribe supplementary medical examinations beyond the standards described here (e.g. exercise tests, drug screening). Additional tests or medical surveillance may also be required as a result of specific exposures to occupational health and safety hazards in the workplace (noise, vibration, radiation, chemicals, etc.). The medical surveillance of these is also prescribed by specific legislation in most countries.

For those diving in the oil and gas or offshore energy sector, a supplementary certificate is mandatory according to a standard of IOGP, OEUK (formerly OGUK), NOGEPA, Norske H&S directory. These are based on the "Guidelines on the medical examinations of seafarers of the International Maritime Organisation.[2] The certificate must be issued by an accredited oil&gas physician (list of accredited doctors see https://oeuk.org.uk/doctors/find-a-registered-doctor/overseas-doctors/).

[1] ILO 98, (PDF Download): https://www.ilo.org/global/publications/ilo-bookstore/order-online/books/WCMS_PUBL_9221108287_EN/lang--en/index.htm

[2] See: https://www.ilo.org/sector/Resources/codes-of-practice-and-guidelines/WCMS_174794/lang--en/index.htm

Certificate of fitness with or without restrictions

The duty of the medical assessor is to confirm to the employer and, if implemented in the regulations, to the health authorities that the hyperbaric worker is medically fit for a job in a hyperbaric workstation. That means he or she is certifying that in defined conditions (which could be nominal conditions of the workplace, or specific restricted conditions if necessary) the professional activity will not present risks for health and safety of the worker, his co-workers, and persons in the immediate environment higher than those identified and having been already prevented by the employer.

There is a particular need to be diligent in the medical assessment of saturation divers and those working very remotely. It is essential to ensure accurate details of previous and current medical history and there may be a need for more detailed investigations such as blood and other tests.

As medical practitioners we know that "perfect health" doesn't exist, and that the medical preventive examination cannot be more than an assessment to keep the medical risk as low as reasonably practicable and acceptable. Any **restriction** written on a certificate may therefore alert the employer who would ultimately prefer not to employ such a diver or hyperbaric worker. Restrictions, as mentioned on the certificate, should therefore be edited in this view. They should help the employer to facilitate the return-to-work of the employee. Unproblematic restrictions are those referring to diving techniques or degrees of increasing complexity (like offshore diving, hard hat, saturation, scuba in the recreational envelope, etc.). Other restrictions might be related to environmental conditions (still water only, not remote, or even defining the diving location (see the dropdown list in the sample certificate, which is downloadable from www.edtc.org. This listing contains accepted wordings for restrictions). These restrictions should also be notified in the divers or compressed air worker's logbook.

Temporary unfitness to work under pressure needs also to be notified to the employer in the case the worker can be used temporarily for non-hyperbaric work.

Restrictions may be of two kinds:

1. Restrictions on the employer, to be notified on the certificate, containing instructions to the employer, and also notified in the logbook (this category is mentioned in the above paragraph).
2. Restrictions on or instructions for the individual hyperbaric worker. These restrictions or instructions pertain to the individual specifically and pertain to aspects for which the employer would not be responsible (e.g. must lose weight; ensure extra-medication is available during deployment; etc.). These should be clearly noted in the medical file, not on the certificate.

The assessor must consider conditions that may endanger students or clients of a recreational diving professional. There is also a difference in criteria for selection of recreational professionals and scientific and media divers compared to the clearly defined criteria for commercial and military divers, thus acceptance criteria might be lower for these groups (see also chapter 5).

Someone found to be unfit to dive or work under pressure (or fit to dive only with certain limitations) should be informed in general terms about the reason for this conclusion.

The **certificate** must not contain any confidential medical details, but it should clearly state which category of hyperbaric work it covers and whether the fitness to work is unrestricted or, otherwise, shall provide a precise definition of any restriction (see sample form below). The certificate should also state the type of assessment performed (in-depth or routine annual), the date of the next assessment and the examining doctor's address and contact details (for verification of the certificate and possible contact in case of an incident).

Competence of medical assessors

Regulations define which medical doctors may become officially recognised (accredited/ appointed/ designated) to issue fitness to work certificates for working divers or compressed air workers respectively. It is important to note that there are often separate regulations governing divers and compressed air workers, particularly when they are under the auspices of different authorities. The variation in recognition arrangements results from concomitant variation in training and competence to make an appropriate medical assessment. In some countries it is therefore routine practice for the accredited and contracted occupational medical physician to endorse a fitness to work certificate issued by an assessor who is a diving and/or hyperbaric medicine specialist, to ensure legality.

Recognising this situation, the EDTC has previously adopted a standard describing appropriate training objectives for diving and hyperbaric medicine physicians in Europe, which it now wishes to extend to compressed air physicians also. These EDTC and ECHM standards should lead to equivalent training of all hyperbaric assessors throughout Europe and internationally as far as these standards are accepted at the appropriate level (see appendix D of this manual). Accordingly, an accredited medical doctor can refer the candidate to a hyperbaric medicine specialist of a defined competence level for an in-depth examination.

The employees right and duty

The medical examiner must respect the confidentiality of the medical information of the candidate obtained during the evaluation. Therefore, the result of the assessment must be recorded on a certificate that does not contain any medical details, but it must clearly state the category of hyperbaric work it covers and whether the fitness to work is unrestricted or otherwise provide precisely defined restrictions placed on the employer (e.g. "may only dive with a full-face mask or helmet") or conditions that may be met (e.g. "may only dive as part of handicapped divers programme").

A copy of the medical examination record, which remains in the hands of the medical examiner, should be given to the worker who needs to retain it for scrutiny by his next medical examiner. Medical surveillance records (related to workplace hazards) are based on legal requirements, and some are required to be kept for long periods (up to 40 years in some cases).

Apart from the documented statement of fitness (medical certificate), it is the duty of any employee to inform the employer if there is a subsequent health condition may have altered his or her fitness since the date of the assessment and to seek medical advice while being temporarily unfit.

The assessment record, with details of any restrictions, should be co-signed by the examining doctor AND the candidate. Not only does this demonstrate informed consent but this may prove important at a later date, if the worker denies having a medical problem that may affect their safe ability to work.

The examiner must also be aware of the consequences of declaring someone "unfit for work under pressure". In many countries or circumstances this may precipitate financial compensation for the rest of the life by the employer or the health authorities (insurance). Conversely, if a doctor is too restrictive in the context of uncertainty (e.g. for fear being made responsible), this could be interpreted by the worker as a violation of the non-discrimination legislation (e.g. well controlled diabetes or after recovered from a medical problem without a relevant risk of further complications). Therefore, a hyperbaric worker should not lose his ability to work due to a hypothetical, theoretical or fanciful risk that is not confirmed by evidence or soundly based on first principles.

If someone is found to be unfit, or fit with a restriction, the person should be advised of his/her right to a review by the relevant supervising body (as arranged by the national Health and Safety authority or professional association). The worker may have to apply in writing to that office within a certain time period for a review of their case, normally by a hyperbaric medicine specialist and a specialist in the relevant medical field, sometimes followed by a panel review. These procedures may differ from country to country. Examiners should ensure they are aware of the procedures applicable to their practice, so they can advise the diver or hyperbaric worker appropriately.

General criteria of medical fitness for hyperbaric work/occupational diving

Although the hyperbaric hazards of working in a hyperbaric environment are principally the same for all divers, including sports divers, diving instructors, scientific divers, fishing divers, police divers, commercial inshore or offshore divers and all compressed air workers, the risks associated with that specific work may vary according to the different exposure procedures and work tasks (see chapter 5). These risks are reduced by appropriate training, skills and the equipment used. The following table gives an overview of the essential principles of medical fitness for performing hyperbaric work safely:

Principles of Medical Fitness to Work in Hyperbaric Conditions

- Consider medical conditions that may limit the ability to perform the job in the hyperbaric environment as a diver or compressed air worker
  (e.g. communicate, manage responsibility, maintain mental fitness and for a diver to swim or for a compressed air worker to undertake heavy physical exercise)
- Consider medical conditions that may jeopardize the safety of the worker or the team (e.g. loss of consciousness, orientation, panic attack)
- Consider medical conditions that might deteriorate as a result of hyperbaric exposure and, for divers, immersion (e.g. uncontrolled asthma)
- Consider medical conditions that may predispose the hyperbaric worker to a hyperbaric disorder or occupational illness (e.g. presence of PFO after a neurological DCI episode, dysfunction of Eustachian tube)

The assessor has a responsibility to exclude any person with a contraindication to hyperbaric work, based on his appropriate training in diving and hyperbaric medicine and using the acknowledged standards for medical fitness to work under pressure. His/her decision will depend to some extent on the exposure or diving technique and task of the hyperbaric worker.

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. This list should NOT be regarded as complete but may help as a guide in planning further specialist examinations and referrals. The recommendations need not be followed dogmatically, rather the fitness should be considered in the context of the particular working conditions of the individual (see more about risk assessment and work related risks in chapter 5), including considerations in terms of the specific tasks the person will be involved in, the environmental conditions, remoteness of the operation and any potential hazards (apart from pressure) to which the person may be exposed [cf. ILO Guidelines 1998, §3.11] [3].

To consider these aspects, the examining doctor needs an appropriate basic knowledge of occupational medicine and of the relevant working environment. In some countries a common decision by an occupational medical doctor and a hyperbaric medical assessor as a consultant represents a possible solution to address possible shortcomings.

The guidelines represent the current scientific state of the art and the opinion of the medical subcommittee of the EDTC and of a larger international expert group (see list in the annexe). Further development and refinement is to be expected.

[3] ILO 98, (PDF Download): https://www.ilo.org/global/publications/ilo-bookstore/order-online/books/WCMS_PUBL_9221108287_EN/lang--en/index.htm

The assessment procedure

In several aspects, the assessment of a hyperbaric worker, like that of any occupational assessment, differs from a routine clinical consultation that is characterised by a patient seeking help from a medical doctor. The medical assessment of hyperbaric workers and divers is required in terms of national regulations concerning hyperbaric work, and the worker is initially not likely to know his medical examiner. The assessor should ensure that the worker is made aware of the dual loyalties of the assessor towards the worker being assessed (responsibility and loyalty of the doctor towards the employee) and the employer or potential employers (responsibility and loyalty of the doctor towards the employer). Although the hyperbaric worker may sometimes be free to choose his medical assessor, it is recommended that the same assessor continues to perform the follow-up assessments for as long as possible.

The EDTC Medical Sub-committee strongly recommends that the questionnaire on the **medical history** is completed by the assessing doctor and the examinee together, to ensure that the candidate understood and answered the questions correctly. Getting the list of past and actual medical diagnoses and treatments from the family doctor is recommended where feasible. The record should be signed by the worker, with the doctor as witness, to confirm the correctness of the entries. This also gives the assessing doctor a chance to study the behaviour, mental state, and ability of the candidate to communicate.

If there are symptoms or a diagnosis in the history-taking session which are clearly incompatible with safe working in a diving or hyperbaric environment, this should be documented, and the physical examination may be omitted.

Apart from that, all the **examinations** included in the checklist must be performed if the final certificate is stating that "*the assessment has been performed in conformity with the EDTC standards for the medical assessment of hyperbaric workers*". Besides the known warning signs (yellow flags), age and constitutional risks (obesity, smoking, low physical fitness) will justify further tests like lipid profiles, cardiovascular indicators or low-dose-HRCT of the lungs, which will help to decide about potential further specialist investigations (Indications for HRCT of the lungs are specified in the chapter “general guidelines”/airway assessment). Routine chest X-rays are no longer indicated, but low-dose CT and MRI are the modern investigations requested on indication. Any examination or test that cannot be adequately performed by the assessing medical 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 specialists’ consultations** should contain specific questions that need to be clearly delineated by the medical assessor using the appropriate chapters of this manual. The specialist will perform the appropriate supplementary examinations and return his answers but should refrain from expressing an opinion on fitness for hyperbaric work. This final decision concerning the medical fitness rests with the medical examiner of divers or compressed air workers respectively, who is legally designated for this task. A template referral letter is provided in the appendix C, underlining the specific request to the specialist to not express an opinion on medical fitness to dive or work in hyperbaric environments to the referred worker to avoid miscommunication and confusion.

Hyperbaric medicine experts may be contacted for advice in difficult cases (usually other hyperbaric or diving medicine physicians or designated hyperbaric medical advisors appointed by the according authority).

Frequency of assessments

The EDTC standards distinguish 3 types of assessments: in depth assessments (initial and periodicals), routine (annual) re-assessments and special re-assessments after injury or decompression illness. Other reassessments are due when workers change the kind of work they perform or their work exposure changes, necessitating a change in medical surveillance. Not yet implemented systematically but recommended by ILO[4] are postemployment health assessments (bones and other LTHE, end-of-career-exam).

Initial in-depth medical examination

The first medical examination of a potential diver or hyperbaric worker is particularly important for determining future safety when working in the hyperbaric environment. 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 career duration that is reasonable and worthwhile. 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 straightforward. In contrast, medical disqualification during or after training implies significant financial penalties for the individual.

The situation in tunnelling is different, since potential compressed air workers are usually proposed by their employer, and they can still revert to their former usual occupation if unsuccessful. Most compressed air tunnellers also only ever work on one or two compressed air projects in their entire tunnelling careers but will usually have a relatively rudimentary introduction to the possible risks and physiological complications associated with their hyperbaric work.

Annual assessments

Major annual routine medical examinations are no longer recommended by the EDTC. Instead, it is intended that an in-depth medical examination is carried out at intervals of several years only and that the annual medical evaluation takes the form of a monitoring of a functional auto-assessment of the diver at work. These annual assessments are clinical reviews based on personal interviews with a medical assessor of divers supplemented by further investigations if indicated (see the template-form "Routine annual medical assessment").

In exceptional cases, in countries with limited access to a medical examiner of divers in remote locales, an equivalent procedure can be organised, combining a physical visit to a local occupational medicine doctor and a telephonic consultation with the diving medicine specialist. There is no strong evidence that an annual medical check by a diving medical physician is more efficient preventing health or safety concerns of divers than a combination of self-assessment on a form that is then analysed and approved by a competent physician[5].

It is noted that reduced examinations as described here cannot be accommodated within the context of the legislative requirements of a number of countries. National regulatory prescriptions shall always overrule these guidelines, which are based on scientific consensus and evidence.

The periodical in-depth assessment

Besides this annual assessment, a periodical in-depth assessment (including a complete examination) is needed at variable intervals. The recommended interval for young healthy divers working under normal conditions is 5-yearly. This interval should be reduced with increasing age, usually above 45 or 40 years, or earlier according to the examiner's judgement after a re-assessment.

In addition to the proposals in this section, health surveillance actions may require evaluation at intervals that are often prescribed in legislation and the details of such examinations are often also legally prescribed. These are to be specifically linked to the exposures of the person during the previous working term. While prescribed examinations are mainly focussed on safety at work, there are various ways health aspects are dealt with. Monitoring and prevention of long-term health effects are not always covered by national legislations.

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[4] ILO 98, (PDF Download): https://www.ilo.org/global/publications/ilo-bookstore/order-online/books/WCMS_PUBL_9221108287_EN/lang--en/index.htm

[5] Sames C, Gorman D, Mitchell S. Postal survey of fitness-to-dive opinions of diving doctors and general practitioners. *Diving Hyperb Med.* 2012;42(1):24-29.)

During diving operations, the contracted diving medical advisor (DMA) should also give more attention to fitness to dive between the "medicals". For problems arising during work the DMA has to develop a systematic process to decisions and approaches when confronted to unfamiliar situations. Specific pre- and post-exposure checks are established for saturation operations.

Re-assessment after illness, injury, or decompression illness

The purpose of assessment of fitness to return to diving after illness, surgery or injury is primarily to determine whether there are any factors that may affect subsequent safety at work under pressure. Reporting of an illness, injury or a hyperbaric disease is the diver's own responsibility. Generally, the hyperbaric medicine physician (or occupational medical doctor) of the company is to be informed, in some countries also the health authorities.

These assessments follow conventional principles, 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 emergency. The medical doctor must know the tasks which the hyperbaric worker is expected to perform and the hazards they may encounter upon their return to work. If there is any doubt, the examiner should seek information and advice from someone else, e.g. 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 pressure limit, which is rarely meaningful. **Any restrictions should be notes for the employer to facilitate return-to-work**. This kind of assessment, after DCI or pulmonary barotrauma, should be performed by a hyperbaric or diving medicine physician (advanced training level according to the EDTC/ECHM training standards, see appendix D).

A guidance to do such a resume diving or hyperbaric working assessment for those who experienced a decompression injury or barotrauma is in the appendix B.

The EDTC examination forms (p.18-24 are screenshots. Find the originals in appendix F)

The checklists and forms shown in this manual should provide assistance to the examining physician. They represent a consensus proposal by the national representatives of the Medical Sub-committee of the EDTC and internationally as far as these standards are accepted and may be incorporated into the existing routine procedures of each country.

National certifications for fitness to dive may state that the assessment was performed in accordance with the standards of the EDTC (see sample below).

The **examining protocol (medical record)** is a checklist relating to any signs and symptoms as well as containing the medical 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 kept in mind when completing the certificate. The record of any fitness to work assessment must be filed and traceable within the examiner’s office for at least ten years.

It is recommended to provide the examined diver/CAW with a digital copy of the medical record, including test results, for those who are likely going to work in other countries or change their employer.

All **examination forms can be downloaded from www.edtc.org**

Medical **certificates for working offshore**: For those diving in the oil and gas or offshore energy sector, a supplementary certificate is mandatory according to a standards of IOGP, OEUK (formerly OGUK), NOGEPA and Norske H&S directory. Most items of the examination protocol are covered by this EDTC standard, apart from the measurement of the "shoulder-to-shoulder distance" (relevant for escaping ditched helicopter's windows, see HUET standard), which can only get attested by an accredited oil & gas doctor (to get accreditation needs a 2 days training and an annual fee). Find accredited doctors at https://oeuk.org.uk/doctors/find-a-registered-doctor/overseas-doctors/

STANDARD RECORD FORMS
MEDICAL ASSESSMENT FOR WORK UNDER PRESSURE

Family name / First name:	
Date of birth (Passport No & country):	
Street address:	
Postal code / City / Country:	
Telephone / e-mail:	
Occupation / type of diving:	
Company / Training agency:	

IN DEPTH ASSESSMENT: HISTORY (initial and periodical)

The history should be taken by the examining doctor together with the diver to make sure that the candidate has understood the questions properly and to give the examining doctor a chance to study the behavior and mental state of the candidate during the consultation. An adapted diver's 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. For offshore workers see O&G UK questionnaire]
2. Physical performance: sports activities, frequency of training, previous sports or occupational medical assessments. Any incapacity for work in the past 3 years (more than 3 weeks), any incapacity for military service
3. Lifestyle: smoking, alcohol, lifestyle drugs, detox-treatment
4. Weight, height, any changes during last year; pregnancy?
5. Prescribed medications, medical treatments since last assessment (physician?)
6. Mental illness: psychiatric or psychological problems, anxiety, depression, panic disorders, claustrophobia; any treatments
7. Respiratory problems (dyspnea, coughing, expectorations, pneumothorax, asthma, COPD, ENT or chest surgery, O_2)
8. Previous or current cardiovascular problems (blood pressure, heart-rhythm disturbances, coronary heart disease)
9. Seek available data for 10y-risk estimation (cholesterol total, HDL, syst blood pressure), use web-calculators like www.heartscore.org, https://static.heart.org/riskcalc/app/index.html#!/baseline-risk, www.cvdcheck.org.au .
10. Epileptic fits (seizure, absences, hyperventilation fits)
11. Loss of consciousness, dizziness, cranio-cerebral injury
12. Stroke, TIA, disease of brain and nervous system
13. Motion sickness
14. Migraine, headaches
15. Dental problems, prostheses
16. Sinus problems
17. Ear problems, external or middle-ear otitis, tympanic rupture, hearing difficulties (even unilateral), audiograms?
18. Diabetes mellitus, other metabolic or endocrinological diseases
19. Gastrointestinal problems (gastritis, bowel irregularities, blood in stools, hemorrhoids, jaundice, hepatitis, gallbladder disease, hernia)
20. Kidney diseases, Cystitis, blood in urine
21. Skin disease
22. Allergy, hay fever
23. Blood or immune system disorders (incl. sickle cell disease)
24. Musculo-skeletal problems (back or joint pain, rheumatism, arthritis, injuries, tendinopathies)
25. Vision
26. All hospitalisations, operations, accidents
27. Diverse: tuberculosis? Other infections? Cancer?
28. Family history

Results: (make notes of results from history taking on page 3):

STANDARD RECORD FORMS
MEDICAL ASSESSMENT FOR WORK UNDER PRESSURE

IN DEPTH ASSESSMENT (CONTINUED): EXAMINATION

These examinations represent a minimum. If in doubt or when history or signs might represent a contraindication, further evaluation is necessary (see reference section of the EDTC manual "medical assessment for work under pressure" ISBN 978-3-9522284-3-2).

1. Height, weight, body mass index (BMI), to assess cardiovascular risk, if indicated, also fat% (waist circumference, impedance-tests, or others)
2. Otoscopy with Valsalva-test (or Toynbee, check 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 section)
6. If age 45 and more years: additional blood tests may be done to evaluate the 10-y risk of cardiovascular event (e.g. https://www.heartscore.org/en_GB/access-heartscore-quick-calculator). Stress ECG and eventually other cardiological investigations by cardiologist
7. Lung function including FEV_1, FVC, flow-volume-curve (or peak-flow if curve not available). If not within lower limits of normal (LLN, the new GLI standard), see contraindications in reference section.
8. Submaximal stress-test for aerobic capacity (give reference, examples see annex A). If VO_2 max. extrapolation from tables is below expected maximal workload, see contraindications pages
9. Laboratory: complete blood picture count, hematocrit, 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 judgment (see introductory remarks and contraindications section)
12. Additional examinations:
    - resting ECG only at initial assessment to detect eventual risk indicators for sudden death, also for young workers
    - if assessment of lung structure is thought to be indicated perform (low dose) high-resolution CT-scan of lung (to exclude emphysema/bullae)
    - screening for long term effects (bone necrosis): specially for divers who average 20 hours of diving per week and diving over 30m, but also in presence of pain-only-bends immediately or 3m after pain-bends not resolving under recompression treatment: MR imaging (or x-ray of hips and shoulders AP), blood-test for lipids.
    - any consultation of specialists or diving medicine experts: see referral templates for some cases.
    - audiogram if required for hearing conservation program.

Conclusions and comments (informed consent), remarks for divers:

Date/City: ....

Signature of medical examiner of divers: ....

Signature of candidate (optional): ....

STANDARD RECORD FORMS
MEDICAL ASSESSMENT FOR WORK UNDER PRESSURE

Checklist and results from history taken by medical examiner of fitness for hyperbaric work

1. Diving history	
1.1. Motivation	
1.2. Diving since...	
1.3. Experience recreational diving (no of dives)	
1.4. Competence level recreational (certificate)	
1.5. Specialty competence (Nx, Tek, cave, rebr)	
1.6. Experience from prof diving (no of hours)	
1.7. Competence prof diving (certification, year)	
1.8. Diving/hyperbaric jobs (incl. military)	
1.9. Problems/incidents/accidents from diving or hyperbaric work (DCI, Barotrauma, lungs …)	
2. Lifestyle features	
2.1. Sports activity (type and intensity/frequency)	
2.2. VO_2 max estimation from questionnaire [1]	
2.3. Weight changes, pregnancy	
2.4. Smoking (never, ex since.., pack/years)	
2.5. Lifestyle drugs (brain doping, psychotropics, dependence, treatments)	
2.6. Alcohol (what, doses and frequency)	
2.7. Prescribed medications	
Incapacity for work >3w/last 3y (incl. incapacity for military if obligatory)	
3. Medical history:	
3.1. Surgical operations	
3.2. Hospital stays	
3.3. Medical treatments and results (resolved, persistent, recurrence)	
3.4. Accidents	
3.5. Permanent medical conditions (diagnosis)	
3.6. Disabilities, handicaps	

Signature of candidate: .... Signature of examining doctor: ....

The diver or hyperbaric worker confirms with his signature being aware of the fact that denying any element of the history may have severe consequences for himself, members of the team and the employer's company. This means you will be responsible for any damage resulting from such denial.

[1] questionnaire of annexe A may serve for rough estimation if no stresstest is performed

STANDARD RECORD FORMS
MEDICAL ASSESSMENT FOR WORK UNDER PRESSURE

Checklist and results from history taken by medical examiner of fitness for hyperbaric work

1. Biometric		2. General	
1.1 Age	y	2.1 Skin & Conjuctivae	
1.2 Height	cm	2.2 Peripheral circulation	
1.3 Weight	kg	2.3 Abdomen	
1.4 BMI		2.4 Urine	
1.5 % fat [2]	%	2.5 Blood Hb / Hk	mg/ml %
1.6 Psychol peculiarity		2.6 Diff, crea, gluc [3]	

3. Audio and vestibular	L	R	4. Eyes	L	R
3.1 Weber/Rinne			4.1 Visus (corr)		
3.2 Otoscopy			4.2 Perimeter [1]		
3.3 Hearing test			4.3 Color vision		
3.4 Nystagm			4.4 3D vision [1]		
3.5 Motion nystagm			4.5 Pupil reflex/isocore		
3.6 Sharpened Romberg	sec		4.6 Eye movements		

5. Airways		6. Cardiovascular	
5.1 Nose		6.1 Heart auscultation	
5.2 Sinuses		6.2 ECG rest / stress [1]	
5.3 Teeth		6.3 Heart-risk SCORE [4]	
5.4 Pharynx		6.4 VO_{2max}/MET(estimation)	
5.5 Lung (clinical/imaging)[5]		6.5 Blood pressure (rest)	syst/diast
5.6 Spirometry flow-volume curve		6.6 Heart rate (rest)	bpm

7. Musculo-skeletal		Comments to above items:
7.1 Vertebral column		
7.2 Motor functions		
7.3 Reflexes / sensory		
7.4 Gait		
7.5 Coordination [1] (finger-nose)		
7.6 Manual dexterity (fine grip)		

✓ = normal N = not checked A = see annex document * abnormal, comment in text field

1) these examinations are optional (mandatory in some countries), EDTC indications see description above
2) waist circumferences, impendence measuring devices and shoulder width may serve as estimation of body composition. Eventually relevant for special work situations and cardiovascular risk interpretation
3) lipid profile if cardiovascular risk estimation is indicated (see above)
4) ESC Heart-risk calculator for 10y risk https://www.heartscore.org/en_GB
5) (low dose) HRCT of lungs on indication only, see General Guidelines/Airway assessment

STANDARD RECORD FORMS
MEDICAL ASSESSMENT FOR WORK UNDER PRESSURE

Family name / First name:	
Date of birth (Passport No & country):	
Street address:	
Postal code / City / Country:	
Telephone / e-mail:	
Occupation / type of diving:	
Company / Training agency:	

ANNUAL MEDICAL ASSESSMENT

History (interview, recommended to be performed 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, nicotine, alcohol)
5. Medications (prescribed)
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)
   - work tasks (jobs, tools, environmental stress)
8. Diving incidents/accidents
9. Any symptoms or problems while diving: transient alterations of sensation (numbness, paresthesia), muscle-of joint-pain, headache, skin symptoms (rushes, itching, subcutaneous emphysema), pressure equilibration problems, dizziness, vertigo, depth-euphoria, exhaustion, panic reaction, other (sinus, teeth, abdominal)

Status: (more exams if indicated after interview or wished by 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 conspicuous findings are observed.

Additional examinations: ....

Specialists consulted: ....

Judgment / Comments (informed consent): ....

____

____

____

Date/City: ....

Signature of medical examiner of divers: ....

Signature of candidate (optional): ....

[add: stamp & email & GLN number]

MEDICAL CERTIFICATE: **FITNESS FOR OCCUPATIONAL DIVING / COMPRESSED AIR WORK**
ÄRZTLICHES ZEUGNIS: **TAUGLICHKEIT FÜR ARBEITEN IM ÜBERDRUCK / TAUCHARBEITEN**
CERTIFICAT MÉDICAL: **APTITUDE A LA PLONGÉE PROFESSIONNELLE OU AU TRAVAIL EN MILIEU HYPERBARE**
CERTIFICATO MEDICO: **IDONEITÀ MEDICA ALL'ATTIVITA' SUBACQUEA PROFESSIONALE**

NAME:

ADDRESS:

E-MAIL:

PASSPORT NUMBER / ID:

The above mentioned person was examined on the indicated date. This medical examination complies with the National Diving Regulations, the EDTC* standards for medical assessment of working divers 2022 and the international standards specified by the Diving Medical Advisory Committee, as contained in IMCA D20/01. Attested fitness means that no relevant contraindications to perform the indicated underwater or compressed air work job were found.

While the fitness to dive certificate attests apropriate medical fitness, certain jobs, in particular offshore and saturation diving need a high physical performance to be "fit for the job". Therefore the examining doctor should add biometric data (body mass index, fat %) and a value of cardio-pulmonary- and muscle-function (as metabolic equivalent of task MET) if requested by the employer.

BMI Fat % Vo2 max MET

(For jobs not requiring these data these informations are optional, can be omitted)

ASSESSED FOR HYPERBARIC EXPOSURE FOR THE FOLLOWING PURPOSE & LEVEL:

PURPOSE:

Purpose of hyperbaric exposure
- A Diving commercial (offshore, inshore, inland, civil engineering)
- B Diving others (SAR, scientific, multi-media, dive leaders, military)
- C Compressed air work (CAW) others (staff of HBOT-chambers, SAR, scientific, technical)
- D Compressed air work (CAW) commercial (tunnelling, caisson work)
- E Surface personnel at diving worksite

LEVEL:

Level of hyperbaric exposure
- 0 no deco stages, normally < 12m
- I air, nitrox, O2 deco (normally < 50m)
- II mixed gas bounce (normally < 80m)
- III closed bell and sat (normally > 50m)
- Non diving personnel

CONDITIONS: [if more than 2 conditions are to be observed, they might be added under comments]

Restrictions groups
A) Senses
B) Decompression/pression/immersion
C) Medical conditions
D) Equipment & personnel
E) Geographical

COMMENTS / SUGGESTIONS:

TYPE OF ASSESSMENT: IN-DEPTH/ ANNUAL ROUTINE - DATE OF NEXT ASSESSMENT:

PHYSICIAN (SIGNATURE & STAMP):
[medical examiners of divers registered by the IDMEB are listed online at www.divemedreg.org]

REG NUMBER

E-MAIL:

PLACE & DATE OF EXAMINATION:

* EDTC: European Diving Technology Committee www.edtc.org. The standards for medical assessment of working divers 2022 are part of the guidelines of EDTC, endorsed as well by the DMAC (Diving Medical Advisory Committee www.dmac-diving.org), compatible with MA1 of UK and G31 of Germany.

Disclaimer: The information on this certificate was logged by the medical practitioner performing the examination, who has full responsibility for the contents thereof. The diver may request a copy of the full medical report including examination data when needed for further medical checks elsewhere. This certification does not include the occupational health evaluations required for exposure monitoring or screening for occupational diseases. Additional certification in this regard must be provided separately.

OEUK and IOGP International Association of Oil & Gas Producers Guidelines:

Medical Aspects of Fitness for Offshore Work: Guidelines for Examining Physicians (2008)

Medical Screening Questionnaire and Examination Record

Surname:	**Forenames:**
Address:	**Tel No:**
Date of Birth:	
GP's Name:	
GP's Address:	
Date of Last Offshore Medical:	**Offshore Occupation/Job Title:**
Emergency Response Role:	

Social/Occupational History	Yes	No	Comments
1. Do you smoke? If so, how many per day?			
2. If an ex-smoker, when did you give up?			
3. Average weekly alcohol consumption: state quantity and type.			
4. Have you ever been exposed to any known occupational hazard such as noise, radiation, dusts, asbestos, chemicals or lead?			
5. Do you use protective clothing, safety glasses or hearing protection?			
6. Have you ever developed any medical condition in connection with your occupation? If so, please give details eg hearing loss/skin condition/wheeze/ backache/muscle strain/blood disease?			
7. Have you ever suffered any industrial injury? If so, please give details.			
8. Have you ever had any previous audiometric screening? Was this normal? State when and where.			
9. Have you ever had previous lung function screening? Was this normal? State when and where.			
10. Have you ever been rejected from employment on medical grounds?			
11. Have you ever received compensation or is there any industrial claim pending?			
12. Have you ever been medivaced from an offshore installation?			
Examining Physician's comments:			

Do you have or have you been diagnosed as suffering from any of the following? *(Please circle and elaborate)*

1. Chest pain/heart pain	Yes	No	
2. High blood pressure/stroke	Yes	No	
3. Asthma/epilepsy/diabetes	Yes	No	
4. Peptic ulcer disease	Yes	No	
5. Kidney disease (eg stones)	Yes	No	
6. Psychiatric disorder (eg anxiety, depression)	Yes	No	
7. Tuberculosis	Yes	No	
8. Cancer	Yes	No	

Do any of your immediate family (parents/brothers/sisters) have a history of any of the above conditions? Please specify:

Do you currently have any of the following?

1. Backache/joint or muscular pain	Yes	No
2. Hernia/rupture	Yes	No
3. Visual impairment	Yes	No
4. Perforated eardrum/discharge from ear	Yes	No
5. Recurrent indigestion	Yes	No
6. Jaundice/hepatitis/gall bladder disease	Yes	No
7. Change in bowel habit/diarrhoea	Yes	No
8. Blood in stools/piles/haemorrhoids	Yes	No
9. Shortness of breath/coughing up blood	Yes	No
10. Recurrent bronchitis/pneumonia	Yes	No
11. Blood in urine/kidney complications/stones	Yes	No
12. Headaches/migraine/dizziness	Yes	No

Physician's comments:

I certify that the above information is correct:

Signed:.. [Employee]

The Examination should include:

Clinical status
BMI (height / weight)
Blood pressure
Spirometry
Audiometry
Near distance vision
Colour vision
Urinary analysis (stick)

For the "Helicopter Underwater Escape Training" HUET a fit-to-train certificate is needed, which must include the "**Bi-Deltoid Shoulder Measurement**". This must be performed by a registered and specially trained physician.
Application for getting registered at: https://oeuk.powerappsportals.com/createoverseasapplication/

General guidelines

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. But divers with hearing loss should be aware of the additional risk of hearing loss due to diving illnesses affecting the inner ear (although rare) and its possible impact on their quality of life.

Audiometry is not systematically required. An audiogram should however be performed after an episode of aural barotrauma. In addition, audiograms are legally required according to a hearing conservation programme, where hazardous noise levels have been identified[1] .

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 certification may be provided 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 (tympanoplasties with homologous or heterologous material need specialist advice). 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 temporary disqualification.
- Atticotomy and canal wall down mastoidectomy without obliteration or canal wall reconstruction (open technique) are disqualifying but a simple mastoidectomy or canal wall up mastoidectomy do not. Such cases need specialist advice.
- Chronic otitis media contraindicates diving until definitively managed.
- Stapes surgery was traditionally a contraindication for diving. However, recent data do not support this view anymore. Individual advice from a specialist should be requested (see referring template letter in annexe).
- Meniere's disease is incompatible with diving as long as there is no remission.
- 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 septum deformity may result in difficulties with Eustachian tube function. Many cases could be rectified easily by an operative intervention.

Dental

Divers require a high standard of dental health. They must be able 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.

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[1] In some countries legislation prescribes an audiogram for first assessments only as a baseline to prove further eventual deterioration. In other countries at each in-depth assessment or annually.

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 functional competence should be obtained.

Assessment of the respiratory system

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 disease 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. The shape of the maximal flow volume loop is another important consideration. However, the application of a fixed FEV1/FVC ratio value to decide on a pass/fail is inappropriate, although it remains an important indicator for specialist referral and further investigations.

Due to false negative results in younger workers and false positive results with increasing age and related to constitutional differences in people of various countries the "Global Lung Function Initiative" (GLI), a worldwide consensus group, recommends using the "lower limits of normal LLN" ("Normality" is still individually calculated based on personal parameters compared to population values. However, the LLN also considers the normal variation within the population and uses the "Z-score", to calculate the population's 5th percentile as cut-off. The previous ("outdated") considered the population median as the "normal" or "predicted" value and compared the individual's value as a "percentage of predicted" – thus ignoring normal variation within the population around the median). 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. That means, with repeated examination, abnormalities are not only detected by comparing the individual to the general population, but also by comparing the individual to his or her own previous values.

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

Radiology: While high resolution CT scan of the lung at the initial assessment would be an appropriate screening tool to identify for bullae, air trapping and other structural lung pathologies, it is not routinely implemented for a number of reasons: 1) Barotrauma is rare in commercial diving and even more in compressed air work and as the presence of small bullae (so-called blebs) are commonly found during HRCT examination (up to 30% of the healthy population), excluding all candidates with this abnormality would be ethically unacceptable; 2) there is a considerable cost; 3) the radiation dose is unacceptable for the yield in diving accidents prevented; 4) The assessment would remain examiner-dependent, as there is actually no consensus about the risk of blebs. The hazard of complications while diving with blebs is certainly there but the risk (probability x severity) of such events is just not known yet (no identified evidence from scientific publications).

The consensus recommendations regarding radiological examinations include performing a (low-dose or ultra-LD) HRCT scan of the lungs if there is a positive clinical indication. A standard chest x-ray is considered insufficient for this screening. Indications include:

at the initial in-depth assessment:

- History of pneumothorax
- Recurrent broncho-pneumoniae
- BMI < 20 (slender subjects more likely to suffer a Pneumothorax) who are active smokers with >10 Packyears, cannabis or cocaine consumers (known to develop blebs)

at any assessment:

- If spirometry values < LLN
- After exposure to lung-cancerogenic agents
- Unexplained presence of dyspnoea or thoracic pain

No further routine radiology of the thorax is required unless clinically indicated[2], but the requirement for radiological evaluation may vary according to the local prevalence of infectious diseases (e.g. tuberculosis) that is common in some countries or urban areas[3].

Further investigations will need specialist referral: direct measurement of max O_2-uptake, blood gases, spiroergometry, extended lung function with total body plethysmography, helium uptake, etc.

Contraindications and/or conditions requiring careful evaluation

"Absolute" means the candidate is unfit without need for further assessment. "Relative" means further assessment by a respiratory specialist is needed.

- Acute respiratory disease;
  Absolute: temporary, until completely healed and medically reassessed
- Chronic obstructive airways disease;
  Absolute: Gold grade > 1 and 1B, C, D
  Relative: Gold grade 1A
- Chronic lung disease which results in a reduction of exercise capacity (pulmonary fibrosis idiopathic, post infective or toxic, sarcoidosis, etc);
  Relative: all cases (absolute: if FVC < LLN)
- previous spontaneous pneumothorax (PSP);
  Absolute: first 5 years after PSP, if not surgically corrected
  Relative: > 5 years after PSP and no smoking, for recreational diving
- the presence of blebs and/or bullae;
  Absolute: large and/or multiple bullae
  Relative: apical blebs
- Pneumothorax, not spontaneous but provoked by unusual respiratory stress or following surgery;
  Absolute: healing period of at least 3 months required
  Relative: after 3 months. A detailed investigation by a specialist laboratory must show normal lung function and no evidence of local or generalised airflow obstruction. Radiology should exclude significant fibrotic scarring.
- Chest injury, particularly penetrating injury resulting in pleural adhesions or pulmonary scarring (excl. uncomplicated rib fractures);
  Relative: all cases
- After thoracic surgery;
  Relative: candidate clinically fit and documented normal lung function. An additional opinion concerning fitness to dive should be sought from a backup diving medicine specialist.

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 (on treatment) who are not triggered by maximal exercise 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. International legislation aiming to accommodate and enable individuals with disabilities and to not unfairly exclude individuals without evidence, would suggest that “asthmatics” must be allowed to dive professionally. If this is implemented, meticulous data collection is required to confirm the validity of such a change in policy.

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[2] In some countries legislation prescribes a chest x-ray and baseline and/or at specific intervals and sometimes hyperbaric oxygen challenge test ($TcPO_2$) annually or in other intervals.

[3] Meintjes WAJ, Davids LR, van Wijk CH. A retrospective review of the utility of chest X-rays in diving medical examinations. DHM. 2023;53(3):237-242. doi: 10.28920/dhm53.3.237-242. PMID: 37718298.

The examiner should follow the most recent GINA guidelines[4] to assess the asthmatic.

Contraindications:

- Absolute: GINA-score: “partly” or “uncontrolled” asthma, lung function below LLN
- Relative: GINA-score: “well controlled” asthma, lung function within the normal range and stable with provocation (e.g. exercise) testing, no other risk factors. Treatment according to GINA-standard step 1 or 2 (leukotriene antagonist therapy to be well monitored or avoided). Specialist referral is necessary at initial assessment but later only as required. 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. Experienced divers with mild, stable asthma with no dive-related complications should not unnecessarily be disqualified.

Professional divers assessed with a possible diagnosis of asthma should usually be declared either fully fit or unfit for a job. It is unlikely that a certificate of fitness with a restriction on diving activity (for example depth) would be acceptable for employment. Stable asthmatic divers who were declared fit to dive may use serial peak flow measurements for self-monitoring their control between assessments. If (e.g. due to viral upper respiratory tract infection) a short-acting bronchodilator is required or if daily diurnal variation >10%, they should refrain from diving activity for at least 48 hours.

Cardiovascular assessment

The function of the cardiovascular system should be sufficient to enable the diver to sustain strenuous activity at depth. An increased risk of loss of consciousness or incapacitation should be excluded.

History taking and physical exam must take into account the main risk factors:

1. Diving related immersion inducing blood shift (centralisation), cold, hyperoxia-induced vasoconstriction, decompression induced venous bubbles.
2. Congenital pathologies as potential causes of sudden death. Before age 35 mostly hypertrophic cardiomyopathy, arrhythmogenic right ventricular disease, channelopathies, but rarely also congenital or acquired coronary artery disease (CAD).
3. Contracted/developed pathologies as causes of immersion pulmonary oedema or fatal diving accidents, e.g. in first line CAD (assess risk factors), responsible for 80% of sudden death in population of age over 35.

Electrocardiogram: A (once only) resting ECG examination is justified for younger workers due to risk of sudden death secondary to hereditary pathologies (60% detected by ECG, i.e. a good negative predictive value).

Beyond age 35, coronary artery disease (CAD) becomes the major risk for sudden death. Although paradoxically, ECG may in most cases appear normal, in view of the high incidence of CAD associated diving fatalities, ECG examinations are still helpful to visualise traces of past events or for comparison in future. If there is a suspicion of increased cardiac risk (age, obesity, diabetes, family history, etc.), the risk should first be determined according to the NICE guidelines with the calculator (including the necessary measurements and laboratory tests); then, those who have more than low risk, should be assessed by a cardiologist.

Symptom-limited stress ECG-tests in isolation have a low diagnostic value in determining the presence of coronary artery disease. They should be targeted at a high-risk CAD population only and should be performed by a qualified physician in a facility where appropriate resuscitation equipment exists. Other specific tests may be indicated by a cardiologist with special interest in diving medicine.

[4] Global Initiative for Asthma 2019, www.ginasthma.org

Contraindications:

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

Coronary Heart Disease

- At the initial entry examination, any individual found to have ischaemic heart disease should be declared unfit.
- Symptomatic ischaemic heart disease or a requirement for medication to control a cardiac condition is incompatible with diving. Primary preventive medications like low-dose aspirin or cholesterol reducing drugs are acceptable.

An individual who is symptom free following coronary bypass surgery, after minimally invasive revascularisation or after percutaneous transluminal coronary angioplasty (PTCA) might be certified as fit to dive if 3 to 6 months after the intervention, the following criteria are met:

- The procedure has been demonstrated to produce revascularisation.
- The stress ECG reveals no abnormality.
- The applicant remains symptom free 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 investigations considered appropriate (e.g. 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 initial entry medical examination.
- Any dysrhythmia that might cause incapacity in the water will disqualify.

Pacemakers

In most cases the indication for pacing is likely to be a contraindication to diving. Careful assessment of the type of diving and the type of pacemaker involved will be required and, if necessary, will require specialist cardiological advice. Defibrillators for tachyarrhythmias are contraindicated, otherwise only models with certified pressure test to one bar above the maximal diving pressure are acceptable.

Patent Foramen Ovale

Routine screening for the presence of an intracardiac shunt (in the absence of clinical signs and symptoms of concern) is not a requirement for either the initial entry examination or the periodic 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 is indicated in a diver who has suffered neurological, vestibular, or cutaneous (livedo racemosa) decompression illness suggestive of embolic-type illness, where the dive profile was not obviously contributory. The risk associated with a PFO (if confirmed to be present) is highly dependent on the number of mobilised bubbles after a dive (e.g. physical activity may mobilise more), central venous pressure peaks and the size of the PFO. Return to work after such an incident would require absence of disabling neurological sequelae and accommodation in the workplace must in all cases be arranged (change to “low bubble diving”).

In cases where it would not be feasible for the employer to adapt the workstation it may be appropriate to propose closure of a PFO to allow continued unrestricted diving.

Screening for PFO will also be recommended for divers without a history of dive accidents, but that had a TIA, cryptogenic stroke, or recurrent migraine. They may have had this examination already as part of the assessment of this disease, so that it may not need to be redone, but it should be considered as part of the decision.

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

Blood Pressure
Resting blood pressure should not exceed 140 mmHg systolic or 90 mmHg diastolic.

Mild hypertension (not exceeding 160 systolic or 100 diastolic) would not be an absolute 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.
- Ultimate restrictions to consider would include to avoid cold exposure, deep air dives or hyperoxic mixtures, that are all associated with additional vasoconstriction (thus increased peripheral resistance and rise in blood pressure).

Where doubt exists a cardiologist with a knowledge of diving medicine should be consulted.

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);
- conditions known to be associated with impaired organ perfusion.
- conditions that may confuse occupational diseases (e.g. Raynaud's phenomenon in divers working with vibrating equipment like Jackhammers)

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 a part of the examination. Where doubt exists specialist clinical psychological assessment might be required.

Symptoms of neuropsychological nature are sometimes reported by individuals following long periods of exposure to hyperbaric conditions (including PTSD, Dysexecutive Syndrome, Excitotoxicity type, etc.). Specialised diagnostics are required to prove or exclude association with the workplace.

Predisposition to impairment of consciousness, convulsions, disturbances of speech, vision or motor control or disturbances of orientation and balance are all conditions 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 in-depth assessments and a permanent record of the examination needs to be retained as a baseline.

Balance and control of positioning should be examined by performing the sharpened Romberg test, as described by Lee[5] .

Neuro-psychiatric Assessment

Individuals should be free from debilitating 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.

When assessing the mental fitness, the primary considerations in all cases must include not only the risk to the individual's safety and/or that of those around him or her, but also the risk of recurrence of psychiatric or psychological disorders or symptoms thereof and the impact this may have. Special consideration should include the various kinds of stress associated with the type of work, remote location and risks involved.

ADHD: A history of past attention-deficit-hyperactivity-disorder (ADHD) should not be an absolute contraindication and cases with persistent ADHD may be passed fit, if well controlled with stable treatment, no drug side-effects and able to safely perform the professional tasks during the required period of time. Behavioural instability and deep diving are however contraindications. Periodical feedback with the treating doctor is required for risk assessment.

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 free of epileptic convulsions for five years and they did not use any treatment during this time, 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, especially in the first year following the incident.
- A history of head injury is compatible with diving if there has been loss of consciousness of less than 30 minutes without focal localising signs and if the period of post traumatic amnesia (defined as the time to the restoration of continuous memory) is less than 24 hours. Minor linear skull fractures are acceptable if the criteria above are met. The cases of mild to moderate head injury, especially if recurrent, require full neurological and psychometric assessment.
- Major intracranial tumour surgery is disqualifying while minor surgical procedures (e.g. for some meningiomas) might be compatible with professional diving if the risk of seizures is not elevated.

[5] Lee CT. Sharpening the Sharpened Romberg. SPUMS J. 1998 Sep;28(3):125-32. PMID: 11542272.

- Psychiatric disorders which, while quiescent, still exclude passing an individual as fit to dive:
  - schizophrenia
  - bipolar affective disorder
  - unipolar affective disorder

Disorders which, if resolved or stable and asymptomatic due to treatment, may allow passing an individual as fit to dive, include:

- 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. Each individual with an endocrine disorder must therefore be jointly assessed for fitness 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 an exclusion for diving, after treatment with radioiodine and on replacement therapy, their fitness should be considered favourably, after exclusion of 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[6]

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 limited career prospects and the high probability of later disqualification due to complications. However, under special conditions they might be trained under medical supervision and then become divers for limited diving operations (e.g. scientific diver in an aquarium or divers in other benign conditions).

Once diabetes was diagnosed in a working diver, an automatic disqualification would previously have been applied but is no longer acceptable. The three main considerations include the nature of the work, the degree of control achieved by treatment and the knowledge/ understanding of the candidate regarding the disease and the risks involved. 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 treated with insulin.

[6] More detailed recommendations can be found in the manual, chapter 4 reference section, 6.2. diabetes mellitus/recommendations. See also Jendle 2020 (doi: 10.28920/dhm50.2.135-143. PMID: 32557415)

In addition to the acute problems diabetics may experience, long-term complications are also of concern and should disqualify if present: 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 with every examination.

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 should 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 usually 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 continuous therapy with proton pump antagonists. This management could therefore be acceptable after careful consideration and an adequate symptom free interval (also for saturation divers). A 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 could lead to disqualification, because of the likelihood of being misdiagnosed when a hazard of diving illness is present. Chronic inflammatory bowel disease would be cause for rejection. Acute distal colitis or proctitis would result in temporary unfitness, pending 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 social implications may pose a problem. Disqualification on medical grounds is not appropriate.
- Abdominal wall herniation must be a cause for temporary disqualification until repaired because of the risk of incarceration and strangulation, 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 glucose level. Sickle cell disease should be excluded (sickle cell test or haemoglobin electrophoresis mandatory only for individuals who are likely 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 in men and 10.5 g/dl in women are the minimum acceptable levels.

- Sickle cell disease or thalassaemia major is a contraindication. There is no published evidence that carriers of the sickle cell and thalassaemia traits are 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 appropriately in Mediterranean candidates.

Assessment of the musculo-skeletal system

For a novice diving candidate during the entry medical examination, the standards are much tougher than for those who have ten years' experience and a good work record. For the latter the application of standards could become much more pragmatic. To become a working diver, the candidate must have unimpeded mobility and dexterity and must have sufficient physical strength 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. Any shortcomings may require further evaluation to determine the impact on diving, for example, the impact it may have on managing the diving equipment, the performance of emergency procedures (such as retrieval of the demand valve), etc. A functional capacity evaluation or evaluation by a dive instructor may be useful.

- Divers with a history of back pain should be carefully assessed, bearing in mind the heavy lifting all divers are typically 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 locomotor system may be compatible with some forms of diving. A restricted fitness may therefore be appropriate, and a workplace adaptation must be checked by the contract medical adviser.

Bone necrosis

Dysbaric osteonecrosis (DON) is the one well-established occupational health hazard of diving. It can also occur in persons who have dived 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 more commonly found in those with a record of decompression illness (particularly pain-only-bends) and can even follow a single episode of exposure to pressure. It has not yet been observed in those who dive within the no-decompression-stop range only and very rare in those who dive within the limits of the USN and similar compressed air tables. It is observed once individuals are diving deeper than 30 metres (100 fsw) and increasingly so in saturation divers with deeper experience.

"Long bone x-rays" of the hips, shoulders (and earlier also the knee) were standard for many years, but these 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 (despite the increased costs). MRI can detect (a few days after a bend) bone oedema very early – so it may produce false positives, meaning some lesions likely heal without progressing to a necrotic infarct.

There are fishermen-divers and sponge scavengers who dive for several hours per day, some as shallow as 20 metres (66 fsw), without appropriate decompression procedures, and in these divers the condition is also very commonly diagnosed. Even in these cases, the condition develops very slowly. The typical delay between the date of known first exposure to the first detectable x-ray change is approximately 10 months. However, the use of MRI in divers with bends (pain) has demonstrated some early bone lesions that evolved into DON after a month.

Many diving doctors recommend that all new entrants on graduating should be considered for baseline 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 or other saturation exposures (e.g. in tunnelling), according to the risk assessment of the contract medical adviser. These records must be stored longer than the lifetime career of the diver. Baseline imaging is however not required in countries with a “no fault” compensation system (where DON is listed as an “automatic” compensable occupational disease if an employee was exposed to a pressurised working environment). Routine health surveillance for DON by means of radiological screening (x-ray or MRI) is no longer recommended. It should however be considered for those with clinical symptoms, such as pain referable to a joint (often resembling a rotator cuff injury in divers) and for those who have had a decompression illness (not necessarily presenting in the same joint). Screening is focused on the shoulder and hip joints. DON has not been described in other joints and shaft lesions are rarely of orthopaedic significance.

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 cannot be the sole reason for medical disqualification. The strong advice to give up diving is based on the need for the individual to avoid excessive weight bearing at that joint and the hazard of further bubble injury. Fitness certification will ultimately be based on the functional capacity of the individual, and whether they are able to perform the inherent demands of the job (including ingress/ egress, moving around the vessel or dive site, etc.).

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. As decompression stress can be monitored by ultrasound detection of post decompression intravenous bubbles, such data would also be required for further epidemiological research.

Vision

The diver should be able to see well enough to perform his job 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. If indicated, the examiner should perform fundoscopy and confrontational visual field testing.

- Modern gas-permeable contact lenses are acceptable for diving. Divers requiring visual correction can also use a corrective faceplate if they are using their own diving mask. 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 during the initial medical entry 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 eyeball is incompressible and corneal laser and other surgery on the eye should not be a contraindication to diving once any gas pocket retained in the eye after surgery has been resorbed and scar formation is concluded, and visual acuity has stabilised.

Performance, lifestyle, and temporary contraindications

Some constitutional characteristics of a subject that are not considered as disease may be of importance when evaluating fitness to work under pressure:

Physical fitness

Work under pressure can be physically and mentally demanding. Divers should maintain a good level of physical fitness. This becomes particularly important in underwater emergencies where they may have to carry out a self-rescue or rescue another diver. The same is true for tunnellers.

According to the need of the workplace an appropriate method of assessment should be used to estimate the aerobic capacity and respiratory fitness (see guidance in the appendix A).

Obesity

Obesity is reputed to predispose to decompression illness and is inversely related to fitness. There are some caveats in the application of the body mass index (BMI), and the waist circumference would more readily identify changes in visceral fat deposition. Some degree of adiposity can protect against the cold. As an indicator of fitness, exercise tolerance testing seems to be the most appropriate to use (see above). The examiner should also consider the impact of obesity on safety (equipment fit, accessing, and working in confined spaces and conducting a rescue). BMI >35 and excessive waist circumference should be a reason for a check with the family doctor, because of the risk for (non-pressure-related) severe health complications.

Age – Adolescence

While children as young as 8 years may start diving in protected settings in a recreational setting, professionals will only exceptionally be younger than 16 years as trainees. Important considerations would include the capability to understand safety issues and to do their jobs responsibly.

Age – Advanced age

There is no upper age limit for commercial diving. Screening for age-related pathologies is however needed to assess ultimate physical or mental impairments incompatible with safe work under pressure.

Drugs and smoking

Medicaments: 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 and demands of the workplace.
- the underlying pathology.
- The assessment must include that of the underlying condition for which medication is being taken and in certain cases this 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 (and how long it would take to replenish in a worst-case scenario – for instance when a diver is offshore in bad weather). Consideration should be given to the potential for unexpected side effects, particularly during the first days after initiation of therapy, or appearing as a result of interactions or resulting from the working situation. Every situation needs to be judged on an individual basis.
- Many therapies that used to have considerable psychoactive effects and side-effects are replaced nowadays by modern drugs with much less such effects. Once absence of side effects and acceptable risk from pharmaceutic effects are confirmed, many drugs may become compatible with a job under pressure. While the possibility of a drug to cause a certain side effect is listed in

the literature or package insert, each case should still be individually assessed. If an individual does not present with those side effects, they should not be disqualified purely on theoretical grounds, apart from those that are likely to present under pressure (e.g. sedating effects in association with nitrogen narcosis, where depth restrictions may be appropriate).

- Smoking: Divers should be discouraged from smoking and use of nicotine containing products
- Alcohol, drug, or substance abuse is incompatible with diving. History of previous abuse must rise doubts about fitness for diving. A lengthy period of stability without any medication should be sought as a minimum.

Temporary contraindications

This chapter includes transient conditions that temporarily represent contra-indications for diving or compressed air work.

Pregnancy

Pregnant divers will be exposed to possible harmful effects that increased pressure may have on the foetus. In particular, the foetus does not have a functional lung bubble filter (they have a fully patent foramen ovale) and consequently any foetal vascular bubbles would result in arterial embolization. Consequently, a pregnant diver or one who suspects being pregnant should not dive.

Otherwise, the same fitness criteria apply to both male and female divers.

Sea sickness, vomiting, diarrhoea

Due to fluid loss, such conditions may develop exsiccosis and thus increased risk of DCS. In consequence, reduced psychological performance and attention are incompatible with safety and demands of the job. Divers should be informed about possible or recommended preventive actions (anti-seasickness drugs, etc.).

Pain

Trauma, inflammation, sunburns, and menstruation may produce strong pain, resulting in deficient executive actions and attention, sometimes also physical performance. As long as such conditions are not resolved or well controlled, work under pressure should not be performed.

Disability, Malignancy

Functional impairment from accident or disease (cancer, etc.) can disable a diver temporarily until the problem is resolved or, sometimes, permanently. If the aptitude for the job and/or the possibility to recue another diver is not guaranteed, diving is contraindicated. After adaptation of the workplace, reasonable accommodation and with assistance by supplementary persons, resumption of the job may be possible. An individual risk assessment is key for such exceptions, typically led by functional capacity evaluations (occupational therapists). Otherwise, any restrictions must be justified taking the relevant non-discrimination legislation into account.

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.

Blood-borne viruses, including HIV positive status, is not automatically a contraindication for diving. Consideration should be given to the protection of employees against blood-borne illnesses, such as through Hepatitis B vaccination, if this is not in place. Recreational diving instructors with active communicable disease should be restricted from teaching buddy breathing practically.

Divers with a history of testing positive for SARS-CoV-2 while asymptomatic or having suffered any symptoms should refer to the specific guidance documents.

Otitis externa

This painful condition is very common among divers in warm waters, humid and hot air. Excruciating pain may develop and even lock the mandibular joint. Oedema may block the ear canal. Until appropriate medical treatment provides complete healing, diving is contraindicated. Divers should be informed about possible or recommended preventive actions (ear drops, rinsing, etc).

Skin disorders and lesions

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

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 exist.

- Urticaria is a transient condition, but if 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 a serious irritant-based skin reaction. The oil-based muds are also irritants. Occasionally reactions to the tannins and chromium have been reported, which could be allergic. Those identified by suffering from allergic contact dermatitis must avoid all future contact with that allergen, but most persons will be found to have an irritant dermatitis which should respond in time to rest and thereafter that person can return to diving.

Resumption of diving or hyperbaric work 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 or professional scientific societies (see list in chapter 7).

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, and especially so if associated with certain cutaneous or visual manifestations or vertigo. Investigations should include contrast echocardiography 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. That means, if there are residua, do these affect safety only ("can the diver still dive safely") or should their health also be assessed (what effect would this have of the long-term health of the individual, and what would the impact of further diving be)?

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 clearly spelt out in all regulations (note that it is in some!), it is an important consideration in the assessment of fitness to resume diving. With a threat to the diver's safety there should be no compromise, and divers should be classified as unfit. However, in the case of future health concerns, the medical examiner should carefully advise the diver. The aim is to balance the risk of future health and disease with the risk of unemployment. The decision to return to diving or to quit should be made by an informed diver[7] : it is his, or her, life and livelihood and each case will be unique. 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. Reduced working capacity and effectiveness after a period of unfitness is a separate issue and should be dealt with in terms of the normal rehabilitative processes.

Recommended times away from hyperbaric exposures:

The limits of the DMAC guidance cited here represent recommended minimal intervals for workers involved in complex hyperbaric operations where a loss of workforce would have a severe impact on the further progress of the project. Under normal conditions, the interval to resume work under pressure will often become longer due to indicated diagnostic investigations. As there is no data to support a specific guidance on absence from diving after an initial DCI insult to avoid short- or long-term health effects, expert opinions still vary considerably regarding the needed waiting periods to achieve an acceptable residual risk.

DMAC 13: Any period off-work of over 7 days due to injury or illness will generally need a clearance by a medical examiner of divers. The recommended **minimum time until medical reassessment is due** after successful treatment with no sequelae are listed below
(Note: this is the actual DMAC guidance 13 rev. 2022; for further update see www.dmac-diving.org).

Simple DCI with **limb pain**, headache, nausea, fatigue etc. and other non-specific manifestations:

- Uncomplicated recovery after recompression therapy: 7days
- Recurrence/relapse requiring further recompression: 14 days

[7] In some countries this is not possible due to legislation (e.g. in France, Portugal and others); recreational diving may be exempted from such restrictions

Neurological DCI uncomplicated and with complete recovery after one recompression treatment and compulsory review by a diving medical specialist:

- No involvement of visual, cognitive, brain stem, vestibular, cerebellar, autonomous, or motor function: 28 days
- Pulmonary DCS (Chokes), visual, cognitive, brain stem, vestibular, cerebellar, autonomous, or motor dysfunction: 3 months

Cutaneous and lymphatic manifestations without neurological involvement (skin rash, itching, livedo racemosa) or swelling of tissues: 7 days

Pulmonary barotrauma resulting in **pneumothorax or mediastinal emphysema**. Following appropriate investigation, including HRCT of chest, a diver may be considered fit to return to diving but not earlier than 3 months after complete recovery.

In cases where **multiple treatments** were required or there are **residual neurological manifestations** due to DCI, even after repeated treatment, the diver should be considered on a case-by-case basis, but usually not allowed to return to diving for 3 months following the injury.

Note:

- 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 may be longer in some cases.
- Medical examiners should also be aware of the fact that some divers deny residual symptoms or past events, especially when they fear implications on their professional career.
- Apart from cases of "simple DCI" and non-diving related off-work periods, a review by a diving medicine specialist is required, and even compulsory in many countries.

Literature & Links

Fitness to dive literature & online links:

This list is only a small selection, mainly consisting of English resources. We are aware that many useful and high-quality books and online sites are available in other languages.

Books:

Azzopardi CP, Parker J
The Sports Diving Medical. 3rd ed.
Southend-on-sea. Essex (UK): AquaPress; 2023. 212p.
ISBN-10 1905492473.

Bennett PB, Cronje FJ, Campbell ES
Assessment of diving medical fitness for scuba divers and instructors.
Flagstaff AZ (USA): Best Publishing Company; 2006. 241p. ISBN 10: 1930536313 &
ISBN 13: 9781930536319

Online resources:

www.uhms.org/resources/featured-resources/recreational-diving-medical-screening-system.html
In 2020, the international Recreational Diver Medical Screen Committee (DMSC) released a new diver medical screening system and guidance to the physician. Hosted by the Undersea and Hyperbaric Medicine Society website. North Palm Beach FL (US). Multilingual. Approved by WRSTC, CMAS, UHMS, DAN.

https://dan.org/health-medicine/travelers-medical-guide/planning-and-preparedness/fitness-to-dive/
Divers Alert Network. Durham NC (US)

www.scuba-doc.com
Comprehensive information about diving and undersea medicine for the non-medical diver, the non-diving physician and the specialist by Ernest S. Campbell, M.D., FACS

www.hse.gov.uk/diving/index.htm
Guidance for divers and doctors from the Health and Safety Executive of the British Government. The "medical examination and assessment of working divers (MA1)" document lists specific medical standards.

www.ukdmc.org
Provides Advice on diving medicine issues, including assessment of fitness to dive. UK Diving Medical Committee, an independent Recreational Diving Medicine Expert Group, cooperating with the UK recreational diving organisations.

www.medsubhyp.fr/recommandations-en-sante-au-travail/
MEDSUBHYP-SFST Recommandations de bonne pratique - Prise en charge en santé au travail des travailleurs exposés au risque hyperbare. 2023.[pdf book, french]. Marseille (FR): Société de Physiologie et de Médecine Subaquatiques et Hyperbares de langue française & Société Française de Santé au Travail; 2023. 252p.

General diving and hyperbaric medicine

Books

Alf Brubakk & Tom S. Neuman:
Bennett and Elliott's Physiology and Medicine of Diving, 5th ed. 779p.
Elsevier Science Ltd, Philadelphia USA (2003)
ISBN 0-7020-2571-2

Carl Edmonds, Michael Bennett, John Lippmann, Simon Mitchell
Diving and Subaquatic Medicine, 5th Edition. 866p.
CRC Press, London New York (2016)
ISBN 9780367575557

Alfred A. Bove & Jefferson C. Davis
Diving Medicine, 4th Edition. 656p.
WBSaunders Company Ltd, Philadelphia USA (2003)
ISBN 9780721694245

Frantisek Novomesky & Akin S. Toklu
Fundamentals of diving medicine 254p.
Osveta Publ House, Martin, Slovak Republic (2021)
ISBN 978-80-8063-500-8

US Navy Naval Sea Systems Command
US Navy Diving Manual, Revision 7A. 990p.
Government Printing Office, Washington DC, USA (2018)
SS521-AG-PRO-010, 0910-LP-115-1921
https://www.navsea.navy.mil/Home/SUPSALV/00C3-Diving/Diving-Publications/

F. M. Jardine & R. I. McCallum
Engineering and Health in Compressed Air Work. 668p.
Spon Press, London UK (1992)
ISBN: 9780367401955

John Bevan
The Professional Diver's Handbook. 384p.
Submex Ltd, England & Wales (2011)
ISBN 978 0 9508242 6 0

Hal Lomax
Commercial Diver Training Manual, 7th Edition. 590p.
Best Publishing Company, Flegstaff AZ USA (2023)
ISBN-10: 1930536925, ISBN-13: 978-1930536920

Costantino Balestra & Jacek Kot
Hyperbaric Medicine. 156p.
Mdpi AG, Basel, Switzerland (2023)
ISBN-13: 978-3036564678, ISBN 978-3-0365-6466-1 (PDF)

Bruce R. Wienke
Science of Diving: Concepts and Applications. 440p.
CRC Press, New York, USA (2015)
ISBN-10: 0367738279, ISBN-13: 987-0367738273

Albert A. Bühlmann
Decompression-Decompression Sickness. 90p.
Berlin New York: Springer-Verlag (1984)
ISBN 0-387-13308-9. EAN 9783662024096

Costantino Balestra & Peter Germonpré
The Science of Diving. 272p.
LAP Lambert Academic Publishing (2014)
ISBN: 978-3-659-66233-1

Costantino Balestra & Peter Germonpré
Diving deeper into SCUBA Science
Acrodacrolivres (2017)
ISBN: e-ISBN 9782512007364

Scientific journals:

Diving and Hyperbaric Medicine (DHM)
Journal of the South Pacific Underwater Medicine Society & of the European Underwater and Baromedical Society. Melbourne, Australia
E-ASSN 2209-1491, ABN 29299823713 [online]

Underwater and Hyperbaric Medicine Journal (UHM):
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Alert Diver Magazine [Online]
The official magazine of Divers Alert Network DAN
https://alertdiver.eu/en_US/ (European edition, 9 languages)
https://www.dansa.org/alert-diver (South African edition, English)
https://world.dan.org/alert-diver/ or https://dan.org/alert-diver/ (US edition, covers America and Asia, English)

Links to Scientific Societies:

Europe:

Austria: Österreichische Gesellschaft für Tauch- und Hyperbarmedizin (ÖGTH), www.oegth.at

Belgium: S.B.M.H.S./ B.V.O.O.G: Société Belge de Médecine Hyperbare et Subaquatique sprl, (Belgische Vereniging voor Overdruk en Onderwatergeneeskunde), Avenue Jules Malou 63, www.sbmhs.be
1040 Bruxelles - Belgique

Czech Republic: Česká společnost hyperbarické a letecké medicíny (Czech Society of Hyperbaric and Aviation Medicine), http://www.cshlm.cz

Danmark: Danish Aerospace- and Diving Medical Society
https://dfdms.dk
Useful information for professional diving and licencing of MEDs available from: Danish Maritime Authorities, https://dma.dk

Finland: The Finnsh Society of Diving and Hyperbaric Medicine, Suomen sukellus-jaylipainelääketieteellinen yhdistys (SSLY)

France: La société de physiologie et médecine subaquatique et hyperbare de la langue française (MedSubHyp), www.medsubhyp.com

Germany: Gesellschaft für Tauch- und Überdruckmedizin (GTÜM), www.gtuem.de

Hungary: Magyarországi Hiperbár- és Búvárorvosi Társaság MHBOT (Hungarian Hyperbaric and Diving Society), https://hbothungary.hu/

Italy: Società Italiana di Medicina Subacquea ed Iperbarica (SIMSI), www.simsi.org

Netherlands: Nederlandse Vereniging voor Duikgeneeskunde (Dutch Society for Diving Medicine), www.duikgeneeskunde.nl

Norway: The Norwegian Baromedical Society (NBF), www.baromedisin.no
Useful information regarding diving medicine in Norway is also available from: www.dykkemedisin.no

Spain: Comite Coordinador de Centros de Medicina Hiperbarica (CCCMH), www.cccmh.com
and Sociedad Española de Medicina Subacuática e Hiperbárica (SEMH), www.asemhs.org

Sweden: Swedish Aero-Nautical Medical Association,
www.sanma.nu and Swedish Hyperbaric Medical Society (SHMS)

Switzerland: Swiss Underwater and Hyperbaric Medical Society (SUHMS), www.suhms.org

Turkey: Sualti ve Hiperbarik Tip Dernegi, (Turkish Underwater and Hyperbaric Medical Society), www.sualti.org

United Kingdom: British Hyperbaric Association (BHA), https://ukhyperbaric.com/
For occupational diving we rather refer to the DIVING medical grouping, which is the UKDMC (UK Diving Medical Committee), also containing the list of medical referees as designated by the HSE for commercial diving, www.ukdmc.org

International Addresses:

USA: Undersea and Hyperbaric Medical Society, www.uhms.org

Australia & New Zealand (South Pacific): South Pacific Underwater Medicine Society, www.spums.org

Canada: Canadian Underwater and Hyperbaric Medicine Society, www.cuhma.org

Europe: European Underwater and Baromedical Society, www.eubs.org

Southern Africa: Southern African Underwater and Hyperbaric Medical Association, www.sauhma.org

Asia: Asian Hyperbaric and Diving Medicine Association, www.ahdma.org

Nigeria: Hyperbaric Medical Practitioners Society of Nigeria, https://hmpsn.ng

Brazil: Sociedades Brasileira de Medicina Hiperbárica, https://sbmh.com.br/

Mexico: Asociación Mexicana de Medicina Hiperbárica, www.medicinahiperbaricamx.com/ , for hyperbaric medicine also: Red Latinoamericana de Cámaras Hiperbáricas CYTED, pauloaravena@gmil.com, https://cyted.org/redhiperoxit

Divers Alert Network:

https://dan.org

https://world.dan.org

https://daneurope.org

https://dansa.org

https://danjapan.gr.jp

Links for standards of training & safety:

EDTC European Diving Technology Committee
www.edtc.org
Focus on making professional diving safer by setting standards of good practice developed through cooperation of delegates from the industry, unions, authorities and medicine of its 25 member countries

ECHM European Committee for Hyperbaric Medicine
www.echm.org
Focus on making hyperbaric oxygen treatment safer and efficient by supporting research and developing consensus statements through cooperation of representatives of 34 national scientific societies within Europe

DMAC Diving Medical Advisory Committee
www.dmac-diving.org
Independent body, comprising international diving medical specialists, focused on providing advice about medical and certain safety aspects of commercial diving. Supported and administered by IMCA

IMCA International Marine Contractors Association
London, UK
www.imca-int.com
focus on safety of the offshore and inshore commercial industry

ADCi Association of Diving Contractors International Inc.
www.adc-int.com
USA. focus on safety of the offshore and inshore commercial industry

ESDP European Scientific Diving Panel
www.esdpanel.eu
focus on competence standards and training of occupational science divers (OSD), while for citizen science diving (CSD) legal framework, aims, actors, and public are different (cf recreational diving organisations)

AAUS American Academy of Underwater Sciences
www.aaus.org
focus on competence standards and training of occupational scientific divers

ITA-AITES International Tunnelling and Underground Space Association, Châtelaine, Switzerland
www.ita-aites.org
focus on safety standards and Information for the tunnelling industry (including compressed air work)

BTS-CAWG British Compressed Air Working Group of the British Tunnelling Society
https://de.bts-cawg.co.uk/
focus on competence and safety of tunnelling operations (international)

ADAS Australian Diver Accreditation Scheme,
Dunoon, NSW, 2480, Australia
https://adas.org.au/
International commercial and occupational diver certification scheme administered on a cost-recovery basis by the ADAS Board under the direction of the Australian Department of Resources, Energy and Tourism

DCBC Diver Certification Board of Canada
www.divercertification.com
Certifies occupational divers, accredits schools which train occupational divers. The DCBC is a federally incorporated not-for-profit body which is the only national body certifying offshore and inshore commercial divers in Canada

DGT Direction Générale du Travail
Ministère du travail, de la santé et de la solidarité, Paris, France
https://travail-emploi.gouv.fr/ministere/organisation/organisation-des-directions-et-services/article/organisation-de-la-direction-generale-du-travail-dgt
French labour department. Regulates and supervises training centres for occupational and commercial divers in France

PSA Petroleum Safety Authority (Norway)
www.psa.no
Regulates certification for surface-oriented and saturation diving offshore (recognized for diving worldwide by IMCA).

Arbeidstilsynet: Norwegian Labor Inspection Authority
https://www.arbeidstilsynet.no/en/
regulates inland diving in Norway

SAUHMA Diving Medical Registry of the South Africa
https://database.sauhma.org/
On behalf of the Department of Employment and Labour of South Africa, SAUHMA keeps a databank of diving and hyperbaric medical doctors, validates their competence and CPD. Furthermore, they keep a registry of valid divers and compressed air workers medical certificates

Department of Employment and Labour of South Africa
https://www.labour.gov.za/
Regulates the activities of people who dive as part of their employment, except for those involved in diving connected to minerals and energy, who are nominally controlled by the Department of Mineral Resources and Energy (www.dmre.gov.za)

IDMEB Diving Medical Registry of the International Diving Medical Expert Board
hosted at the Scuola superiore di studi universitari e di perfezionamento Sant'Anna, Pisa, Italy
www.divemedreg.org
IDMEB keeps a databank of diving and hyperbaric medical doctors worldwide, validates their competence and CPD. It is supported by DMAC and EDTC

IDSA International Diving Schools Association
Pijnacker, Netherlands
www.idsaworldwide.org
IDSA has set a standard for the training of commercial divers, which is in accordance with IMCA and EDTC standards. It is an association of training centres worldwide.

NAUI National Association of Underwater Instructors
https://www.naui.org
Training organisation for recreational diving

PADI Professional Association of Diving Instructors
www.padi.com
Training organisation for recreational diving, including handicapped and citizen science divers programs

SSI Scuba Schools International
www.divessi.com
Training organisation for recreational diving

CMAS Confédération Mondiale des Activités Subaquatiques (world underwater federation)
www.cmas.org
Training organisation for recreational diving, including handicapped and citizen science divers programs

BSAC British Sub-Aqua Club
www.bsac.com
Training organisation for recreational diving

Appendix A
Reliable tests of physical fitness

What is the purpose?

Fitness for work comprises three components, namely (1) the Ability to perform the inherent requirements of the job, (2) the Endurance to perform the work for the entire work shift and (3) the absence of Risk to health and safety of self, others, and the operation in general. Fitness to dive medicals are generally focused on the third component of fitness – in other words, medical conditions that represent a risk for the particular work under pressure (diving, compressed air work, saturation). The second component of fitness for work ("Endurance") relate to the physical fitness of a candidate, and also needs to be assessed. Low physical fitness is not a risk *per se,* but a potential limitation to fulfil the task, which can be the underwater job but also the contingency activities like self-rescue or assistance rescuing a team member, including access to a vessel or platform with all the heavy diving gear, particularly under difficult sea conditions.

Employers may therefore insist upon a certain level of **performance** to be attested by the doctor.[1] The task of a medical examiner may thus be to appraise the performance, which is characterized by strength, exercise capacity and agility. A full assessment would need a referral to a fitness training agency or physiotherapy.

A separate issue, but often tested in relation with fitness screening, is the exercise test to screen for **cardiovascular risks** that is normally performed by a cardiology specialist.[2] [3] With a test under maximal workload with ECG monitoring MEDs can optionally get relevant information as well. In an occupational medical practice however reliable results just estimating aerobic capacity can be achieved with simplified protocols.

Pulmonary oxygen uptake capacity: oxygen diffusion may be impaired despite good physical fitness and spirometry. This is particularly relevant in post infection periods (covid, etc) and aging individuals. While diffusing capacity testing needs specialist pulmonology engagement, monitoring O_2-saturation with pulse-oximetry is easy to perform during any exercise test and could be used as proxy measure. Baseline O_2-saturation < 95% at sea level and drop of O_2-saturation by > 5% from baseline at maximal effort are warning signs.[4] These devices measure red colour pattern shift and display estimated O_2-saturation according to a validated algorithm. Dark skin,[5] [6] [7] [8] vasoconstriction, increased carboxyhaemoglobin levels (smokers) and poor-quality devices may however display unreliable results.[9] [10]

Which test is reasonably practicable?

The **gold standard is spiroergometry**. Oxygen consumption is measured in function of increasing workload until exhaustion, i.e., when the respiration quotient changes (ventilatory threshold).[11] This procedure however needs a sophisticated physiological laboratory,[12] thus, it is beyond the scope of routine medical preventive screening.

Since heart rate (HR) increases proportionally with workload (P) as does the oxygen consumption (VO_2), VO_2 can be calculated from HR and P,[13] [14] but it is also related to gender and body composition.[15] [16] To obtain VO_{2max} we can use measured HRmax at exhaustion (**maximal stress test with indirect VO_2 estimation**).

Maximal HR, if not known, can be estimated as 220 – age.[17] This widely used approach is now replaced by more reliable formulas found by regression of bigger data pools that keep a standard error of 6 to 15 bpm even for age groups over 60 years.[18] [19] [20] Testing may thus be performed observing HR at various P in a submaximal range. VO_{2max} will then get calculated using the gradient of HR/P (slope of the curve) and the estimated HRmax. This is called a **submaximal indirect VO_{2max} estimation**.

To get the gradient HR/P we need at least 3 stages of increasing P with a maximal heart rate over 75% of the estimated maximum.[21] Clinical testing is standardised and validated for treadmills with variable inclinations, cycle ergometers with electronically controlled power levels and steps of defined hight. Standard errors are not far from direct measurements,[22 12] but tend to overestimate VO_{2max}.[23]

Further test simplifications have been described:

- The Astrand-Rhyming test, which is still widely used and well documented. With this test VO2max is estimated using HR/P at only one stage, so that even the slope to the estimated HRmax is guessed from statistical values only, so that the standard error is accordingly higher.[24 25 26]
- The sit-to-stand one minute test roughly estimates P at only one point, thus estimating the approximate VO_{2max} value. However, this test is a good overall screening of strength and exercise capacity, and results can be evaluated using reference tables. Furthermore, this test can indicate limitations in respiratory performance when O2 saturation decrements are detected (with pulse oximetry).[27 28.]
- The most radical reduction is a self-estimation of performance using a **validated questionnaire** (e.g., the validated Huet-questionnaire with a standard error of around 6% compared to the gold standard). The reliability of the test is however dependent on the candidate's sincerity. [29 30 31]

Outdoor maximal exercise stress tests:

Functional tests such as the time taken to swim a defined distance, as an annual measure of continuing fitness can provide longitudinal monitoring. Validated and standardized tests include:

- The stage 1 test, developed by N.L. Jones, uses increasing multiple steps to the maximum workload. $VO_{2\,max}$ is estimated as 3.5 x body weight[kg] + 10.98 x watt reached [32].
- The 12 min run test, developed by K.H. Cooper, measures the maximum distance run in 12 min. as a maximal effort, while estimating $VO_{2\,max}$ as: (number of meters covered /100 x 2) - 5.[33]

How to cope with the bias of indirect VO_{2max} predictions

While spiroergometry has a variability (standard error/ mean value) of 5 - 9 %,[34] indirect techniques will have higher variations due to the simplifications of the validated formulas. A comparative study by van Ooij[23] showed that highly selected, fit and relatively young navy divers have an average VO_{2max} of 45.5 (men) and 39.8 (females), which means that 58% of females and 25% of males did not achieve VO_{2max} of 40 ml/kg.min (11.4 METs). Thus, they would have failed if this was the limit to pass.

As some of the popular submaximal tests will considerably overestimate the performance of testees, we recommend using the formula of the Jones protocol,[12] which shows the smallest such bias. The authors found 43.6 % males and 26.6 % females with false positive and 2.0 % males resp. 4.5 % females with false negative results compared to the spiroergometry measurements around the VO_{2max} 40 threshold.

For the described inherent variability of the indirect VO_{2max} tests[26 12] we recommend using the predicted results as an indicator of performance, but not as a selection criterium for fitness per se.

Additional comments

It is important to note that no individual is able to perform work at their VO_{2max}. Sustained work is performed at a level below the maximum. The MED should use the information to determine the level of exercise an individual is able to sustain.

Any test using heart rate as part of the calculation of VO_{2max} estimation can be influenced by taking Beta blockers. It has become well known that divers are taking these medications to improve their physical test performance and MEDs should be aware of these biases (e.g. see Chester Step Test, below).

User guidance for some performance assessments

Four examples of typical performance assessments as described above are presented on the following pages

Note: These example forms are screenshots in reduced quality. Originals are in Appendix F, also available from www.edtc.org):

Example 1 **maximal stress test with indirect VO_2 estimation**
Cycle ergometer. reference values [35] [36] [37]

Example 2 **submaximal stress test with indirect VO_2 estimation**
Chester step test [38] [39] [40] [41] [42]

Example 3 **sit-to-stand one minute test**
STS protocol [43] [44] [28] [45] [27] [46] [47] [48]

Example 4 **HUET physical performance questionnaire**
Questionnaire [49]

Submaximal aerobic stress test – Multistage

CYCLE ERGOMETER TEST

1 **Definitions**:

$VO_{2(abs)}$ = Oxygen uptake [ml O_2/min]
$VO_{2(rel)}$ = Oxygen uptake/kg/min [ml O_2/min • kg]
$VO_{2(rel.max)}$ = Maximal relative O_2 uptake
Other suffixes instead of max: sm = Submax (80% of max)

M = Bodymass [kg]
P = Power [W]
MET = Metabolic Equivalent of Task
BP = Blood pressure
HR = Heart rate (pulse)

1 MET = Metabolic energy consumption at rest
= 3.5ml O_2/min • kg = 1.162 W/kg

2 **Find appropriate setup for the candidate**

a) Estimate $VO_{2(max)}$ of candidate
(from last test or questionnaire or self-rating of fitness class).

$VO_{2(rel.max)}$ = ...mlO2/min•kg (estimated)

b) Calculate predicted maximal power stage (in Watt) for a target $VO_{2(submax)}$ = 80% $VO_{2(max)}$ (from estimation in a) using formula of ACSM

$P_{(max)}$ = ... (predicted)

Pmax = ($VO_{2(rel.max)}$ - 7) * M / 10.8 → $P_{(submax)}$ = P_{max} * 0.8

$P_{(sm)}$ = ... (predicted)

c) Set maximal heart rate HR_{max} either estimated with formula **211 – 0.64 • age** (std-error 5-10 bpm, Nes, HUNT-study 2012), or preferably using the **real HR_{max} if available**.

HR_{max} = ...min^{-1}(predicted)

3 **Perform cycle ergometer test**

- Start with 50W/2min - 100W/2min - 150W/2min up to Pmax
- Cycle pace with 60 cycles/min constant
- Monitor heart rate every 30sec (not stopping exercise!)
- Use last HR value per stage. Should not vary from second last one >5% (steady rate)
- Stop when: pace not possible (muscles), HR = HR_{max}, respiratory exertion (use VAS), pain or other symptoms

HR Rest = ... min^{-1}/BP ....
HR 50W = ...min^{-1}/BP...........
HR 100W = ...min^{-1}/BP...........
HR 150W = ...min^{-1}/BP...........
HR 200W = ...min^{-1}/BP...........
HR 250W = ...min^{-1}/BP...........
HR 300W = ...min^{-1}/BP...........

HR post ….' = …….min^{-1}/BP……….
HR post ….' = …….min^{-1}/BP……….
HR post ….' = …….min^{-1}/BP……….

Stop criterion:..................................

4 **Predict aerobic capacity using graphical plot (Table A, page 2)**

- x-Axis = Watt (and $VO_{2(test)}$). y-Axis = HR
- Draw a straight line through HR points
- Draw horizontal line at HRmax (from 2c above)
- Draw a vertical line down from crossing point of test HR/HR_{max}. $P_{(max)}$ can be found on x-Axis

$P_{(max)}$ from plot= ....W

5 **Get VO2(rel.max)** using formula of 2b above (ACSM) or better interpolating from matrix in Table A (Kikkonos,FRIEND study)

$VO_{2(rel.max)}$ = ... ml O_2/min•kg

6 **Get METs** dividing by 3.5

METs = ...

7 **Compare your results with normal values** (see tables B+C of p.2)

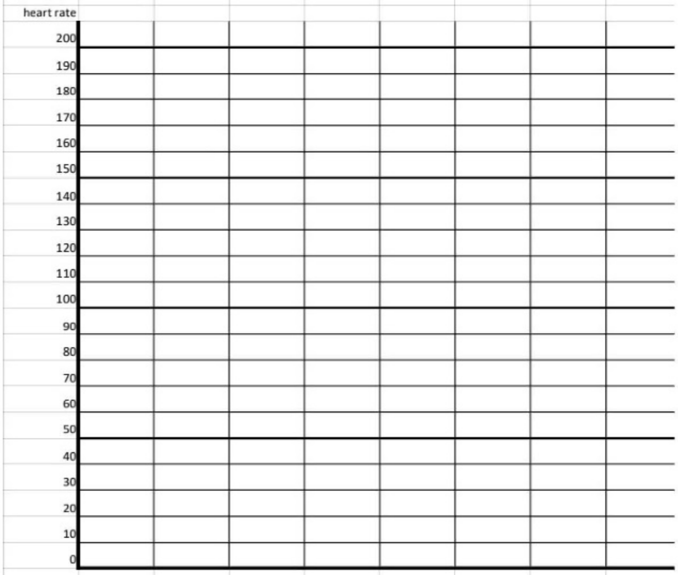
Fitness class = ...

Fitness percentile = ...

Name and date ....

Table A

Graphical Plot for finding VO2max from results of cycle ergometre test



weight[kg]	50	100	150	200	250	300	350 power[Watt]
50	14.1	24.8	35.4	46.1	56.7	67.4	78.0
55	13.2	22.9	32.5	42.2	51.9	61.6	71.3
60	12.4	21.2	30.1	39.0	47.9	56.7	65.6
65	11.7	19.9	28.1	36.3	44.5	52.6	60.8
70	11.1	18.7	26.3	33.9	41.5	49.1	56.7
75	10.6	17.7	24.8	31.9	39.0	46.1	53.2
80	10.2	16.8	23.5	30.1	36.8	43.4	50.1
85	9.8	16.0	22.3	28.6	34.8	41.1	47.3
90	9.4	15.3	21.2	27.2	33.1	39.0	44.9
95	9.1	14.7	20.3	25.9	31.5	37.1	42.7
100	8.8	14.1	19.5	24.8	30.1	35.4	40.8
105	8.6	13.6	18.7	23.8	28.9	33.9	39.0
110	8.3	13.2	18.0	22.9	27.7	32.5	37.4
115	8.1	12.8	17.4	22.0	26.6	31.3	35.9
120	7.9	12.4	16.8	21.2	25.7	30.1	34.6

⟸ VO_2 max (after Kokkinos non-sex-specific equation)

Equations for Predicting Maximal Oxygen Uptake

a/ Liguori G. ACSM's Guidelines for Exercise Testing and Prescription (S.491)

VO2max = 7 + (0.03 * Power[watt] / weight[kg])
be aware that this equation is overestimating performance (bias of 15.46±0.13%)

b/ Kokkinos et al. Eur J Prev Cardiol 2018; 25(10), 1077-1082

for males:
VO2max = 3.5 +(1.76 * 6.12 * power[watt] /weight[kg])

for females:
VO2max = 3.5 +(1.65 * 6.12 * power[watt] /weight[kg])

non-sex-specific:
VO2max = 3.5 +(1.74 * 6.12 * power[watt] /weight[kg])

These formulas are based on FRIEND registry prediction values (bias only 0.51±1.1%)

- **Instructions for drawing** the graph: see page 1, point 4
- Use o for heartrate
  v for systolic BP
  ʌ for diastolic BP
- Find $VO_{2\,max}$ from P_{max} & weight (Table A)

Table C DOI: 10.5935/2359-4802.20190057

Table 6 - Classification of cardiorespiratory fitness - AEMA table

Men										
Classification	Percentile	7 - 12 years (n = 32)	13 - 19 years (n = 151)	20 - 29 years (n = 543)	30 - 39 years (n = 969)	40 - 49 years (n = 853)	50 - 59 years (n = 440)	60 - 69 years (n = 229)	70 - 79 years (n = 77)	≥ 80 years (n = 26)
Very poor	≤ 20	< 28.77	< 34.76	< 29.79	< 28.37	< 26.53	< 24.23	< 20.61	< 18.26	< 16.11
Poor	40	28.78 - 35.30	34.77 - 39.73	29.80 - 34.41	28.38 - 32.73	26.54 - 30.43	24.24 - 27.75	20.62 - 23.79	18.26 - 20.64	16.12 - 17.20
Moderate	60	35.31 - 38.21	39.74 - 44.60	34.42 - 38.51	32.74 - 37.08	30.44 - 34.30	27.76 - 31.29	23.80 - 27.08	20.65 - 22.22	17.21 - 19.04
High	80	38.22 - 44.64	44.61 - 50.10	38.52 - 42.75	37.09 - 42.58	34.31 - 39.07	31.30 - 35.56	27.09 - 31.00	22.23 - 25.64	19.05 - 22.76
Very high	100	> 44.65	> 50.10	> 42.76	> 42.58	> 39.07	> 35.55	> 31.00	> 25.64	> 22.76
Women										
Classification	Percentile	7 - 12 years (n = 25)	13 - 19 years (n = 107)	20 - 29 years (n = 471)	30 - 39 years (n = 874)	40 - 49 years (n = 759)	50 - 59 years (n = 551)	60 - 69 years (n = 322)	70 - 79 years (n = 123)	≥ 80 years (n = 16)
Very poor	≤ 20	< 23.00	< 24.90	< 23.15	< 21.61	< 19.22	< 17.63	< 15.95	< 14.18	< 13.97
Poor	40	23.01 - 26.20	24.91 - 27.80	23.16 - 26.05	21.62 - 24.42	19.23 - 21.92	17.64 - 20.16	15.96 - 18.13	14.19 - 15.95	13.96 - 15.87
Moderate	60	26.21 - 29.23	27.81 - 30.44	26.06 - 29.00	24.43 - 27.10	21.93 - 24.54	20.17 - 22.33	18.14 - 20.04	15.56 - 17.78	15.88 - 17.25
High	80	29.24 - 35.15	30.45 - 35.30	29.01 - 33.00	27.11 - 30.51	24.55 - 27.92	22.34 - 25.25	20.05 - 22.29	17.79 - 20.90	17.26 - 19.11
Very high	100	> 35.15	> 35.30	> 33.00	> 30.51	> 27.92	> 25.25	> 22.29	> 20.90	> 19.11

Table B (from Loe, HUNT study. 2013)
https://doi.org/10.1371/journal.pone.0064319.

males - Percentiles of age related fitness [vo2max]

%	20-29y	30-39y	40-49y	50-59y	60-69y	70+y
1	34.9	31.7	29.3	25.4	23.6	20.2
5	40.6	36.8	34.5	30.4	28.2	24.6
10	43.6	39.5	37.3	33.1	30.6	27.0
20	47.3	42.8	40.7	36.4	33.6	29.8
30	50.0	45.2	43.2	38.7	35.7	31.9
40	52.3	47.2	45.3	40.7	37.5	33.7
50	54.4	49.1	47.2	42.6	39.2	35.3
60	56.5	51.0	49.2	44.5	40.9	37.0
70	58.8	53.0	51.2	46.5	42.7	38.7
80	61.5	55.4	53.7	48.8	44.9	40.8
90	65.2	58.7	57.1	52.1	47.8	43.6
95	68.2	61.4	59.9	54.8	50.2	46.0
99	73.9	66.5	65.1	59.8	54.8	50.4

females - Percentiles of age related fitness [vo2max]

%	20-29y	30-39y	40-49y	50-59y	60-69y	70+y
1	21.8	24.2	22.4	21.1	19.2	16.2
5	25.4	28.8	27.0	25.0	22.7	19.7
10	27.3	31.3	29.6	27.1	24.6	21.6
20	29.6	34.3	32.6	29.6	26.8	23.9
30	31.3	36.4	34.8	31.4	28.4	25.6
40	32.8	38.3	36.7	33.0	29.8	27.0
50	34.1	40.0	38.4	34.4	31.1	28.3
60	35.4	41.7	40.2	35.8	32.4	29.6
70	36.9	43.6	42.0	37.4	33.8	31.0
80	38.6	45.7	44.2	39.2	35.4	32.7
90	40.9	48.7	47.2	41.7	37.6	35.0
95	42.8	51.2	49.8	43.8	39.5	36.9
99	46.4	55.8	54.4	47.7	43.0	40.4

doi:10.1371/journal.pone.0064319.t002

Name and date: ....

Submaximal aerobic stress test - Multistage

CHESTER STEP TEST

1 Definitions:

$VO_{2(abs)}$ = Oxygen uptake [ml O_2/min]
$VO_{2(rel)}$ = Oxygen uptake/kg/min [ml O_2/min • kg]
$VO_{2(rel.max)}$ = Maximal relative O_2 uptake

H = Height of step [m]
M = Bodymass [kg]
f = Step-frequency [min^{-1}]
MET = Metabolic Equivalent of Task

Other suffixes instead of max: sm = Submax (80% of max)
Test = VO_2 calculated from H and f

1 MET = Metabolic energy consumption at rest
= 3.5ml O_2/min • kg = 1.162 W/kg

2 Find appropriate setup for the test

a) Estimate $VO_{2(rel.max)}$ of candidate (from last test or questionnaire or self-rating of fitness class).
$VO_{2(rel.max)}$ = ...ml/min•kg

b) Choose optimal H targeting a $VO_{2(test)}$ at 30 steps/min^{-1}
$VO_{2.sm}$ = 80% VO_{2max} (from estimation in a) using formula of ACSM)
$VO_{2(rel.sm)}$ = ... ml/min• kg

$VO_{2rel(step)} = (0.2 • f)+(1.33 • 1.8 • H • f) + 3.5$
or read from table A (from page 2)

$VO_{2(st\ I.}$ .... cm x 15) ....
$VO_{2(st\ II.}$ .... cm x 20) ....
$VO_{2(st\ III.}$ .... cm x 25) ....
$VO_{2(st\ IV.}$ ....cm x 30) ....

c) Set maximal heart rate HR_{max} either estimated with formula **211 – 0.64 • age** (std-error 5-10 bpm, Nes, HUNT-study 2012), or preferably using the **real HR_{max} if available**.
HR_{max} = ...min^{-1}

3 Perform step test

- Stage I = 15/min, Stage II = 20/min, Stage III = 25/min...
- 2min "up-up-down-down"- stretch knees completely, head is upright
- Pace with metronome, set at 4•f. To be changed every 2min for next stage
- Monitor HR every 30sec (not stopping exercise!)
- Use mean of last 3 HR values per stage. Should be within 5% variance (steady state).
- Stop when: step rate cannot be hold or HR = HRmax or Borg VAS>18 or pain

HR(stage I) = ... min^{-1}
HR(stage II) = ... min^{-1}
HR(stage III) = ... min^{-1}
HR(stage IV) = ... min-

4 Predict aerobic capacity using graphical plot (page 2)
x-Axis = $VO_{2(stages)}$, y-Axis = HR
Draw a line through datapoints (neglect stage I and max if deviating)
Draw a horizontal line at HRmax (from 2b above)
Draw a vertical line down from crossing of test-results line with horizontal line, which gives VO_{2max} on the x-Axis
$VO_{2(rel.max)}$ = ...ml/min•kg

5 Get METs dividing by 3.5
METs = ...

6 Compare your results with normal values (tables B+C of page 2)
Fitness class = ...
Fitness percentile = ...

Name and date ....

Submax aerobic steptest_Multistage_240203.docx

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Graphical Plot for finding VO2max from results of multistage step-test

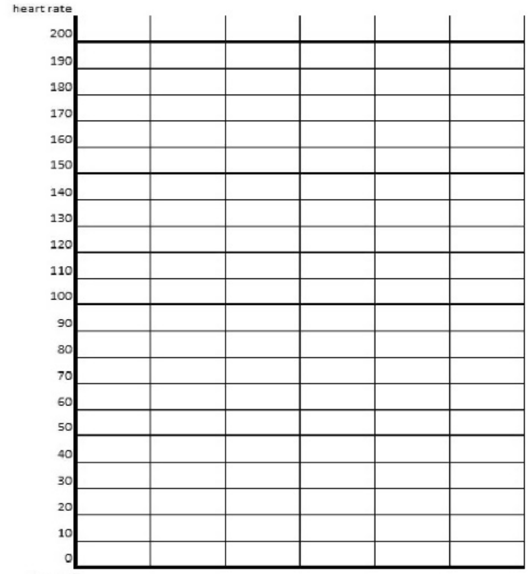

Table A

step height [cm]	15	20	25	30	35
20	13.7	17.0	20.5	23.9	27.6
25	15.5	19.5	23.5	27.5	31.4
30	17.3	21.9	26.5	31.0	35.6
35	19.0	24.3	29.4	34.6	39.8
40	20.9	26.7	32.4	38.2	44.0

step frequency [min−1]

table A VO2 calculated by formula VO2 = (10.8 * P / M) + 7 [Ref ACSM]

Table C (DOI: 10.5935/2359-4802.20190057)

Table 6 - Classification of cardiorespiratory fitness - AEMA table

Men										
Classification	**Percentile**	**7 - 12 years (n = 32)**	**13 - 19 years (n = 151)**	**20 - 29 years (n = 543)**	**30 - 39 years (n = 969)**	**40 - 49 years (n = 853)**	**50 - 59 years (n = 440)**	**60 - 69 years (n = 229)**	**70 - 79 years (n = 77)**	**≥ 80 years (n = 26)**
Very poor	≤ 20	< 28.77	< 34.76	< 29.79	< 28.57	< 26.53	< 24.23	< 20.61	< 18.26	< 16.11
Poor	40	28.78 - 35.30	34.77 - 39.73	29.80 - 34.41	28.58 - 32.73	26.54 - 30.43	24.24 - 27.75	20.62 - 23.79	18.26 - 20.64	16.12 - 17.20
Moderate	60	35.31 - 38.21	39.74 - 44.60	34.42 - 38.51	32.74 - 37.08	30.44 - 34.30	27.76 - 31.29	23.80 - 27.08	20.65 - 22.22	17.21 - 19.04
High	80	38.22 - 44.64	44.61 - 50.10	38.52 - 42.76	37.09 - 42.58	34.31 - 39.07	31.30 - 35.56	27.09 - 31.00	22.23 - 25.64	19.05 - 22.76
Very high	100	> 44.65	> 50.10	> 42.76	> 42.58	> 39.07	> 35.56	> 31.00	> 2 5.64	> 22.76
Women										
Classification	**Percentile**	**7 - 12 years (n = 25)**	**13 - 19 years (n = 107)**	**20 - 29 years (n = 471)**	**30 - 39 years (n = 874)**	**40 - 49 years (n = 759)**	**50 - 59 years (n = 551)**	**60 - 69 years (n = 322)**	**70 - 79 years (n = 123)**	**≥ 80 years (n = 16)**
Very poor	≤ 20	< 23.00	< 24.90	< 23.15	< 21.61	< 19.22	< 17.63	< 15.95	< 14.18	< 13.97
Poor	40	23.01 - 26.20	24.91 - 27.80	23.16 - 26.05	21.62 - 24.42	19.23 - 21.92	17.64 - 20.16	15.96 - 18.13	14.19 - 15.95	13.98 - 15.87
Moderate	60	26.21 - 29.23	27.81 - 30.44	26.06 - 29.00	24.43 - 27.10	21.93 - 24.54	20.17 - 22.33	18.14 - 20.04	15.96 - 17.78	15.88 - 17.25
High	80	29.24 - 35.15	30.45 - 35.0	29.01 - 33.00	27.11 - 30.51	24.55 - 27.92	22.34 - 25.25	20.05 - 22.29	17.79 - 20.90	17.26 - 19.11
Very high	100	> 35.15	> 35.00	> 33.00	> 30.51	> 27.92	> 25.25	> 22.29	> 20.90	> 19.11

Table B

males - Percentiles of age related fitness [vo2max]

%	20-29y	30-39y	40-49y	50-59y	60-69y	70+y
1	34.9	31.7	29.3	25.4	23.6	20.2
5	40.6	36.8	34.5	30.4	28.2	24.6
10	43.6	39.5	37.3	33.1	30.6	27.0
20	47.3	42.8	40.7	36.4	33.6	29.8
30	50.0	45.2	43.2	38.7	35.7	31.9
40	52.3	47.2	45.3	40.7	37.5	33.7
50	54.4	49.1	47.2	42.6	39.2	35.3
60	56.5	51.0	49.2	44.5	40.9	37.0
70	58.8	53.0	51.2	46.5	42.7	38.7
80	61.5	55.4	53.7	48.8	44.9	40.8
90	65.2	58.7	57.1	52.1	47.8	43.6
95	68.2	61.4	59.9	54.8	50.2	46.0
99	73.9	66.5	65.1	59.8	54.8	50.4

females - Percentiles of age related fitness [vo2max]

%	20-29y	30-39y	40-49y	50-59y	60-69y	70+y
1	21.8	24.2	22.4	21.1	19.2	16.2
5	25.4	28.8	27.0	25.0	22.7	19.7
10	27.3	31.3	29.6	27.1	24.6	21.6
20	29.6	34.3	32.6	29.6	26.8	23.9
30	31.3	36.4	34.8	31.4	28.4	25.6
40	32.8	38.3	36.7	33.0	29.8	27.0
50	34.1	40.0	38.4	34.4	31.1	28.3
60	35.4	41.7	40.2	35.8	32.4	29.6
70	36.9	43.6	42.0	37.4	33.8	31.0
80	38.6	45.7	44.2	39.2	35.4	32.7
90	40.9	48.7	47.2	41.7	37.6	35.0
95	42.8	51.2	49.8	43.8	39.5	36.9
99	46.4	55.8	54.4	47.7	43.0	40.4

doi:10.1371/journal.pone.0064319.t002

Submax aerobic steptest_Multistage_240203.docx

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Royal Brompton and Harefield hospitals

Adaptation for EDTC fitness-to-dive manual

NHS

1 MINUTE SIT-TO-STAND TEST

One-minute sit to stand test instructions for patients

We are asking patients to complete a one-minute sit to stand test during the medical examination, or even at home before a phone or video appointment. Step-by-step guide for the test:

Some tips before you start the test

- Wear loose, comfortable clothing and sturdy, non-slip shoes.
- Do not do the test, if you are feeling more unwell, have a current infection, the weather is very hot

The equipment you need

- A straight-backed chair which has a flat, hard seat and no arm rests. A dining chair, for example
- Stopwatch or timer
- Pulse oximeter

One-minute sit to stand test instructions

1. Place the back of the chair against a wall to stop it moving while you are doing the test.
2. Before you start, measure your oxygen levels and heart rate using a pulse oximeter and measure breathlessness using the BORG breathlessness scale. Write down all the results in the table on page 2.
3. Set a timer for one minute. Make sure you put the timer so you can see it easily when you are doing the test (normally someone else will time the test).
4. Sit down in the chair so that your feet are flat on the floor.
5. Then put your hands on your hips, let them hang by your sides or hold them loosely together.
6. Stand up from the chair until your legs are **completely** straight – making sure that you do not use your hands or arms to help you. Then sit back down again. This counts as one sit to stand.
7. Continue sitting up and down on the chair as many times as you can in one minute.
8. Rest for a few seconds if you need to during the test, and then carry on if you can.
9. Stop the test at any time if you feel unwell, have chest pain, dizziness or severe breathlessness.
10. When you finish the test write down how many sit to stand exercises you completed in one minute.
11. Then measure your heart rate and oxygen levels using the pulse oximeter and your breathlessness using the BORG scale.
12. Write down these results in the table on the next page so we can compare them at your next appointment.

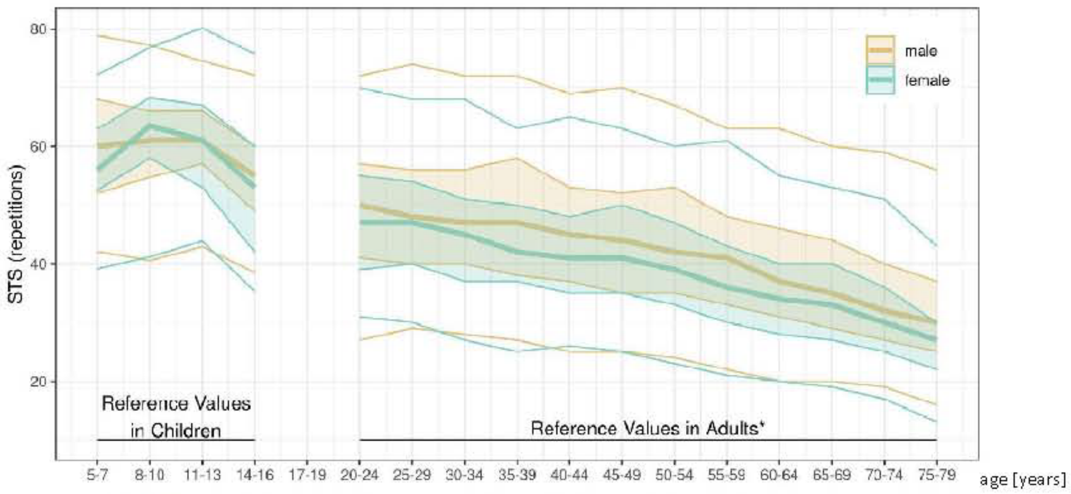
Borg GA. Psychophysical bases of perceived exertion. Med Sci Sports Exerc 1982;14:377–81

Royal Brompton and Harefield hospitals are part of Guy's and St Thomas' NHS Foundation Trust.

1-minute sit-to-stand-test

	pre	post 0	post 1'	post 2'	post 3'
sat-O2					
Heart rate					
peak flow					

name:	
date / time	
number of standups:	



To cite: Haile SR, Fühner T, Granacher U, *et al.* Reference values and validation of the 1-minute sit-to-stand test in healthy 5–16-year-old youth: a cross-sectional study. *BMJ Open* 2021;**11**:e049143. doi:10.1136/bmjopen-2021-049143

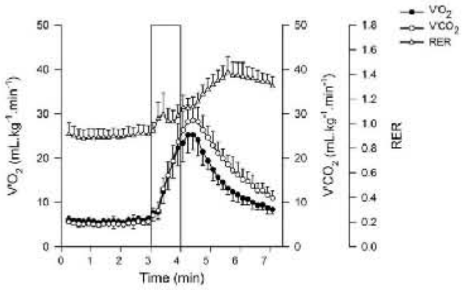
Strassmann A, Steurer-Stey C, Lana KD, *et al.* Population-based reference values for the 1-min sit-to-stand test. *Int J Public Health* 2013;58:949–53.

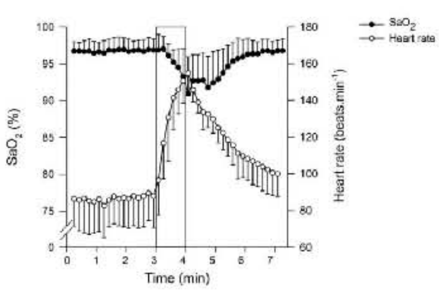
equation (adapted from [17]):

$$Power_{STS}(Watt) = \frac{(LL-0.4) * body\ mass * g * STS_{reps}}{Time_{STS}}$$

LL represents the leg length (in m); 0.4 the seat height (in m); g the acceleration of gravity (9.81 $m.s^{-2}$); STS_{reps} the number of repetitions during the 1-min STS test and $Time_{STS}$ the duration of the test (60s).

In this study, very strong correlations were observed between $Power_{STS}$ (W) and CPET-derived absolute $V'O_{2peak}$ ($L \cdot min^{-1}$)





Cited from: Radtke T, Hebestreit H, Puhan MA, Kriemler S. The 1-min sit-to-stand test in cystic fibrosis - Insights into cardiorespiratory responses. J Cyst Fibros. 2017 Nov;16(6):744-751. doi: 10.1016/j.jcf.2017.01.012

[17] Takai Y, Ohta M, Akagi R, Kanehisa H, Kawakami Y, Fukunaga T. Sit-to-stand test to evaluate knee extensor muscle size and strength in the elderly: a novel approach. J Physiol Anthropol 2009;28:123–8

QUESTIONNAIRE TO PREDICT MAXIMAL OXYGEN UPTAKE

Benoît Huet, Dépt. d'éducation physique, Université de Montréal, 1984
(English adaptation by Luc Léger)

HUET QUESTIONNAIRE

Note: Put the number corresponding to your choice in the blank space in the right margin

1	**What kind of physical effort does your job (or studies) require?**	**Score**	
	• Intense (e.g. lumberman, furniture mover)	2	
	• Relatively intense (e.g. constructor, messenger)	1	
	• Not so intense (e.g. department store salesman)	0.5	
	• Sedentary (e.g. white collar, office worker, student)	0	
2	**What kind of physical activities do you usually do?**		
	• Those that make you sweat or breath heavier on a regular basis (e.g. jogging, cross-country, skiing)	3	
	• Those that make you breath heavier intermittently (e.g. walking, racquetball)	2	
	• Those that make you breath slightly heavier (e.g. walking, softball)	1	
	• Easy of accuracy activities (e.g. bowling, archery)	0.5	
3	**During this past year, how many times a month have you practiced your favourite physical activity?**		
	• 0 to 4 times per month	0	
	• 5 to 8 times per month	1	
	• 9 to 12 times per month	2	
	• 13 times or more per month	3	
4	**What is the usual duration (minutes) of your exercise period?** *Note: If your answer to question 2 was 0.5, record "0" in the right margin*		
	• Less than 15 min	0	
	• 16 to 30 min	1	
	• 31 to 45 min	2.5	
	• 46 to 60 min	3.2	
	• 61 min o more	3.5	

5	**How do you usually qualify your exercise sessions:** *Note: If your answer to question 2 was 0.5, record "0" in the right margin*	**Score**		
	• Very easy	1		
	• Easy	1.5		
	• More or less difficult	2.5		
	• Difficult	3		
	• Very difficult	3.5		
6	**When age 10 to 16 years old, did you do physical exercises on a regular basis?**			
	• On a regular basis (more than 4 times a week)	2		
	• Not often (3 times or less a week)	1		
	• Rarely (1 time or less a week)	0		
7	**How many cigarettes a day to you smoke?**			
	• 0 to 2	0		
	• 3 to 15	-1		
	• 16 or more	-2		
8	**According to your own judgement, how much extra (fat) weight do you have?**			
	• 0 to 1 kg (0 to 2 lbs)	1		
	• 1.5 to 3 kg (3 to 6 lbs)	0		
	• 3.5 to 5 kg (7 to 10 lbs)	-1		
	• 5 kg or more (ll lbs or more)	-2		
		Sum of 1 - 8		**X1**
9	**Did you ever perform physical activities or sports in a competition setup**			
	• No	0		
	• Yes, regional events (e.g. popular racing)	3		
	• Yes, provincial or state events	4		
	• Yes, national or international events	5		
10	**Do you suffer from any of the following pathological conditions and nevertheless have your physicians' permission to practice intense or regular physical activities?** Diabetes; hypertension, cardiac or respiratory problems; asthma; obesity; arthritis			
	• Yes	-5		
	• No	0		
		Sum of 9 + 10		**X2**

Name: ....

Date: ....

Y = Predicted maximal O_2 uptake (VO_{2max})
Y (♂) = 45.334 - (0.322 • age) + (1.729 - (0.018 • age)) • X1 + X2
Y (♀) = 37.145 - (0.316 • age) + (0.951 - (0.004 • age)) • X1 + X2

VO_{2max} predicted: ....

huet_Max O2 uptake_questionnaire_E_221130.docx

Ref: Trivel et al, Validity of the Huet Questionnaire (2004)

Literature:

[1] IMCA. Guidance on health, fitness and medical issues in diving operations [internet]. London: International Marine Contractors Association; 2018 Oct. Available from: https://www.imca-int.com/product/guidance-on-health-fitness-and-medical-issues-in-diving-operations/

[2] Guazzi M, Adams V, Conraads V, Halle M, Mezzani A, Vanhees L, AHA: Arena R, Fletcher GF, Forman DE, Kitzman DW, Lavie CJ, Myers J. Clinical recommendations for cardiopulmonary exercise testing data assessment in specific patient populations. Eur Heart J. 2012 Dec;33(23):2917–2927. doi.org/10.1093/eurheartj/ehs221.

[3] Fletcher GF, Balady GJ, Amsterdam EA, Chaitman B, Eckel R, Fleg J, Froelicher VF, Leon AS, Piña IL, Rodney R, Simons-Morton DA, Williams MA, Bazzarre T. Exercise standards for testing and training: a statement for healthcare professionals from the American Heart Association. Circulation. 2001 Oct 2;104(14):1694-740. doi: 10.1161/hc3901.095960. PMID: 11581152.

[4] Forman DE, Myers J, Lavie CJ, Guazzi M, Celli B, Arena R. Cardiopulmonary exercise testing: relevant but underused. Postgrad Med. 2010 Nov;122(6):68-86. doi: 10.3810/pgm.2010.11.2225. PMID: 21084784; PMCID: PMC9445315.

[5] Andrist E, Nuppnau M, Barbaro RP, Valley TS, Sjoding MW. Association of Race With Pulse Oximetry Accuracy in Hospitalized Children. JAMA Netw Open. 2022 Mar 1;5(3):e224584. doi: 10.1001/jamanetworkopen.2022.4584. PMID: 35357460; PMCID: PMC8972025.

[6] Gottlieb ER, Ziegler J, Morley K, Rush B, Celi LA. Assessment of Racial and Ethnic Differences in Oxygen Supplementation Among Patients in the Intensive Care Unit. JAMA Intern Med. 2022 Aug 1;182(8):849-858. doi: 10.1001/jamainternmed.2022.2587. PMID: 35816344; PMCID: PMC9274443.

[7] Henry NR, Hanson AC, Schulte PJ, Warner NS, Manento MN, Weister TJ, Warner MA. Disparities in Hypoxemia Detection by Pulse Oximetry Across Self-Identified Racial Groups and Associations With Clinical Outcomes. Crit Care Med. 2022 Feb 1;50(2):204-211. doi: 10.1097/CCM.0000000000005394. PMID: 35100193; PMCID: PMC9070439.

[8] Valbuena V S M, Seelye S, Sjoding M W, Valley T S, Dickson R P, Gay S E et al. Racial bias and reproducibility in pulse oximetry among medical and surgical inpatients in general care in the Veterans Health Administration 2013-19: multicenter, retrospective cohort study. BMJ 2022; 378 :e069775 doi:10.1136/bmj-2021-069775

[9] Jubran A. Pulse oximetry. Crit Care. 2015 Jul 16;19(1):272. doi: 10.1186/s13054-015-0984-8. PMID: 26179876; PMCID: PMC4504215.

[10] Sinex JE. Pulse oximetry: principles and limitations. Am J Emerg Med. 1999 Jan;17(1):59-67. doi: 10.1016/s0735-6757(99)90019-0. PMID: 9928703.

[11] Balady GJ, Arena R, Sietsema K, Myers J, Coke L, Fletcher GF, Forman D, Franklin B, Guazzi M, Gulati M, Keteyian SJ, Lavie CJ, Macko R, Mancini D, Milani RV; American Heart Association Exercise, Cardiac Rehabilitation, and Prevention Committee of the Council on Clinical Cardiology; Council on Epidemiology and Prevention; Council on Peripheral Vascular Disease; Interdisciplinary Council on Quality of Care and Outcomes Research. Clinician's Guide to cardiopulmonary exercise testing in adults: a scientific statement from the American Heart Association. Circulation. 2010 Jul 13;122(2):191-225. doi: 10.1161/CIR.0b013e3181e52e69. Epub 2010 Jun 28. PMID: 20585013.

[12] Jones NL, Kane JW. Quality control of exercise test measurements. Med Sci Sports. 1979 Winter;11(4):368-72. PMID: 530034

[13] Barron AJ, Dhutia NM, Gläser S, Koch B, Ewert R, Obst A, Dörr M, Völzke H, Francis DP, Wensel R. Physiology of oxygen uptake kinetics: Insights from incremental cardiopulmonary exercise testing in the Study of Health in Pomerania. IJC Metab Endocr. 2015 Jun;7:3-9. doi: 10.1016/j.ijcme.2015.02.002. PMID: 26339572; PMCID: PMC4547190.

[14] Liguori G, American College of Sports Medicine. ACSM's Guidelines for Exercise Testing and Prescription. 11th ed. Philadelphia: 2021. 541p. ISBN 9781975150198 (paperback) | ISBN 9781975150211 (epub).

[15] Kokkinos P, et al. A new generalized cycle ergometry equation for predicting maximal oxygen uptake: The Fitness Registry and the Importance of Exercise National Database (FRIEND). Eur J Prev Cardiol 2018; 25(10), 1077-1082. DOI: 10.1177/2047487318772667.

[16] De Souza e Silva CG, et al. A reference equation for maximal aerobic power for treadmill and cycle ergometer exercise testing: Analysis from the FRIEND registry. Eur J Prev Card. 2018, 25(7):742–750. DOI: 10.1177/2047487318763958.

[17] Fox SM III, Naughton JP, Haskell WL. Physical activity and the prevention of coronary heart disease. Am Clin Res. 1971; 3(6):604-632.

[18] Tanaka H, Monahan KD, Seals DR. Age-predicted maximal heart rate revisited. J Am Coll Cardiol. 2001 Jan;37(1):153-6. doi: 10.1016/s0735-1097(00)01054-8. PMID: 11153730.

[19] Nes BM, Janszky I, Wisløff U, Støylen A, Karlsen T. Age-predicted maximal heart rate in healthy subjects: The HUNT fitness study. Scand J Med Sci Sports. 2013 Dec;23(6):697-704. doi: 10.1111/j.1600-0838.2012.01445.x. Epub 2012 Feb 29. PMID: 22376273.

[20] Inbar O, Oren A, Scheinowitz M, Rotstein A, Dlin R, Casaburi R. Normal cardiopulmonary responses during incremental exercise in 20- to 70-yr-old men. Med Sci Sports Exerc. 1994 May;26(5):538-46. PMID: 8007799.

[21] Björkman F. Validity and reliability of a submaximal cycle ergometer test for estimation of maximal oxygen uptake. [Internet] [PhD dissertation]. Stockholm: Gymnastik och idrottshögskolan, GIH; 2017. Available from: http://urn.kb.se/resolve?urn=urn:nbn:se:gih:diva-5095

[22] Rusdiana A. Analysis Differences of Vo2max between Direct and Indirect Measurement in Badminton, Cycling and rowing. Intern J Appl Exerc Physiol. 2020 VOL.9 (3):162-170. Doi: 10.26655/IJAEP.2020.3.5.

[23] Van Ooij PJ, T. Takken, Antoinette Houtkooper, Robert van Hulst . Measured versus calculated maximum oxygen uptake: a world of difference? J Occ Soc Security Med. 2009 Oct;17(10):441-446. doi: 10.1007/BF03081315 . Available from: https://www.researchgate.net/publication/225151973_Gemeten_versus_berekende_maximale_zuurstofopname_een_wereld_van_verschil [accessed Dec 12 2022].

[24] Latin RW, Berg K, Kissinger K, Sinnett A, Parks L. The accuracy of the ACSM stair-stepping equation. Med Sci Sports Exerc. 2001 Oct;33(10):1785-8. doi: 10.1097/00005768-200110000-00026. PMID: 11581567.

[25] Astrand PO, Rodahl K. Textbook of Work Physiology. New York: McGraw-Hill; 1977. 650p. ISBN 9780070024052.

[26] González Camarena R, Carrasco Sosa S. Consumo de oxígeno máximo directo e indirecto en sujetos sedentarios residentes de la altitud moderada [Direct and indirect maximum oxygen consumption in sedentary subjects living at a moderate altitude]. Arch Inst Cardiol Mex. 1989 May-Jun;59(3):273-8. Spanish. PMID: 2782990.

[27] Haile SR, Fühner T, Granacher U, Stocker J, Radtke T, Kriemler S. Reference values and validation of the 1-minute sit-to-stand test in healthy 5-16-year-old youth: a cross-sectional study. BMJ Open. 2021 May 7;11(5):e049143. doi: 10.1136/bmjopen-2021-049143. PMID: 33963059; PMCID: PMC8108674.

[28] Crook S, Büsching G, Schultz K, Lehbert N, Jelusic D, Keusch S, Wittmann M, Schuler M, Radtke T, Frey M, Turk A, Puhan MA, Frei A. A multicentre validation of the 1-min sit-to-stand test in patients with COPD. Eur Respir J. 2017 Mar 2;49(3):1601871. doi: 10.1183/13993003.01871-2016. PMID: 28254766.

[29] Trivel D, Calmels P, Léger L, Busso T, Devillard X, Castells J, Denis C. Validity and reliability of the Huet questionnaire to assess maximal oxygen uptake. Can J Appl Physiol. 2004 Oct;29(5):623-38. doi: 10.1139/h04-040. PMID: 15509875.

[30] Sjostrom, M., Ainsworth, B.E., Bauman, A., Bull, F.C., Hamilton-Craig, C.R., & Sallis, J.F. (2005). Guidelines for data processing analysis of the International Physical Activity Questionnaire (IPAQ) - Short and long forms [internet]. IPAC. 2005. CRID 1573950400545533440. Available from: https://www.researchgate.net/file.PostFileLoader.html?id=56f92d66615e27d49a658031&assetKey=AS%3A344600888791041%401459170662924

[31] World Health Organization WHO. Global physical activity questionnaire (GPAQ) [internet]. Nov 2021. Available from: https://www.who.int/publications/m/item/global-physical-activity-questionnaire

[32] Jones NL. Clinical Exercise Testing. 4th ed, Philadelphia: Saunders; 1997.

[33] Cooper KH, A Means of Assessing Maximal Oxygen Intake, JAMA. 1968:203:135-138.

[34] ATS/ACCP. Statement on Cardiopulmonary Exercise Testing. Am J Respir Crit Care Med Vol 167. Pp 211–277, 2003. DOI: 10.1164/rccm.167.2.211. Available from: www.atsjournals.org

[35] Loe H, Rognmo Ø, Saltin B, Wisløff U. Aerobic capacity reference data in 3816 healthy men and women 20-90 years (HUNT study). PLoS One. 2013 May 15;8(5):e64319. doi: 10.1371/journal.pone.0064319. Erratum in: PLoS One. 2013;8(11). doi:10.1371/annotation/e3115a8e-ca9d-4d33-87ef-f355f07db28e. PMID: 23691196; PMCID: PMC3654926.

[36] Pollock NW, Buzzacott P. Measuring aerobic fitness in divers. Diving Hyperb Med. 2014 Sep;44(3):174. PMID: 25311329.

[37] Maritz JS, Morrison JF, Peter J, et. al. A practical method of estimating an individual's maximal oxygen uptake. Ergonomics. 1961;4:97-122.

[38] Reed JL, Cotie LM, Cole CA, Harris J, Moran B, Scott K, Terada T, Buckley JP, Pipe AL. Submaximal Exercise Testing in Cardiovascular Rehabilitation Settings (BEST Study). Front Physiol. 2020 Jan 8;10:1517. doi: 10.3389/fphys.2019.01517. PMID: 31969825; PMCID: PMC6960105.

[39] Sykes K. and Roberts, A. The Chester step test-a simple yet effective tool for the prediction of aerobic capacity. Physiotherapy. 2004;90:183-188.

[40] de Andrade CH, de Camargo AA, de Castro BP, Malaguti C, Dal Corso S. Comparison of cardiopulmonary responses during 2 incremental step tests in subjects with COPD. Respir Care. 2012 Nov;57(11):1920-6. doi: 10.4187/respcare.01742. Epub 2012 Jun 15. PMID: 22709990.

[41] Latin RW, Berg K, Kissinger K, Sinnett A, Parks L. The accuracy of the ACSM stair-stepping equation. Med Sci Sports Exerc. 2001 Oct;33(10):1785-8. doi: 10.1097/00005768-200110000-00026. PMID: 11581567.

[42] Druskins LM. Assessing aerobic capacity: A comparison of five step-test methods [master thesis]. Texas Tech University; 1993. Available from https://ttu-ir.tdl.org/handle/2346/60900

[43] Bohannon RW, Crouch R. 1-Minute Sit-to-Stand Test: Systematic review of procedures, performance and clinimetric properties. J Cardiopulm Rehabil Prev. 2019 Jan;39(1):2-8. doi: 10.1097/HCR.0000000000000336. PMID: 30489442.

[44] Büsching G. Short Physical Performance Battery Test - Ein Muss in der Geriatrie. Physiopraxis. 2015 Jan. doi: 10.1055/s-00000162. German.

[45] Fernandes AL, Neves I, Luís G, Camilo Z, Cabrita B, Dias S, Ferreira J, Simão P. Is the 1-Minute Sit-To-Stand Test a Good Tool to Evaluate Exertional Oxygen Desaturation in Chronic Obstructive Pulmonary Disease? Diagnostics (Basel). 2021 Jan 22;11(2):159. doi: 10.3390/diagnostics11020159. PMID: 33499088; PMCID: PMC7911810.

[46] Radtke T, Hebestreit H, Puhan MA, Kriemler S. The 1-min sit-to-stand test in cystic fibrosis - Insights into cardiorespiratory responses. J Cyst Fibros. 2017 Nov;16(6):744-751. doi: 10.1016/j.jcf.2017.01.012. Epub 2017 Feb 7. PMID: 28188010.

[47] Strassmann A, Steurer-Stey C, Lana KD, Zoller M, Turk AJ, Suter P, Puhan MA. Population-based reference values for the 1-min sit-to-stand test. Int J Public Health. 2013 Dec;58(6):949-53. doi: 10.1007/s00038-013-0504-z. Epub 2013 Aug 24. PMID: 23974352.

[48] NHS. Royal Brompton and Harefield hospitals. One-minute sit to stand test instructions. Information for pulmonary hypertension patients [internet]. Apr 2021. Available from: https://www.rbht.nhs.uk/sites/nhs/files/Leaflets/One%20minute%20sit%20to%20stand%20test%20instructions%20-%20April%202021.pdf

[49] Trivel D, Calmels P, Léger L, Busso T, Devillard X, Castells J, Denis C. Validity and reliability of the Huet questionnaire to assess maximal oxygen uptake. Can J Appl Physiol. 2004 Oct;29(5):623-38. doi: 10.1139/h04-040. PMID: 15509875.

Appendix B

Checklist for resumption of work after DCI

European Diving Technology Committee – Fitness to dive standards

Checklist for resumption of work under pressure after DCI or diving emergency

This is an expert assessment which should be restricted to a diving physician with appropriate experience and competence in both hyperbaric and occupational medicine.

The aim is to evaluate whether the experienced emergency or medical condition affects the risk for future diving or hyperbaric exposures.

This assessment should usually not be conducted before treatment and rehabilitation are concluded.

The assessment step-by-step:

- **Analysis of the case**: Exploration of causes and finding a pathogenetical explanation for the problem
  a) Was the accident easily predictable? (in-depth-anamnesis, diving technique and history, accident dive profile). If doubtful analyse dive profile using a software showing the degree of supersaturation during the dive, ideally indicating the “gradient factor”.
  b) Are symptoms and signs and their evolution typical (suggestive) of a particular pathogenesis? (autochthonous bubbles / arterial AGE bubbles / venous bubbles shunting / secondary growth of arterial micro-bubbles / inflammatory effects from endothelial damage / capillary leak / lung congestion with IPO / IEBT / IEDCS / lung barotrauma / marine animal effects/ etc.).
  c) Even if symptoms are “typical”, consider alternative causes that could explain the presentation (differential diagnoses), then estimate the degree of certainty of the primary diagnosis (evident / highly probable / probable, i.e. >50% / possible, i.e. <50% / improbable, i.e. not excluded)
  d) Create a hypothesis: final diagnosis with pathogenetical explanation.
- **Extent of the injury/ tissue damage**:
  - Severity of initial symptoms (pain, livedo, sensory, motor, vestibular, lymphatic, pulmonary, cardial)
  - Evolution of symptoms and signs
  - Easily resolving in 24h (spontaneously, with surface oxygen or with 1 x HBOT)
  - Not further resolving after > 1 x HBOT
  - Sequelae (irrelevant, disabling for what kind of activities, etc.)
  - Silent sequelae (neuronal penumbra, dysbaric bone necrosis, etc.)
- **Likelihood of a recurrence**:
  Estimation based on clinical evaluation and epidemiological evidence (IPO / history of > 1 DCI / PFO / eustachian tube dysfunction / lung pathology / behavioural predispositions (psych.))
- **Severity of potential future episodes**:
  Impact on quality of life or fitness to work
- **Conclusion**:
  Define condition for resumption of work under pressure, evaluating the risk, i.e., combining likelihood and severity of future complications:
  - Unacceptable risk: stop diving
  - Acceptable with increased risk control: low-bubble diving / adapted work place conditions / hyperbaric work without immersion / etc.
  - Acceptable, but delayed: Extend temporary unfitness until foreseeable consolidation of injured tissues or subject to further rehabilitation
  - Acceptable: declare "fit for work under pressure" if general examination does not show further contraindications.

Appendix C – Extract of EDTC-Manual ISBN 3-9522284-2-7 / 2024-05

Appendix C

Educational and training standards for physicians in diving and hyperbaric medicine

Prepared by the Joint Educational Subcommittee of the European Committee for Hyperbaric Medicine (ECHM) and of the European Diving Technical Committee (EDTC)

Note: This appendix contains an extract of the training standards 2011.

Training standards are actually under revision. The full text of the actual version is available from www.edtc.org.

Also downloadable from the website of EDTC:

- *"Training Objectives for a diving medicine physician 2013" (39 pages).*
- *Competence and conditions for the recognition of level 3 diving doctors are defined in a separate standard: "EDTC Competence standards for physicians of occupational diving and tunnelling companies 2019".*

Introduction

These educational and training standards are the result of some years of international discussion and extensive educational experience both in diving and hyperbaric medicine. It is based on two main documents:

1. "*Educational and Training Standards for the Staff of Hyperbaric Medical Centres*" written in 1997 by Jordi Desola, representative of the European Committee for Hyperbaric Medicine (ECHM), and Jurg Wendling, representative of the European Diving Technical Committee (EDTC) for the Joint Educational Subcommittee of the ECHM and EDTC.[1]
2. "*Training Objectives for a Diving Medicine Physician based on current ECHM, EDTC and DMAC sources*" prepared by David Elliott with subsequent input from members of the EDTC and DMAC committees and from several non-European members of the Pisa Initiative.[2]

Those documents have been further reviewed by the members of the Joint Educational Subcommittee of the ECHM and the EDTC in 2011.[3] At that time "Training Objectives for a Hyperbaric Medicine Physician" were added (prepared by Wilhelm Welslau and Jacek Kot). Based on the modular structure of the proposed training courses, a minimal number of study hours needed to achieve the training objectives were proposed for both level 2D (Diving Medicine) and level 2H (Hyperbaric Medicine).

Definition of jobs

Before any consideration of a training programme, the training objectives of each job needs to be defined in relation to the competencies that are expected from the incumbent. Several jobs in diving and hyperbaric medicine have common tasks and objectives and it is therefore possible to optimise the efficiency of the educational program and avoid too much overlap by adopting a modular structure. We therefore first defined the jobs that are compatible with the other EDTC and ECHM standards:

[1] Members of the Joint Educational Subcommittee of the ECHM and EDTC 1997: Jordi Desola (Spain, chair ECHM workgroup), David Elliott (United Kingdom), Pasquale Longobardi / P. Pelaia (Italy), Francis Wattel (France), and Jürg Wendling (Switzerland, chair EDTCmed).

[2] L'Abbate A, Elliott D. *The Pisa inter-university initiative for the medical and physiological support of complex and deeper diving*. Diving Hyperb Med. 2009;39:110-111.

[3] Members of the Joint Educational Subcommittee of the ECHM and EDTC 2011: Jordi Desola (Spain), David Elliott (United Kingdom), Jürg Wendling (Switzerland), Pasquale Longobardi (Italy), Alessandro Marroni (Italy), Wilhelm Welslau (Germany) and Jacek Kot (Poland).

Level 1. "Medical Examiner of Divers" (MED)

- Competent to perform the "Fitness to dive assessments" of working and recreational divers and compressed air workers but excluding the return to diving assessment following major decompression incidents.
- Basic proficiency in occupational medicine is highly recommended for those of Level 1 who examine commercial divers and compressed air workers.

Level 2D. "Diving Medicine Physician" (DMP)

- 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 diving medical 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 comply with the standards.
- Should have certified skills and basic practical experience in fitness-to-dive assessment, management of diving accidents, safety planning for professional diving operations, advanced life support and acute trauma care as well as general wound care.

Level 2H. "Hyperbaric Medicine Physician" (HMP)

Responsible for hyperbaric sessions at the treatment site (with backup of a hyperbaric medicine 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 a certified specialist in anaesthesia and intensive care to comply with the standards).
- Competent to assess and manage clinical patients for HBO treatment.

Level 3. "Hyperbaric medicine expert or consultant (hyperbaric and/or diving medicine)"

- Competent as chief of a hyperbaric facility (HBO centre) and/or to manage the medical and physiological aspects of complex diving activities.4
- 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.

4. "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.

Training programs

This chapter describes the principles of training to the level of competence required for the jobs defined in Chapter 2. As the jobs require a certain amount of knowledge and theoretical basis, but also practical skills and basic experience, the following training steps using a modular approach are proposed:

- Course level 1 "Medical examiner of divers" (diploma)
- Course level 2D "Diving medicine" (diploma)
- Course level 2H "Hyperbaric medicine" (diploma)

[4] Optional additional qualification for bell diving (saturation, mostly offshore).

- Individual applied training (clinical on-site or performing skills training modules and specialised courses) to achieve the practical experience and skills for a certificate of competence as diving medical physician (2D) or a certificate of competence is hyperbaric medicine physician (2H).
- Final assessment for certification as diving medicine physician or hyperbaric medicine physician, independent of course faculties (the goal is an international standard).
- CME: Refresher courses and skills trainings according to the agreed plans.

The Level 2D and Level 2H physician will already have the status of specialist accreditation (“board certification”) in a field of clinical medicine. However, the subsequent experience that the doctor will then need to acquire and the requirements for later revision are not addressed here. Theoretical courses, even with practical exercises included in teaching hours, will not replace the clinical experience. So, the level 2D and level 2H should be treated as an initial training of young physicians before getting experience in normal work at the diving site or in the hyperbaric facility.

Content of modules

The required competence needed for each subject differs at each of Levels 1, 2D, 2H and 3 (Table 1). Description of levels of competence is included in the Appendix 1. Training objectives for both Level 2D and Level 2H are included in Appendix 2 and 3, respectively.

In order to take into account the development of modern educational techniques, a credit system will be used by the accreditation body with a conversion rule ensuring that all content of the syllabus will be presented to the students regardless of the method.

Table 1. Modules with level of competence (LoC) and proposed number of hours (NoH).
Levels of competence: a – basic; b - need to know; c - must be expert.

	Jobs:	1	2D LoC	2D NoH	2H LoC	2H NoH	3
1	**Physiology & pathology of diving and hyperbaric exposure:**			**24**		**30**	
1.1	Hyperbaric physics	**b**	**c**	**2**	**c**	**2**	**c**
1.2	Diving related physiology I (functional anatomy, respiration, hearing and equilibrium control, thermoregulation)	**b**	**c**	**2**	**b**	**1**	**c**
1.3	Hyperbaric pathophysiology of immersion	**b**	**c**	**1**	**a**	**2**	**c**
1.4	Pathophysiology of decompression	**b**	**c**	**2.5**	**b**	**2.5**	**c**
1.5	Acute dysbaric disorders: a brief introductory section	**b**	**c**	**2.5**	**b**	**2.5**	**c**
1.6	Chronic dysbaric disorders (Long term health effects)	**b**	**c**	**2**	**a**	**2**	**b/c**
1.7	HBO-Basics – physiology and pathology	**-**	**b**	**4**	**c**	**10**	**c**
1.8	Oxygen toxicity	**a**	**c**	**2**	**c**	**2**	**c**
1.9	Pressure and inert gas effects	**a**	**c**	**1.5**	**a**	**1.5**	**c**
1.10	Medication under pressure	**b**	**c**	**1.5**	**c**	**1.5**	**c**
1.11	Non-dysbaric diving pathologies	**a**	**c**	**3**	**-**	**3**	**c**
2	**Diving technology and safety:**			**8**		**8**	
2.1	Basic safety planning	**b**	**b**	**1**	**-**	**1**	**a/c**
2.2	Compressed air work	**b**	**b**	**1**	**b**	**1**	**a/c**
2.3	Diving procedures	**b**	**c**	**1**	**a**	**1**	**a/ c**
2.4	Characteristics of various divers	**b**	**b**	**0.5**	**a**	**0.5**	**a/c**
2.5	Diving equipment	**b**	**b**	**0.5**	**a**	**0.5**	**a/c**
2.6	Diving tables and computers	**b**	**b**	**2**	**b**	**2**	**a/c**
2.7	Regulations and standards for diving	**b**	**b**	**1**	**-**	**1**	**a/c**
2.8	Saturation diving	**b**	**c**	**1**	**-**	**1**	**a/c**

3	**Fitness to dive**			**4**		**4**	
3.1	Criteria and contraindications (for divers, tunnel workers and HBOT patients and chamber personnel)	**c**	**c**	**2**	**c**	**2**	**c**
3.2	Fitness to dive examination and assessment	**c**	**c**	**1**	**c**	**1**	**c**
3.3	Standards and regulations (professional and recreational)	**c**	**c**	**1**	**b**	**1**	**c**
4	**Diving accidents:**			**10**		**10**	
4.1	Diving incidents and accidents	**a**	**c**	**1**	**a**	**1**	**c**
4.2	Emergency medical support (with no chamber on site)	**-**	**c**	**2**	**c**	**2**	**c**
4.3	Decompression illnesses	**a**	**c**	**2**	**c**	**2**	**c**
4.4	Immediate management of decompression illnesses: recompression tables and strategies	**a**	**c**	**3**	**c**	**3**	**c**
4.5	Rehabilitation of disabled divers	**-**	**a**	**1**	**a**	**1**	**b/c**
4.6	Diving accident investigation	**-**	**a**	**1**	**a**	**1**	**c/a**
5	**Clinical HBO:**			**8**		**42**	
5.1	Chamber technique (multiplace, monoplace, transport chambers, wet recompression)	**-**	**b**	**2**	C	**6**	**c**
5.2	HBO: Mandatory Indications	**-**	**a**	**2**	**c**	**6**	**c**
5.3	HBO: Recommended Indications	**-**	**-**	**-**	**c**	**4**	**c**
5.4	HBO: experimental and anecdotal indications	**-**	**-**	**-**	**b**	**2**	**c**
5.5	Data collection / statistics / evaluation	**-**	**b**	**1**	**b**	**3**	**c**
5.6	General basic treatment (nursing)	**-**	**b**	**-**	**c**	**4**	**c**
5.7	Diagnostic, monitoring and therapeutical devices in chambers	**-**	**c**	**1**	**c**	**5**	**c**
5.8	Risk assessment, incidents monitoring and safety plan in HBO-Chambers	**-**	**b**	**1**	**c**	**9**	**c**
5.9	Safety regulations	-	**c**	**1**	**c**	**3**	**c**
6	**Miscellaneous**			**2**		**2**	
6.1	Research standards	**-**	**a**	**1**	**a**	**1**	**c**
6.2	Paramedics teaching program	**-**	**b**	**0.5**	**a**	**0.5**	**c**
6.3	Management /Organisation of HBO facility	**-**	**a**	**0.5**	**a**	**0.5**	**c**
7	**Practical training:**			**24**		**24**	
7.1	Fitness of the course participants	-	+	**2**	+	**2**	+
7.2	Practical revision of examination skills	+	+	**1**	+	**1**	+
7.3	Practice in HBO-T (including pressure test and experience of nitrogen narcosis)	-	+	**8**	+	**8**	+
7.4a	CPR	-	+	**2**	+	**2**	+
7.4b	Practice in field first aid (diving accidents)	-	+	**2**	-	**2**	+
7.5	Underwater experience	(+)[5]	+[6]	**4**	-	**4**	+
7.6a	Demo : professional diving	+	+	**4**	-	**1**	+
7.6b	Demo : HBO-T	-	+	**1**	+	**4**	+
	TOTAL:	**28**	**-**	**80**	**-**	**120**	**-**

5 recommended
6 exceptions possible, if important reasons of unfitness to dive

Certificate of competency and recertification

Audit of training courses and harmonised final assessment

Free movement of qualified personnel - the main goal of these standards - will only be possible if a credible authority certifies their competency of specifically trained candidate. With the definition of auditing agency for the course modules and an internationally harmonised final assessment of the candidates, this goal is almost achieved. This is in conformity with other international efforts (from USA, Australia and South Africa) and should not be limited to the geographical area of Europe. An institution supervising the validity of individual certificates and serving as identification databank should be established in the future.[7]

Logbook

The practical skills training should be monitored and validated by the certifying institution. The candidate shall have a logbook with the list of the criteria to be fulfilled and the relative weight of each action. These units added will give a score. Using this system, the candidates may compensate for some missing score points by adding surplus points from another action.[8]

Certification

Certificates of competence may be handed out by a nationally accredited institution or an internationally acknowledged agency.

Recertification

A revalidation of a specialist's status through continuous medical education is now generally introduced for all medical professionals. According to the EU-guidance, the professionals define the conditions and in an interval of 3 years[9] all certificates must be renewed. In most of the EU-countries, the conditions for maintaining the active status of an individual are defined by some system of continuous medical education credit points (CME, alternatively called continuous professional development CPD).

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 diving and hyperbaric medicine to those who would not attend the diving and hyperbaric scientific congresses.

The training standards define the minimum requirement for this in a flexible way that provides enough freedom for the national bodies to establish a more detailed system (see table 3). It is expected that these national requirements will be compatible with our guidance.

[7] In Europe such function has been delegated to the European College of Baromedicine (ECB, www.ECBM.org).

[8] The detailed mechanism is under preparation.

[9] Until Diving and Hyperbaric Medicine is not recognized as specialisation, the proposed interval for renewing of certification is at least every 5 years or less, if defined by national regulations.

6.5. Summary

Table 2. Summary of levels - conditions for certification and recertification.

	Diploma	Certificate of Competency	Continuous medical education
Level 1 „Medical Examiner of Divers”	Approved physician (w/o specialty). Successful completion of Course Level 1	Diploma “Medical Examiner of Divers” (Level 1)	Renewal at least every 5 years Proof of examinations of 30 divers in the last 3 years and Successful completion of a refresher course or equivalent (16 hours, content of course 1)
Level 2D „ Diving Medicine Physician”	Diploma I Successful completion of course 2D	Diploma 2D Attestation of skills and practical experience in fitness to dive assessment, management of diving accidents, safety planning for professional diving operations (according to a score with the logbook). Attested skills in basic and advanced life support including external automatic defibrillation (equivalent to ACLS). Certified skills in acute trauma care (equivalent to ATLS) and wound care. Basic proficiency in occupational medicine. Final assessment (internationally based, according to the Pisa initiative).	Renewal at least every 5 years Continuing experience in the field of professional diving (e.g. advising a professional diving contractor or some equivalent activity or alternatively attending a skills training course) and scientific update by participation in a refresher course, congress or literature studies. Reactivation after laps should be on the basis of specifically approved course
Level 2H „Hyperbaric Medicine Physician“	Diploma 1 Successful completion of course 2H Proof of 6 months work as medical intern in intensive/critical care	Diploma 2H 6 months work as medical intern in an approved hyperbaric centre	Renewal at least every 5 years Continuing experience in the field of HBO therapy and scientific update by participation in a refresher course, congress, or literature studies. Reactivation after laps should be on the basis of a specifically approved course.
Level 3 „Expert in Diving Medicine” / „Expert in Hyperbaric Medicine” / „Expert in Diving and Hyperbaric Medicine”	*recognition of a level 3 expert by ECHM and level 3 Diving medical advisor by EDTC are specified in a separate document.*	*recognition of a level 3 expert by ECHM and level 3 Diving medical advisor by EDTC are specified in a* separate *document.*	*recognition of a level 3 expert by ECHM and level 3 Diving medical advisor by EDTC are specified in a separate document.*

Appendix D
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MSH: The co-authors of the MedSubHyp-SFMT Workgroup
SUHMS: The co-authors of the original Swiss manual's reference section

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Appendix E
Forms

These forms are available for individual download from www.edtc.org

Medical examination:

- Initial and In-depth Medical Assessment
- Annual Medical Assessment
- Certificate of Fitness for Work under Pressure

Forms and checklists for physical performance tests:

- Cycle Ergometry Exercise test
- Chester Step-test
- One-minute sit-to-stand test
- Huet Questionnaire to predict maximal oxygen uptake

Referral letters for specialist advice:

> The following pages should help medical examiners of divers and hyperbaric workers to refer candidates with recognised risks to a specialist. These template forms explain that the specialist is requested to return specific information to the examiner, who then assess the overall risk and hand out the certificate. In other words, it is not the specialist that decides whether the candidate is fit or unfit for hyperbaric exposures.

- Referral for specialist advice (general form)
- Referral for ENT specialist advice
  This form contains recommendations to ENT specialists what examinations are expected to clarify the risk of hyperbaric exposures.