

Diving fitness

what GPs need to know

Recreational scuba diving is a fast growing leisure sport, and many patients require their doctors to be capable of giving an opinion about their medical fitness to dive. It is essential that the examiner have an understanding of the hyperbaric environment. This article discusses diving fitness and the current regulatory framework in Australia.

ROBYN WALKER

MB BS, DDHM

Dr Walker is Deputy Fleet Medical Officer, Maritime Headquarters, Potts Point, NSW.

To certify that a person is fit to undertake any form of diving requires that individual to be physically fit, medically healthy and psychologically stable. Many doctors limit their consultation to the exclusion of disease rather than undertaking a comprehensive assessment based upon their knowledge of different marine environments, range of diving equipment, diving gas mixtures to be used and the skills required to ensure the diver's safety.

The approach to diving fitness varies from country to country. Some countries demand a mandatory diving medical with very prescriptive guidelines. This approach protects the diving instructor agency (and in the process the medical practitioner accepts all the risk), but the candidate has limited opportunity to participate in the

process. Other countries have no requirement for the prospective diver to undergo a diving medical, and the candidates assume all the risk. They are also denied the opportunity to discuss this risk with a diving medical doctor.

The recreational diver has more flexibility than a professional diver in when and where he or she dives. In some environmental conditions no recreational diver is fit to dive, whereas in other circumstances diving is safe for most individuals. Professional and military divers, however, have a requirement to complete their tasks no matter how hostile the environment. The professional and military diver often works in a team and must be able to replace, or be replaced by, other members as the task demands. Therefore, all individuals must be capable of performing all jobs.

IN SUMMARY

- Follow the medical guidelines for scuba diving contained within either the Australian Standard or the SPUMS diving medical examination pro-forma.
- Consider whether the diver has a condition or disease that affects his or her in-water safety, or the safety of companion divers.
- Physical fitness does not infer fitness for scuba diving.
- Divers over the age of 40 should undergo regular review, and consideration should be given to conducting a maximal exercise test.
- Provide clear and rational explanations to a prospective diver who is being declared unfit to dive – to discourage the candidate presenting to another medical practitioner and failing to disclose his or her condition.

Diving medical examinations guidelines

Australian Standards has produced guidelines for diving medical examinations (see the box on page 22). These standards are considered best practice, and although a medical practitioner can deviate from the standard he or she may be required to defend that position in court against expert testimony from diving medical specialists. Queensland is the only State in Australia that currently has an industry code of practice, requiring all entry-level divers to have passed the diving medical examination in accordance with AS 4005.1-1992. The South Pacific Underwater Medicine Society (SPUMS) publishes a diving medical examination pro-forma, from which the Australian standards developed. The Australian standards and SPUMS diving medical pro-formas may be copied by medical practitioners for use in their surgeries.

Questions to consider

Whichever guidelines are used, there are four important questions to consider when assessing fitness to dive:¹

- does the diver have a condition or disease that affects his or her in-water safety?
- does the disease or condition affect the safety of other divers who might have to lend assistance?
- will diving exacerbate the condition or disease?
- will diving result in any long term sequelae in the presence of the condition or disease?

Asthma, for instance, is associated with reduced exercise tolerance and may well prevent the diver from swimming against a one-knot current back to the boat. Consequently, the buddy diver may have to assist the impaired diver (who is also likely to be experiencing panic) as well as exert considerable energy to reach the vessel. Asthma is known to be precipitated by saltwater inhalation and exercise, both clearly possibilities while diving. Asthma is associated with air trapping, which may predispose the individual to pulmonary barotrauma of ascent and cerebral arterial gas embolism, which can result in death or serious neurological sequelae. Clearly, all four questions are answered in the affirmative and the candidate with asthma should be advised not to dive.

This approach can be used for all conditions but presupposes the doctor understands the environment and equipment to be used. The doctor is

Diving fitness

This image is unavailable due to copyright restrictions

To the uninformed, restricting a diver to shallow depths may offer a level of protection. However, as the greatest pressure changes occur in the first 10 m of water, the novice diver is at most risk near the surface. Fitness to dive is a complex issue requiring GPs to have a clear understanding of the underwater environment, the diving equipment and the physical and psychological health of the patient.

© ART AND SCIENCE, 1993

advised to explain rationally any decision to exclude a candidate from diving (using the above questions as examples). If a candidate is told without adequate explanation that he or she is not fit to dive, the candidate is likely to present to another practitioner and not disclose the medical condition so as to be passed fit. The diver is the loser in this scenario; this is of little consolation if the diver

Diving medical examinations guidelines

- AS 4005.1-1992: Training and certification of recreational divers (cited in the industry code of practice, but a new standard was released in 2000, see www.standards.com.au)
- AS/NZS 2299.1:1999: Occupational diving operations
- Queensland Government Industry Code of Practice: Compressed air recreational diving and recreational snorkelling
- South Pacific Underwater Medicine Society diving medical (revised December 1999)

and/or the diving buddy suffers a serious injury as a result of nondisclosure.

The doctor must take care when conducting diving medical examinations on poor- or non-English speaking tourists who wish to undertake a recreational diving course. Translators must be used if the doctor is to provide a comprehensive and informed decision regarding the individual's fitness to dive.

Physical fitness

Aquatic conditions can change dramatically within a short period of time. The

dive may commence in ideal conditions with flat seas and no current, and 40 minutes later the diver may surface in stormy conditions with a 2 m swell and over one knot of current. The diver must have sufficient reserves to cope with such conditions and render assistance to his or her buddy if required. Candidates who can swim 200 m without fins in less than five minutes are more likely to succeed in diving than those who cannot meet this relatively undemanding standard. Although a candidate may be a champion athlete in a particular sport, this does not automatically imply fitness to dive. The champion swimmer with asthma is such an example.

Age

Most diving physicians do not recommend that children dive deeper than 9 m prior to reaching osteogenic maturity (i.e. closure of the epiphyses). Although there is no direct evidence to support this, the belief is that bubbles (which form on every dive) may impair the growth plate and result in a shortened long bone.

Children do not have the physical or psychological maturity to deal with unexpected underwater hazards. Although the parents may declare their child will only dive with them, is it fair to expect, say, a 10-year-old child to render assistance to the parent if the parent becomes disabled in the water?

SPUMS and Australian Standards recommend 14 years as the minimum age for diving certification. Many schools conduct learn to dive classes as part of the school physical fitness curriculum. When consulted, I discuss the risks of diving with both the child and the parent. As a result, many elect to delay the diving experience until a later date.

There is no upper age limit for diving, but cardiovascular fitness should be assessed very carefully. Sudden death is increasingly being reported in middle-aged male divers, and this is thought to be cardiac in origin. Divers over the age of 40 should undergo regular review, and consideration should be given to conducting a maximal exercise test. Some have suggested that the ability to perform exercise up to 13 mets (metabolic equivalent units) be considered a reasonable minimum for diving activities.²

Cardiovascular system

Cardiovascular diseases are responsible for up to 25% of deaths in recreational scuba divers. The presence of serious cardiovascular disease disqualifies the candidate from diving because of the risk of sudden collapse or decreased exercise tolerance.

Respiratory system

Divers should be free from significant respiratory disease. At times, diving requires extreme physical exertion, and the lungs must also be able to tolerate rapid changes in volumes and pressures with equal compliance throughout the lungs.

A history of pneumothorax (either spontaneous or traumatic) precludes diving. Spontaneous pneumothoraces occur predominantly in young men and result from the rupture of small apical subpleural blebs. There is a high incidence of recurrence, and the rupture of a pleural bleb underwater may result in a tension pneumothorax. Surgical pleurodesis may prevent the recurrence of the pneumothorax, but it does not remove all blebs

Method for assessing a candidate with a history of asthma*

| | |
|---|------|
| • History of asthma over the last five years | Fail |
| • Requirement for bronchodilators over the last five years | Fail |
| • Respiratory rhonchi or other abnormality on auscultation | Fail |
| • High pitched expiratory rhonchi on hyperventilation | Fail |
| • High pitched expiratory rhonchi 5 to 10 minutes after exercise | Fail |
| • FVC <75% predicted, FEV ₁ <80% predicted | Fail |
| • FEV ₁ /FVC <75% predicted | Fail |
| • Bronchial provocation testing producing >10% reduction of expiratory flow rates after histamine, hypertonic saline, or exercise | Fail |
| • If all of the above are clear and the chest x-ray is normal | Pass |

*Devised by the Diving Medical Centre, Sydney.

and does not prevent cerebral arterial gas embolism. Also, this procedure may result in lung adhesions and decreased distensibility of the lungs, predisposing to pulmonary barotrauma.

Penetrating chest injuries, chest surgery and traumatic pneumothoraces are also considered as disqualifying conditions. Any scar within the lungs may affect local compliance and distensibility or promote gas trapping and predispose the candidate to pulmonary barotrauma.

Asthma, as previously discussed, is considered a disqualifying condition for diving. Recent debate has centred on the use of agents such as budesonide, which block the hyper-responsiveness of airways and effectively render the individual nonasthmatic. The debate continues because of the difficulties associated with long term compliance with medication and the maintenance of this nonresponsive state. One method for assessing potential divers with a history of asthma is presented in the box on page 22.

Most diving medical standards include spirometry and require that the forced vital capacity (FVC) be more than 4 L in males and 3 L in females and the forced expiratory volume in 1 second (FEV₁) be greater than 80% of the predicted values. Spirometry is useful for detecting obstructive or restrictive pulmonary disease, but contrary to popular belief the FEV₁/FVC ratio is not predictive for pulmonary barotrauma. The only lung volume measurement that has been associated with increased risk of pulmonary barotrauma is an FVC of less than 3 L.

Chest x-rays are no longer considered a mandatory investigation in prospective divers with no history of respiratory illness, a normal physical examination and acceptable lung function results. However, candidates should be told that without an x-ray the presence of cysts, bullae, fibrotic lesions and adhesions cannot be excluded. It is also wise to document that this advice has been given and the patient has accepted the risk.

Consultant's comment

Dr Walker has covered this subject with both expertise and clarity. It has been a long and tortuous path for diving medical physicians to impress on their medical colleagues the need for special training and skills for the safe performance of diving medical examinations. The situation has now improved, to the great safety benefit of all divers. However, there are still some medical practitioners who consider that a medical degree alone qualifies them to perform these assessments. With the ready availability of certified postgraduate courses in Australia, there is now no excuse for the continuation of such practices. Divers and diving instructors, as well as medical officers, now have a clear responsibility to seek assessments from only such qualified doctors. While this article cannot deal with every presently contentious issue (for which further advice should be sought from diving medical specialists), it is required reading for all GPs and specialists.

Dr John Williamson

Former Director of Diving and Hyperbaric Medicine
Royal Adelaide Hospital, SA

Upper respiratory tract

Acute disorders, such as an upper respiratory tract infection or allergic rhinitis, will temporarily disqualify the diving candidate. Vasoconstrictor agents should not be used when diving because of the risk of rebound congestion and barotrauma of ascent.

Nasal and sinus polyps and a deviated nasal septum may predispose the candidate to barotrauma. However, if he or she has not experienced problems with flying, mandatory referral for surgery is not indicated and a functional

test of middle ear and sinus equalisation in the swimming pool is recommended.

The ear

Eustachian tube function must be normal and the tympanic membrane must be observed to move before a candidate can be certified fit to dive. A healed perforation does not necessarily exclude a candidate; however, the presence of a weakened thin atrophic scar would give rise to concern.

Candidates who have any history of middle or inner ear surgery require

Procedure for sharpened (tandem) Romberg test

- Ensure an even floor space, free of furniture and fittings.
- The candidate should remain in shoes.
- Instruct the candidate to stand heel to toe with arms crossed over chest, right palm to touch left shoulder, left palm to touch right shoulder.
- Instruct the candidate to close the eyes for 60 seconds. During this 60-second period, if the candidate does not lose his or her balance a perfect score of 240 is given.
- If the candidate loses balance, the number of seconds the balance was maintained is counted (e.g. 30 seconds). The test is then repeated for three 60-second periods (to a total of 4 minutes), and all scores within each 60-second period are totalled and placed over 240.
- The pass score is 120.
- The candidate is instructed to resume the test position immediately after any loss of balance and the 60-second test period is recommenced immediately.

Organisations conducting training courses in diving fitness

- Diving Medical Centre, Brisbane: (07) 3376 1056
- James Cook University School of Public Health & Tropical Medicine, Townsville: (07) 4722 5700
- Prince of Wales Hospital Department of Diving & Hyperbaric Medicine, Sydney: (02) 9382 3880
- Royal Adelaide Hospital Department of Hyperbaric Medicine: (08) 8222 5116
- Royal Australian Navy Submarine & Underwater Medicine Unit, Sydney: (02) 9960 0572

SPUMS publishes a list of medical practitioners who are members of the society and who have successfully completed recognised training in diving medicine. This list is available at www.spums.org.au

careful assessment, because they may be predisposed to barotrauma.

Divers should have a baseline audiometry performed as part of their medical. Knowledge of the baseline hearing is very useful when assessing a candidate for likely inner ear barotrauma; it is essential to advise prospective divers that inner ear barotrauma may result in permanent

hearing loss and tinnitus. Candidates with significant noise-induced hearing loss may elect not to dive if made aware that a diving insult could further compromise their hearing.

Vestibular function (which can be assessed by the sharpened Romberg test; see the box on page 23) should be normal. Vestibular dysfunction as a consequence of, for example, Ménière's disease can result in disabling vertigo underwater, compromising the diver's safety.

The eye

Divers' vision must be such that they can read their gauges, avoid underwater obstacles and recognise their boat or in which direction is the shore. Prescription lenses can be fitted to most dive masks and many individuals dive with soft contact lenses without problems. Hard contact lenses, unless fenestrated, should not be worn when diving because of the risk of corneal damage from bubbles that form underneath the lens.

Procedures such as radial keratotomy, where deep incisions are made in the lens, are thought to increase the risk of globe rupture with a face mask squeeze. Newer procedures such as laser excimer keratotomy do not involve such deep incisions, and generally divers have

returned to diving without incident once full recovery has occurred.

Nervous system

Epilepsy is considered a contraindication to diving because of the risks of drowning and pulmonary barotrauma if the fitting diver is brought to the surface during the tonic phase of the convulsion.

Childhood febrile convulsions are not associated with adult epilepsy and do not exclude a candidate from diving.

Migraine, particularly if associated with nausea, vomiting, visual disturbance and neurological symptoms, will compromise a diver's safety. Diving itself is a known precipitant of migraine (raised carbon dioxide tension, cold water, glare, psychological stress and possibly increased oxygen tensions).

Head injuries pose an assessment dilemma because of both the effect on cognitive functioning and the risk of post-traumatic seizures. A high risk of post-traumatic epilepsy is associated with a prolonged period of loss of consciousness, seizure in the immediate post-trauma period, neurological deficit, depressed skull fracture and intracerebral haematoma. It is recommended that a prospective diver with any of the above features should be free of fits for at least

five years without medication before consideration is given to diving fitness.

Any spinal neurological deficit should be considered carefully because added to the limitation associated with the primary disease is the prospect that there may be an increased vulnerability to spinal cord decompression illness (DCI). There is also the dilemma faced by the treating physician if a diver surfaces with a progression of his or her neurological deficit – is this progression due to the disease itself or the onset of spinal DCI? A wrong decision may result in inappropriate treatment and may leave the patient with significant sequelae.

Diabetes mellitus

Diabetes is considered a disqualifying condition. The warning signs of hypoglycaemia are often masked underwater, and it is difficult to take supplementary glucose while submerged. A hypoglycaemic coma in a diver will almost certainly result in drowning. Also, diabetics have an increased risk of coronary artery and peripheral vascular disease, which may affect the individual's exercise response.

Pregnancy

Pregnancy is considered a contraindication to diving because of the unknown

risk to the fetus from bubbles. While the pregnant woman has not been shown to have an increased risk of DCI, any bubbles in the mother will pass through the placenta and, because of the fetal circulation, enter the fetal arterial circulation immediately. This is likely to have an ominous effect. Other difficulties can include: vomiting secondary to morning sickness, decreases in general mobility, the risk of fetal oxygen toxicity if the mother requires treatment for DCI, and the unknown effects of marine envenomation on the fetus.

Conditional certificates

To the uninformed, restricting a diver to shallow depths may offer a level of protection. However, as the greatest pressure changes occur in the first 10 m of water, the novice diver is at greatest risk nearest the surface. Conditional certificates restricting a diver to depths less than 18 m will not be accepted by the recreational diving instructor organisations and are meaningless. This does not prevent the GP from discussing safe diving strategies with patients.

Conclusion

Fitness to dive is a complex issue that requires the GP to have a clear under-

standing of the underwater environment, the diving equipment to be used, and the physical and psychological health of the patient. The GP must provide clear and rational explanations to a prospective diver who is being declared unfit to dive, to discourage the candidate presenting to another medical practitioner and failing to disclose his or her condition. GPs should follow the medical guidelines for scuba diving contained within either the Australian Standard or SPUMS diving medical examination pro-forma. **MT**

References

1. Elliott DH. The basis for medical examination of the diver. In: Elliott DH, ed. Medical assessment for fitness to dive. London: Biomedical Seminars, 1995.
2. Bove F. Cardiovascular diseases and diving. In: Fitness to dive. 34th Undersea and Hyperbaric Medical Society Workshop. Bethesda, MD: UHMS, 1987.

Further reading

1. Edmonds C, Lowry C, Pennefather J. Diving and subaquatic medicine. 3rd ed. Oxford: Butterworth-Heinemann, 1992.
2. Parker J. The sports diving medical. Carnegie, Victoria: JL Publications, 1994.