Diving Medical Guidance to the Physician

These guidelines are typically used by physicians who have been approached by an individual wishing to take part in recreational scuba diving or freediving. They will usually have completed a WRSTC Diver Medical Participant Questionnaire.

Recreational scuba diving and freediving (hereafter "diving") is performed safely by many people. The risks associated with diving may be increased by certain physical conditions, and the relationship to diving may not be readily appreciated by candidates. Thus, it is important to screen divers for such conditions.

A physical examination for diving focuses on conditions that may put a diver at increased risk for decompression sickness, pulmonary overinflation with subsequent arterial gas embolization, and other conditions such as loss of consciousness, which could lead to drowning. Additionally, divers must be able to withstand some degree of thermal stress, the physiological effects of immersion, and have sufficient physical and mental reserves to deal with normal diving and possible emergencies.

The history, review of systems, and physical examination should include as a minimum the points listed below. The list of conditions that might adversely affect the diver is not exhaustive, but contains the most commonly encountered medical problems. The brief introductions serve as an alert to the nature of the risk posed.

The potential diver and his or her physician must weigh the benefits to be had by diving against an increased risk of injury or death due to the individual's medical condition. As with any recreational activity, there are limited data for diving with which to calculate the mathematical probability of injury. Experience and physiological principles only permit a qualitative assessment of relative risk.

For the purposes of this document, **Severe Risk** implies that an individual is believed to be at substantially elevated risk of injury compared with the general population. The consultants involved in drafting this document would generally discourage a candidate with such medical problems from diving. **Relative Risk** refers to a moderate increase in risk, which in some instances may be acceptable. To make a decision as to whether diving is contraindicated for this category of medical problems, physicians must base their judgment on an assessment of the individual candidate. **Temporary Risk** refers to medical problems which may preclude diving but are temporary in nature, allowing the individual to dive after they have resolved.

Following many of the sections is a short list of references that give more information on the topic. The lists are not exhaustive, but examples that may be of particular relevance.

Diagnostic studies and specialty consultations should be obtained as indicated to determine the candidate's status. A list of references is included to aid in clarifying issues that arise.

The following sections are included in this document (click to jump to section):

Version date: 2023-02-28

BEHAVIORAL HEALTH

Behavioral health is one of the most difficult aspects of diver candidate evaluation, because many relevant potential problems may not be apparent and are not easily assessed in an office consultation. This is also an aspect of evaluating suitability for diving in which the diving instructor, who observes the candidate in the field, must also play a part. The diving candidate must be capable of learning and applying a theoretical knowledge base for diving. Significant intellectual handicap is incompatible with independent diving.

Motivational and behavioral traits should be considered if there is obvious related history or problems become apparent during training. Candidates who appear unmotivated, irresponsible, or prone to distraction or panic should be discouraged from diving.

A history of psychiatric disease is not in and of itself disqualifying. Psychotropic medications can be problematic if they are associated with altered level of awareness or sedation, or may alter seizure threshold, (e.g., benzodiazepines, narcotics). What is of primary importance is the individual's current psychological state, and anticipated impact of their mental/psychological history relative to their ability to navigate the potential and anticipated challenges and stresses of diving. The level of baseline mental health, with or without medication, is therefore of greater importance than the theoretical effects of a given medication or class of medications while diving.

Candidates with major depression, bipolar disorder, psychoses, or current drug or alcohol abuse should not dive. Even if a candidate is well controlled on medication (see below for discussion of SSRIs), there may be risks associated with the use of potent antidepressant and antipsychotic drugs in the underwater environment. The tendency for potent psychotropic drugs to impair concentration and cause drowsiness is of particular concern, as is their potential to lower the seizure threshold, and the lack of research data evaluating potential interactions with the pressure environment. Candidates with a past history of major psychiatric problems or drug/alcohol abuse who are stable without medication and withdrawn from drugs and alcohol can be considered on a case-by-case basis, preferably by a physician trained in diving medicine.

Perhaps the most challenging group of candidates from a behavioral perspective in the modern context is those with "mild" depression (those who have never been hospitalized for psychiatric treatment or placed on psychiatric hold or attempted self-harm) or those with mood disturbances treated with selective serotonin reuptake inhibitors (SSRIs). The general use of SSRIs has increased dramatically over recent years in many countries. There are no data describing use of SSRIs among divers, but anecdotally the numbers are significant. Concerns over diving while using SSRIs relate to the disorder being treated and to the potential interaction between the drug and diving. There are many candidates taking these drugs whose mild mood disturbance would not of itself constitute a reason to avoid diving. Evaluation of the potential for an interaction between SSRIs and diving is more difficult. There are no published reports of apparent problems despite what is almost certainly a large number of divers using them. Diving while taking an SSRI is probably acceptable provided that: the treated mood disturbance was mild prior to treatment and has been well controlled by the drug; the drug has been used for at least one month without evidence of relevant side effects; and the candidate is fully counseled about (and accepting of) the relevant risks. If the candidate is considering diving beyond the traditional recreational envelope or using gases other than air, he or she should consult an appropriate diving medicine specialist.

There are also potential risks associated with other drugs used to treat psychiatric conditions, including serotonin-norepinephrine reuptake inhibitors (SNRIs), tricyclic antidepressants (TCAs), monoamine oxidase inhibitors (MAOIs), and atypical agents (including bupropion). Candidates on these medications should be evaluated on a case-by-case basis.

Severe Risk Conditions

- Active major depression, bipolar or psychotic disorder
- History of panic attacks
- Drug or alcohol abuse
- Severe intellectual handicap

Relative Risk Conditions

- Questionable motivation to dive – solely to please spouse, partner or family member, or to prove oneself in the face of personal fears
- Developmental delay/Cognitive impairment
- Anxiety disorder
- History of drug or alcohol abuse
- History of major depression, bipolar, or psychotic disorder
- Use of psychotropic medications
- Claustrophobia or agoraphobia

CARDIOVASCULAR SYSTEMS

Diving places increased demands on the heart. Immersion itself results in an increase in cardiac preload, as does peripheral vasoconstriction with an increase in blood pressure. These changes are typically accompanied by sustained mild to moderate exercise. Perhaps not surprisingly, almost 30% of recreational diving fatalities have a cardiac event as the disabling injury. It follows that the primary goals of evaluating the cardiovascular system in a diving candidate are to identify those who appear to be at risk of myocardial ischemic events, myocardial insufficiency, or other cardiac events (such as arrhythmias) that might disable a diver underwater, and to establish that the candidate has an adequate exercise capacity for diving.

With the above in mind, some cardiac diagnoses are considered to render a candidate unsuitable for diving, including: untreated symptomatic coronary artery disease, dilated or obstructive or previous stress cardiomyopathy, congestive heart failure, moderate or worse pulmonary hypertension, long QT syndrome or other arrhythmia-inducing channelopathies, paroxysmal arrhythmias causing unconsciousness or impairment of exercise capacity, poor exercise capacity of apparent cardiac origin, moderate to severe valvular lesions, complex congenital cardiac disease, atrial septal defect, and the presence of an implanted cardiac defibrillator.
Potential candidates with any of the following should be investigated to exclude a disqualifying condition:

- Exertional chest pain, dyspnea, palpitations, or syncope
- Unexplained syncope/near syncope
- Heart murmur
- Hypertension
- Family history of premature death (sudden/unexpected or cardiac) before age 50, cardiac disease before age 50, cardiomyopathy, arrhythmia, or channelopathy

It is strongly recommended that these candidates be evaluated in consultation with a physician trained in diving medicine and possibly a cardiologist. Successful treatment of disqualifying cardiac disorders may result in a candidate becoming suitable for diving. For example, a candidate with coronary artery disease (including previous myocardial infarction) who has been successfully revascularized may be suitable for diving if inducible ischemia can be excluded and adequate exercise capacity demonstrated (for example, in an exercise stress test). The capacity to sustain exercise at 6 MET (metabolic equivalent of task; 1 MET approximates resting metabolic rate, assumed to approximate an oxygen consumption of 3.5 mL/kg/min; 6 MET approximates an effort of six times resting metabolic rate, approximating an oxygen consumption of 21 mL/kg/min is a pragmatic expectation for a recreational diver, but there may be an occasional need to exercise transiently at higher levels during diving. Similarly, a candidate with a history of paroxysmal arrhythmia who has undergone successful pathway ablation may be suitable for diving. Candidates with any of the above diagnoses who wish to consider diving after appropriate treatment are best referred to a physician trained in diving medicine for evaluation.

Asymptomatic candidates over 45 years of age with risk factors for coronary artery disease should undergo evaluation by a physician. Individuals with a predicted 5-10 year risk of a cardiovascular event >10% using a cardiac risk calculator should be investigated for coronary disease unless they provide a credible history of exercise capacity which renders significant coronary disease very unlikely. A coronary calcium score is a suitable initial investigation, and a myocardial perfusion scan, stress echocardiogram, or CT coronary angiogram should be considered in following up a positive calcium score. Consideration of a tailored investigation pathway for the individual diving candidate is ideally undertaken by a cardiologist in consultation with a physician trained in diving medicine. Candidates who prove to have inducible ischemia or obstructive lesions justifying intervention should not dive until completion of the intervention and demonstration of its success. Candidates with non-obstructive coronary disease not requiring invasive intervention should have aggressive management of risk factors and may be suitable for diving if adequate exercise capacity can be demonstrated. Although an exercise ECG is relatively insensitive to early coronary disease, it has the advantage of demonstrating exercise capacity and can be modified to test sustained exercise at 6 MET.

Left ventricular hypertrophy (LVH) is a risk factor for arrhythmias, which may be induced by exercise or immersion. Candidates for diving with this condition should be counseled about the risks of diving.

A patent foramen ovale (PFO) that exhibits right-to-left shunting with no or minimal provocation is a risk factor for serious neurological decompression sickness. In established divers, such lesions are usually discovered by bubble contrast echocardiography conducted after a relevant episode of decompression sickness. These divers are usually advised either to cease diving, modify their diving to reduce venous bubble formation (venous bubbles crossing from right to left are almost certainly the vectors of harm in this setting), or to have the PFO repaired. Occasionally, new diver candidates have a previously discovered PFO, and in such cases an objective assessment of the shunting behavior of the lesion is required in order to adequately counsel the candidate about the implied risks in diving. If not already done, this is best achieved using bubble contrast transthoracic echocardiography at rest and with provocative maneuvers. It is strongly recommended that the results of such tests are discussed with a physician trained in diving medicine. Routine screening of all diving candidates for PFO is not recommended.

In relation to some specific cardiovascular diagnoses: Treated hypertension with adequate control is acceptable in diving in the absence of other risk factors that would meet a risk threshold indicating screening for coronary artery disease. Atrial fibrillation that is adequately rate-controlled in a candidate without inducible myocardial ischemia and who exhibits adequate exercise capacity is acceptable in diving. However, many such candidates are anticoagulated and the risks of diving whilst anticoagulated would need to be understood and carefully considered by the candidate. This is best achieved through discussion with a physician trained in diving medicine.

Immersion pulmonary edema is a problem that has been seen in swimmers, compressed gas divers, and freedivers. The condition may be under-diagnosed. Risk factors include hypertension, valvular disease, diastolic dysfunction, cardiomyopathies, pulmonary hypertension, hyperhydration, immersion, cold stress, constrictive garments, exercise, and for compressed gas divers, increased breathing resistance (affected by equipment, gas density, and body position), and for freedivers, pulmonary squeeze due to compression during descent. A single episode of immersion pulmonary edema may contra-indicate further diving if no modifiable risk factors are found. Repetitive cases represent a strong contra-indication. A diver or new diving candidate with such a history should be referred to a physician trained in diving medicine for discussion of the relevant issues.

Candidates with pacemakers may be able to dive, though pacemaker-dependent candidates should consider the risks carefully. The pathologic process that necessitated the pacemaker should be considered as should the candidate's functional capacity (see above). Pacemakers must be certified by the manufacturer as able to withstand the pressure changes involved in recreational diving. Devices vary in this regard, but diving beyond 30 meters/100 feet with any of them is unwise.

Severe Risk Conditions

- Untreated symptomatic coronary artery disease
- Dilated or obstructive cardiomyopathy
- Heart failure
- Pulmonary hypertension
- Long QT syndrome or other arrhythmia-inducing channelopathies
- Paroxysmal arrhythmias causing unconsciousness or impairment of exercise capacity
- Poor exercise capacity of apparent cardiac origin
- Moderate to severe valvular lesions
- Complex congenital cardiac disease
- Atrial septal defect
- Presence of an implanted cardiac defibrillator
- Multiple episodes of immersion pulmonary edema

Relative Risk Conditions

- Treated coronary artery disease
- Collectively, risk factors such as age > 45 years, hypertension, smoking, elevated cholesterol and a positive family history may indicate investigation for coronary artery disease
- History of dysrhythmias requiring medication for suppression
- Mild valvular lesions (need periodic re-evaluation)
- Cardiac prostheses or arrhythmias requiring anticoagulation
- Pacemakers
- Single previous episode of immersion pulmonary edema
- Marfan syndrome or other connective tissue disorder (severe risk if there is a history of dissection)
- Left ventricular hypertrophy

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GASTROINTESTINAL

In general terms, there should be no gastrointestinal conditions present that increase the likelihood of vomiting, reflux, bleeding, perforation, diarrhea, or pain. Altered anatomical relationships secondary to surgery or malformations that lead to gas trapping may cause serious problems. Trapped gas expands as the diver surfaces and can lead to rupture or, in the case of the upper GI tract, emesis. Emesis underwater may lead to drowning. Dive activities may take place in areas remote from medical care, and the possibility of acute recurrences of disease must be considered.

Severe Risk Conditions

- Active inflammatory bowel disease
- Gastric outlet obstruction of a degree sufficient to produce recurrent vomiting
- Chronic or recurrent small bowel obstruction
- Severe gastroesophageal reflux
- Achalasia
- Paraesophageal hernia
- Gastroparesis

Relative Risk Conditions

- Inflammatory bowel disease when quiescent
- Functional bowel disorders

Temporary Risk Conditions

- Peptic ulcer disease associated with pyloric obstruction or severe reflux
- Unrepaired hernias of the abdominal wall large enough to contain bowel within the hernia sac could incarcerate

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HEMATOLOGICAL

Abnormalities resulting in altered rheological properties may theoretically increase the risk of decompression sickness. Bleeding disorders could worsen the effects of otic or sinus barotrauma and exacerbate the injury associated with inner ear or spinal cord decompression sickness. Spontaneous bleeding into the joints (eg, in hemophilia) may be difficult to distinguish from decompression illness. Thrombophilic disorders (hereditary or acquired) may facilitate vascular thrombosis and susceptibility to DCS.

Relative Risk Conditions

- Sickle cell disease
- Polycythemia vera
- Leukemia
- Hemophilia/Impaired coagulation
- Recent blood transfusion
- Recent thrombotic episodes
- Hereditary hypercoagulability conditions
    - Factor V Leiden
    - Prothrombin 20210A
    - Protein C deficiency
    - Protein S deficiency
    - Antithrombin deficiency

Temporary Risk Conditions

- Prescription of anti-coagulant drugs of any kind, including platelet aggregation inhibitors

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METABOLIC AND ENDOCRINOLOGICAL

States of altered hormonal or metabolic function should be assessed according to their impact on the individual's ability to tolerate the moderate exercise requirement and environmental stress of sport diving. Obesity may predispose the individual to decompression sickness, can impair exercise tolerance and is a risk factor for coronary artery disease.

Severe Risk Conditions

- The potentially rapid change in level of consciousness associated with hypoglycemia in diabetics on insulin therapy or certain oral hypoglycemic medications can result in drowning. Diving is therefore generally contraindicated, except when conducted according to the consensus guidelines for recreational diving with diabetes.
- Pregnancy: The effect of venous emboli formed during decompression on the fetus has been proven to be potentially detrimental to fetus health. Diving is therefore not recommended during any stage of pregnancy or for women actively seeking to become pregnant. (Note that in cases where pregnancy is discovered after diving, it is not considered grounds for termination.)

Relative Risk Conditions

- Hormonal excess or deficiency
- Obesity
- Renal insufficiency

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NEUROLOGICAL

Neurological illnesses, especially those affecting the spinal cord and peripheral nerves, should be assessed according to the degree of functional compromise present. Any condition that diminishes the reserve capacity of the spinal cord may reduce the likelihood of a full functional recovery, should an episode of spinal decompression sickness occur. Conditions in which there can be a waxing and waning of neurological symptoms and signs, such as migraine or demyelinating disease, may contraindicate diving, because an exacerbation or attack of the pre-existing disease (eg, migraine headache with aura) may be difficult to distinguish from neurological decompression sickness. A history of head injury resulting in unconsciousness should be evaluated for risk of seizure. A diagnosis of epilepsy is considered an absolute contraindication for diving.

Severe Risk Conditions

Any abnormalities where there is a significant probability of unconsciousness, hence putting the diver at increased risk of drowning. Divers with spinal cord or brain abnormalities where perfusion is impaired may be at increased risk of decompression sickness.

Some conditions are as follows:

- Epilepsy or history of seizures, other than childhood febrile seizures
- History of transient ischemic attack (TIA) or cerebrovascular accident (CVA)
- History of serious (central nervous system, cerebral or inner ear) decompression sickness with residual deficits
- Recurrent episodes of loss of consciousness or fainting

Relative Risk Conditions

Complicated migraine headaches, particularly if severe, frequent or presenting with neurological manifestations eg, motor, sensory or cognitive disturbance.

- History of head injury with sequelae other than seizure
- Herniated nucleus pulposus
- Intracranial tumor or aneurysm
- Peripheral neuropathy
- Multiple sclerosis
- Trigeminal neuralgia
- History of spinal cord or brain injury
- Parkinson's disease

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OPHTHALMIC - THE EYE AND THE VISUAL SYSTEM

A Brief Anatomy of the Visual Pathway

The sensory experience that we perceive as vision requires that light entering the eye pass through the cornea, the anterior chamber, the pupil, the crystalline lens, the posterior chamber, and the vitreous body before reaching the retina. Light rays from distant objects are essentially parallel when they impact the eye, and so must be refracted to be focused precisely on the retina and form clear images. The cornea accounts for approximately two-thirds of the required refracting power, and the lens the other one-third.

Once the light rays have been focused on the retina, the photoreceptor cells are stimulated and they, in turn, stimulate the ganglion cells, the inner layer of retinal cells. The retina's ganglion cells travel toward the posterior aspect of the eye and converge at the optic disk to form the optic nerve. The optic nerve then carries visual stimuli back to the occipital cortex of the brain via the optic chiasm and the optic tract.

Periocular Barotrauma

The anterior and posterior chambers of the eye are normally filled with non-compressible fluid. Neither the eye nor the periocular structures of the eyelids or orbit suffer adverse effects from changes in pressure (barotrauma) such as those encountered in diving unless there is a gas space adjacent to the eye (as occurs with a facemask) or within the eye (which may occur as a result of ocular surgical procedures or trauma).

Wearing a facemask creates an air-filled space of which the eyes and the periocular structures form part of one wall. A relative negative pressure can be created if sufficient air is not added to this space through the nose during descent. With sufficient pressure differential, marked lid edema (swelling) and ecchymosis (bruising) as well as subconjunctival hemorrhage may result as tissues and blood vessels are disrupted by this distention. The resulting appearance may be disconcerting to the diver, but typically resolves without sequelae. More severe cases of facemask barotrauma may result in orbital hemorrhage, bleeding within the eye, diplopia (double vision), or damage to the neural structures in and around the orbit. An over-pressure of the air space within the facemask may occur as the diver ascends, but this is not generally a problem since the excess gas tends to leak out of the mask without incident. An unusual presentation of diving-related barotrauma was a breath-hold diver who presented with crepitant swelling and ptosis of his right upper eyelid was found to have orbital emphysema and a bony defect in his lamina papyracea on CT scan. The examining physician attributed these findings to air being forced through the bony defect during repeated Valsalva maneuvers on his dive. The diver was treated with nasal decongestants and prophylactic antibiotics and the orbital air resolved spontaneously.

Intraocular Gas

Barotrauma may also occur in patients who have an intraocular gas bubble. When the pressure increases on descent, the resultant change in the volume of this bubble may cause retinal, uveal, or vitreous hemorrhages as well as partial collapse of the globe. Intraocular gas bubbles have long been considered to be an absolute contraindication to diving, and a recent search for published cases of barotrauma resulting from intraocular gas bubbles found no reports of such injuries, likely because individuals with such bubbles have been adequately warned about avoiding changes in ambient pressure. Vision-threatening fluctuations of intraocular pressure have, however, been noted in animal models of diving with intraocular gas bubbles. Severe pain accompanied by sudden loss of vision has also been reported in individuals with intraocular gas bubbles who have been exposed to the lesser fluctuations of ambient pressure seen in commercial air flight. Patients with intraocular gas should be instructed not to dive as long as any of the bubble remains in the eye.

Visual Effects of Decompression Illness

The eye can also suffer adverse effects from decompression sickness. Optic neuropathy (damage to the optic nerve), nystagmus (a rhythmic back-and-forth movement of the eyes), diplopia, visual field defects, scotomas (blind spots), homonymous hemianopias (symmetrical blind spots in both eyes), orbicularis oculi (eye muscle) pain, cortical blindness, convergence insufficiency, and central retinal artery occlusion have all been reported as manifestations of decompression sickness.

The eye may also be affected when divers suffer arterial gas embolism as a result of pulmonary barotrauma or arterialization of venous emboli through a right-to-left shunt in the heart or lungs. Ocular manifestations of arterial gas embolism include ophthalmic artery occlusion, central retinal artery occlusion, and bilateral ophthalmoplegia.

Diving after Eye Surgery

Finally, surgery in and around the eye should be followed by a convalescent period before returning to diving. Individuals who have recently had eye surgery need to allow a period for wound healing before returning to diving. Potential areas of concern include:

- the potential for pathogens in the water where diving is performed. These pathogens may cause infection non-epithelialized wound surfaces of the cornea, sclera, conjunctiva, or lid tissues;
- pathogens may also cause vision-threatening endophthalmitis (a severe intraocular infection) by entering the eye through unhealed corneal or scleral wounds;
- gas remaining in the eye after ocular surgery may be affected by changes in pressure and result in vision-threatening intraocular barotrauma; and
- the pressure in the gas space created by a diving facemask may not be equalized on descent and result in a relative negative pressure in that space. This may cause subconjunctival hemorrhage that could interfere with glaucoma surgery filtering sites. It could also theoretically cause the rupture of incompletely healed corneal or scleral wounds. .

A few points of particular emphasis:

- Divers who have gas bubbles in the eye following eye surgery should not dive until all gas bubbles are completely resolved.
- Full-thickness corneal procedures result in a corneal scar that never fully regains the strength of the unoperated cornea; although these individuals have an increased risk of corneal rupture if there is a pressure differential across the cornea, such events have not been reported to date. Divers who have had corneal transplants or other full-thickness corneal surgery should be warned about the need to be attentive to equalizing the pressure in their facemasks during descent.
- Divers who have had glaucoma filtering procedures have a theoretical increased risk of complications resulting from both decreased function of the filter as a result of ocular barotrauma as well as intraocular infections as a result of pathogens entering the eye through a patent filtering site and causing a vision-threatening eye infection.
- Finally, diving is contraindicated for patients who have a hollow orbital implant because of the risk of the hollow prosthesis collapsing when exposed to an elevated ambient pressure.

There are to date no controlled studies in the medical literature that address the requisite length of convalescence before a return to diving. The recommendations below are based on the application of wound healing observations in other studies and on clinical experience. They are adapted from previous recommendations published in 1995 that have proven safe in practice since that time.

Recommended Minimum Convalescent Periods Prior to Diving after Ophthalmic Surgery [a]

PROCEDURE	MINIMUM DURATION
Anterior segment surgery	
Anterior lamellar keratoplasty	6 months
Corneal laceration repair	6 months
Glaucoma filtering surgery [b]	2 months
Small incision cataract surgery	1 months
Small incision endothelial keratoplasty	1 months
Photorefractive keratectomy and LASIK	2 weeks
Pterygium excision	2 weeks
Conjunctival surgery	2 weeks
Corneal suture removal	1 weeks
Laser trabeculoplasty or iridectomy	No wait necessary
Laser posterior capsulotomy	No wait necessary
PROCEDURE	MINIMUM DURATION
Vitreoretinal surgery	
Vitrectomy	2 months
Retinal detachment repair	2 months
Pneumatic retinopexy	2 months
Retinal cryopexy for retinal breaks	2 weeks
Laser photocoagulation for retinal breaks	2 weeks

PROCEDURE	MINIMUM DURATION
Oculoplastic surgery	
Sutured wound	2 weeks
Skin graft or granulating wound	Until epithelialization is complete
Enucleationc [c]	2 weeks
PROCEDURE	MINIMUM DURATION
Strabismus surgery	2 weeks

a Diving is contraindicated with any intraocular gas

b Relative contraindication to diving

c Diving is contraindicated with a hollow orbital implant

Severe Risk Conditions

- Intraocular gas.
- Presence of a hollow orbital implant.
- Recent ophthalmic surgery prior to completion of the recommended convalescent period.
- Inadequate vision to function safely in the underwater environment.
- Any acute infectious or inflammatory ocular disorder which produces significant pain, photophobia, diplopia, or decrease in vision.
- Visually significant deficits from previous episodes of decompression sickness or arterial gas embolism.

Relative Risk Conditions

- Functioning glaucoma filter.

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Acknowledgment: Dr. David Harris

March 2022

ORTHOPEDIC

Mobility above and under the water is an essential requirement for any sport or recreational diver. Entering the water from shore or a dive boat, underwater propulsion and exiting into a dive boat or onto shore should be possible without great difficulty.

Relative impairment of mobility, particularly on a boat or ashore with equipment weighing up to 30 kg/66 lb (or significantly more in the case of cold water or for more equipment intensive activities, for example), must be assessed. Orthopedic conditions of a degree sufficient to impair exercise performance may increase the risk.

In some cases, like amputations resulting in various degrees of disability, it would be advisable to judge case by case by a physician trained in diving medicine.

Relative Risk Conditions

- Amputation
- Scoliosis: must also assess impact on respiratory function and exercise performance
- Aseptic necrosis: possible risk of accelerated progression due to the effects of decompression
- Disc prolapse
- Habitual luxation (eg, shoulder, hip, patella)
- Degenerative joint diseases

Temporary Risk Conditions

- Back pain
- Fractures until complete healing of bone and soft tissue and positive weight bearing tests taking into consi deration the weight of the used dive gear on land
- Muscle-tendon and ligament injuries
- Completion of physiotherapy/ rehabilitation regimes

References

Moeller JL. Contraindications to athletic participation. Physic Sportsmed. 1996; 24(9): 57-75.

OTOLARYNGOLOGICAL

Equalization of pressure must take place during ascent and descent between ambient water pressure and the external auditory canal, middle ear, and paranasal sinuses. Failure of this to occur results at least in pain and in the worst-case rupture of the occluded space with disabling and possible lethal consequences. The inner ear is fluid filled and therefore noncompressible. The flexible interfaces between the middle and inner ear, the round and oval windows are, however, subject to pressure changes. Previously ruptured but healed round or oval window membranes may be prone to reinjury with marked overpressurization during vigorous or explosive Valsalva maneuvers. The larynx and pharynx must be free of obstruction to airflow. The laryngeal and epiglottic structures must function normally to prevent aspiration. Mandibular and maxillary function must be capable of allowing the candidate to hold a scuba regulator mouthpiece. Individuals who have had mid-face fractures may be prone to barotrauma and rupture of the air-filled cavities involved.

Severe Risk Conditions

- Monomeric tympanic membrane (TM)
- Open TM perforation
- Tube myringotomy
- History of stapedectomy
- History of ossicular chain surgery
- History of inner ear surgery
- Facial nerve paralysis secondary to barotrauma

- Inner ear disease other than presbycusis
- Uncorrected upper airway obstruction
- Laryngectomy or status post partial laryngectomy
- Tracheostomy
- Uncorrected laryngocele
- History of vestibular decompression sickness
- Symptomatic nasal or sinus polyps
- Ménière's disease

Relative Risk Conditions

- Recurrent otitis externa
- Significant obstruction of external auditory canal
- History of significant cold injury to pinna
- Eustachian tube dysfunction
- Recurrent otitis media or sinusitis
- History of TM perforation
- History of tympanoplasty
- History of mastoidectomy
- Significant conductive or sensorineural hearing impairment
- Facial nerve paralysis not associated with barotrauma
- Full prosthodontic devices
- History of mid-face fracture
- Unhealed oral surgery sites
- History of head and/or neck therapeutic radiation
- History of temporomandibular joint dysfunction
- History of round window rupture
- Symptomatic nasal septum deviation
- Recurrent benign positional vertigo
- Otosclerosis

References

Lechner M, Sutton L, Fishman JM, Kaylie DM, Moon RE, Masterson L, et al. Otorhinolaryngology and diving - part 1: otorhinolaryngological hazards related to compressed gas scuba diving: a review. JAMA Otolaryngol Head Neck Surg. 2018;144(3):252-258.

Lechner M, Sutton L, Fishman JM, Kaylie DM, Moon RE, Masterson L, et al. Otorhinolaryngology and diving – part 2: otorhinolaryngological fitness for compressed gas scuba diving: a review. JAMA Otolaryngol Head Neck Surg. 2018;144(3):259-263.

Molvaer OI. Otorhinolaryngological aspects of diving. In: Bennett PB, Elliott DH, eds. Physiology and Medicine of Diving, 5th ed. Saunders, Edinburgh, 2003. P227-P264.

Wendling J, et al. Otorhinolaryngology. In: Medical Assessment of Fitness to Dive. International Edition. Hyperbaric Editions CH 2502 Biel, 2001. Pp25-48. ISBN 3-9522284-1-9.

PULMONARY

Any process or lesion that impedes airflow from the lungs places the diver at risk for pulmonary over inflation with alveolar rupture and the possibility of cerebral air embolization. Many interstitial diseases predispose to spontaneous pneumothorax: asthma, chronic obstructive pulmonary disease (COPD), cystic or cavitating lung diseases may all cause air trapping.

Undersea and Hyperbaric Medical Society and British Thoracic Society guidelines recommend that asthmatics should be advised not to dive if they have wheeze precipitated by exercise, cold, or emotion. Asthmatic individuals who are currently well controlled and have normal pulmonary function tests may dive if they have a negative exercise test. Many people with asthma have well controlled disease and are physically fit. They may, however, show minor abnormalities on spirometry at rest or after exercise. Those with a history of severe or unpredictable acute exacerbations

are not fit to dive. For those without such a history, the overriding consideration is that the candidate must be physically fit and not impaired after exercise or cold air breathing, which is the normal case of gas expanding from within a scuba cylinder. The best way to assess fitness is with an exercise test. Inhalation challenge tests (eg, using histamine, hypertonic saline or methacholine) are not sufficiently standardized to be interpreted in the context of scuba diving. If persons with breathing issues are cleared to dive, they need to take their regular inhalers and should not dive if suffering symptoms suggestive of exacerbation. Note that the FEV1/FVC ratio may be reduced below predicted, but provided there is no deterioration after exercise and the person performs well on the exercise test, a mildly ostructed spirometric tracing on its own is not a contraindication to diving.

A pneumothorax that occurs while diving may be catastrophic. As the diver ascends, trapped gas expands and could produce a tension pneumothorax. In addition to the risk of pulmonary barotrauma, respiratory disease due to either structural disorders of the lung or chest wall or neuromuscular disease may impair exercise performance. Individuals who have experienced spontaneous pneumothorax are at risk of recurrence, and should avoid diving, even after a surgical procedure designed to prevent recurrence (such as pleurodesis). Surgical procedures either do not correct the underlying lung abnormality (eg, pleurodesis, apical pleurectomy) or may not totally correct it (eg, resection of blebs or bullae). A high-resolution CT (HRCT) scan of the lungs may reveal cysts or blebs that represent a risk. Persons who have no parenchymal abnormality on HRCT and have had bilateral surgical pleurodesis (including VATS pleurodesis) may be cleared to dive. However, in most cases, a history of spontaneous pneumothorax will be an absolute contraindication to diving. Traumatic pneumothorax is not a problem as the likelihood of subsequent spontaneous pneumothorax is vanishingly low.

Structural disorders of the chest or abdominal wall or neuromuscular disorders may impair cough, which could be life threatening if water is aspirated. Respiratory limitation due to disease is compounded by the combined effects of immersion (causing a restrictive deficit) and the increase in gas density, which increases in proportion to the ambient pressure (causing increased airway resistance). Formal exercise testing may be helpful.

The emergence of COVID-19 has placed an additional layer of complexity related to fitness to dive evaluations. It is beyond the scope of this document to prescribe or mandate specific tests or timelines related to fitness to dive determinations. What is of importance is awareness of the potential body systems effected by COVID-19, and to take a thoughtful and thorough history related to disease course, time since the infection resolved, and state of physical and mental health at the time of the examination.

Clinical factors that are important to consider include symptom severity during the infection and need for intensive care (e.g., ventilator support). Disease severity likely correlates with the extent of pulmonary injury and potential cardiac involvement, and in the case of intubation, may be associated with severe deconditioning, muscle atrophy and even post-traumatic stress. As such, assessment of the diver with a history of COVID-19, may require more than just a pulmonary evaluation. At the time of this publication, the medical community does not have sufficient data to support arbitrary requirements for specific testing, nor duration of post-infection convalescence after which individuals can be considered safe to return to diving.

The following documents provide current guidance on investigation of COVID-19 patients prior to diving. This is an area that is evolving and updated often; please see these resources for more current information and considerations regarding these issues.

UC San Diego Guidelines for Evaluation of Divers during COVID-19 pandemic

Centers for Disease Control and Prevention, People Who Are at Higher Risk for Severe Illness

European Committee for Hyperbaric Medicine and European Underwater and Baromedical Society, COVID-19 Pandemic – Position Statements

For those looking for aseptic practices, the following resources may be useful:

Divers Altert Network Europe

Divers Alert Network Americas

Severe Risk Conditions

- History of spontaneous pneumothorax (see notes)
- Impaired exercise performance due to respiratory disease
- Respiratory impairment secondary to cold gas breathing
- Pulmonary hypertension

Relative Risk Conditions

- Asthma, reactive airway disease (RAD), exercise-induced bronchospasm (EIB) or COPD (see notes)
- Solid, cystic or cavitating lesion
- Pneumothorax secondary to:
  - Thoracic surgery
  - Trauma or pleural penetration (see notes)
  - Previous overinflation injury
- Obesity
- History of immersion pulmonary edema or restrictive disease
- Interstitial lung disease: may increase the risk of pneumothorax and likely to limit exertion
- Sleep apnea

References

Godden D, Currie G, Denison D, Farrell P, Ross J, Stephenson R, Watt S, Wilmshurst P. British Thoracic Society guidelines on respiratory aspects of fitness for diving. Thorax. 2003;58:3-13.

DIVERS ALERT NETWORK (DAN)

Divers Alert Network (DAN), a non-profit organization, provides medical information and advice for the benefit of the diving public. DAN is not a regulatory agency and does not set physical standards or guidelines for scuba diving. The responsibility for the decision of whether or not to dive is generally left up to the individual, the physician, as well as the dive provider. This decision, however, should be based on the most current diving medical information available.

DAN may be able to provide current medical literature and information that can be used to assist in this decision-making process. If desired, DAN may also provide referrals to local physicians who are knowledgeable in dive medicine and physiology. However, DAN cannot and does not decide whether an individual may or may not participate in the sport of scuba diving. For more information, please feel free to contact one of the DAN offices listed below.

DAN (US)

Physicians and other medical professionals associated with DAN are available for consultation by phone, during normal business hours Monday through Friday, 8:30 AM to 5:00 PM Eastern Time US.

+1-919-684-2948 ext. 6222

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DAN Southern Africa (South Africa)

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www.DANSA.org

DAN Japan (Yokohama)

+045-228-3066 Medical Information Line service is provided in Japanese only.

www.danjapan.gr.j

*These guidelines were created by the **Diver Medical Screen Committee** (DMSC). The DMSC periodically reviews them to ensure they continue to represent current best practice in hyperbaric medicine.*