These guidelines have been made generally available in order that examining
doctors, Medical Referees and divers can readily refer to them for guidance.
They are not to be interpreted rigidly but by the examining doctor in the light of the
individual divers circumstances.
Where these guidelines are not sufficient to resolve a problem, a Medical Referee
should be consulted.
The final court of appeal for BSAC members is the BSAC Medical Committee.

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CARDIOVASCULAR SYSTEM
CARDIAC ARRHYTHMIAS AND DIVING

The decision on fitness to dive when individuals have a history of cardiac arrhythmia (or evidence which suggests predisposition to such arrhythmias, e.g. Wolff-Parkinson-White or long QT syndromes) must take account of the nature of the arrhythmia (e.g. rate, site of origin, probability of degeneration into a more serious arrhythmia), the frequency and effects of attacks, the presence of associated or causative cardiovascular or non-cardiac diseases, the treatment used and the success of treatment. It is not possible to define every possible circumstance, but these guidelines are intended to cover the most common situations.

Permission to dive will usually be refused if an applicant has either serious underlying cardiac disease (e.g. ischaemic heart disease or cardiomyopathy), or arrhythmias are associated with symptoms which would prove hazardous if they occurred underwater (e.g. syncope, dizziness, dyspnoea, or angina).

Permission to dive will usually be granted when an individual has no evidence of structural cardiac disease but has a history of arrhythmias which are unlikely to cause incapacity in the water, because they do not cause serious symptoms when on land. However permission to dive will usually be accompanied by restrictions on depths and dive times to no-stop diving, so that the diver is always able to make a direct ascent to the surface without risk of being forced to make prolonged decompression stops while suffering the arrhythmia. Restriction to diving only with experienced companions will be a usual requirement.

There are a number of other considerations:
- Whether congenital heart disease or valvular disease will disqualify will depend on the severity and nature of the abnormality (see also medical standard 13, Intracardiac Shunts).
- A history of implantation of cardiac pacemakers, anticoagulation, prosthetic cardiac valves, myocardial revascularisation and myocardial infarction may influence fitness to dive (see medical standards 9, 10, 11, 15, and 17 respectively).
- Underlying metabolic or endocrine abnormalities (e.g. thyrotoxicosis causing paroxysmal atrial fibrillation) should be corrected prior to diving.
- The choice of anti-arrhythmic drug may influence fitness (e.g. if β-blockers cause bronchoconstriction their use will constitute a contraindication to diving).
- Investigations should be performed in an individual with the Wolff-Parkinson-White syndrome to ensure that the refractory period of the accessory pathway is sufficiently great to prevent degeneration of atrial fibrillation into ventricular fibrillation.
- Supraventricular and ventricular ectopic beats will usually be allowed. The exception is when the ectopic beats occur so frequently that symptoms such as dizziness are produced.

Further enquiries about cardiac arrhythmias should be made to Medical Referees who are cardiologists:
Dr. David Lindsay, Consultant Cardiologist, Gloucester Royal Hospital, Great Western Road, Gloucester, GL1 3NN. Tel. 01452-394766.
Dr. Peter Wilmshurst, Consultant Cardiologist, Royal Shrewsbury Hospital, Mytton Oak Road, Shrewsbury, SY3 8XQ. Tel. 01743-261000.

Standard issued January 1996.
CARDIOVASCULAR SYSTEM
CARDIAC PACEMAKERS AND DIVING

Patients with antitachycardia pacemakers and automatic implantable defibrillators may not dive with BSAC.

Patients with pacemakers implanted for treatment of bradyarrhythmias may dive under certain circumstances.

(a) Since implantation of the pacemaker the patient should have been free of cardiac symptoms - notably syncope, dizziness, chest pain and inappropriate dyspnoea.

(b) The patient should be free of significant cardiac disease other than sinus or atrioventricular node disease. There should be no suggestion of significant coronary artery disease, valvular disease or cardiomyopathy.

(c) The patient should be able to mount an appropriate heart response to exercise, i.e. should be able to achieve a heart rate of 80% of (220 minus age in years).

(d) Pacemaker implantation should not have caused any other contraindication to diving, e.g. serious lung damage during subclavian vein puncture.

(e) The pacemaker should be a modern resin filled pacemaker rather than a gas filled model which could result in pacemaker compression at depth.

(f) Ideally, the pacemaker should have been tested under hyperbaric conditions to ensure reliability.

(g) Because some pacemakers are known to malfunction at depths greater than 30 metres, no pacemaker patient should be allowed to dive beyond this depth.

References:

CARDIOVASCULAR SYSTEM
MYOCARDIAL REvascularisation
(CORONARY ARTERY SURGERY AND CORONARY ANGIOplasty)

Following coronary revascularisation some patients have no clinical or objective evidence of myocardial ischaemia. Unfortunately, symptoms recur in some patients soon after revascularisation and over a period time the percentage of patients with recurrent symptoms increases.

Individuals who have had myocardial revascularisation may be permitted to resume diving by the BSAC Medical Committee if they satisfy the following criteria:

1. They were an established diver prior to their coronary revascularisation.

2. They have no cardiac symptoms when off all cardiac medication (although lipid lowering drugs and antiplatelet agents are permitted).

3. They can perform satisfactorily a treadmill exercise test, achieving a good workload (for age, sex and build), with a normal heart rate and blood pressure response without evidence of ischaemia on a 12 lead ECG.

4. There is little residual myocardial dysfunction (particularly a preserved left ventricular ejection fraction).

5. If they have had open heart surgery, they should not have experienced significant lung damage or neurological injury as a result of the surgery.

6. They will not be permitted to dive with novice divers in future, but must dive with experienced companions who can render assistance if required.

7. Fitness to dive will be reviewed annually irrespective of the diver’s age, but should symptoms recur between medical examinations, the diver must cease diving until reviewed.
CARDIOVASCULAR SYSTEM
EXERCISE TESTING FOR ISCHAEMIC HEART DISEASE IN DIVERS

Ischaemic heart disease is the major cause of mortality in middle aged men. A major ischaemic event underwater could prove fatal and endanger a diver’s buddy.

However, the value of screening exercise tests in apparently normal populations have now been largely discredited because of the appreciable false positive and false negative results in such groups. Furthermore we have no control over the quality of equipment or type of standardisation on which the Exercise ECGs on our members would be performed. This only compounds the possibility of false reporting of the test.

Questions in Section A of the medical form enquire about chest pain and other cardiac symptoms. Those with symptoms suggestive of ischaemic heart disease should undergo exercise testing or referral to a local cardiologist as appropriate.

In the case of individuals with a poor family history or hyperlipidaemia but no cardiac symptoms, exercise testing is appropriate, particularly if they smoke, but needs to be interpreted with caution.
CARDIOVASCULAR SYSTEM
HYPER TENSION AND DIVING

Hypertension may predispose to pulmonary oedema when diving (1) and is a risk factor for other cardiovascular events, (e.g. stroke and myocardial infarction) which could prove fatal if they occurred in the water.

Diving is permitted by mild hypertensives if their diastolic blood pressure does not exceed 90 mm Hg in new entrants or 100 mm Hg in established divers and their systolic blood pressure does not exceed 160 mm Hg. These pressures are acceptable if they are attained without treatment or by means of approved treatment.

Approved treatments consist of dietary measures including salt restriction, diuretic therapy (when being used to treat hypertension but not if also being used to treat cardiac failure) and low doses of mild vasodilators (e.g. prazosin, nifedipine or ACE inhibitors). Occasionally a medical referee may approve the use of a low dose of a beta-blocker (preferably cardioselective) or other antihypertensive agent to control hypertension provided the heart rate response to exercise stress is unimpaired. The diver should be able to attain a heart rate which is at least 90% of (220 minus his age in years) beats/minute. If beta-blockers are used there must be no evidence of bronchospasm, preferably assessed by lung function tests performed on and off treatment.

Diving is not permitted even if blood pressure control is adequate if there is evidence of end organ damage resulting from hypertension (i.e. renal, eye or cardiovascular complications, including cardiac enlargement).

References:

CARDIOVASCULAR SYSTEM

INTRACARDIAC SHUNTS AND DIVING

1. Right-to-left shunts

After a dive which allows venous bubble formation, a diver who has an intracardiac right-to-left shunt is at risk of paradoxical gas embolism, which can result in neurological decompression illness (1,2). The evidence suggests that divers with such shunts are at risk, even when they perform dives which are inside acceptable and safe decompression tables (or algorithms) (1). The risk of decompression illness by this mechanism is related to the tissue nitrogen-load (i.e. pressure-time profile), the size of the shunt and presence of other factors likely to cause right-to-left shunting (3,4). Approximately one quarter of the population have a patent foramen ovale or a small atrial septal defect, but the risk of paradoxical embolism is much greater in those with larger shunts (3). Decompression illness is very unusual in sport divers after dives to less than 20 metres and we have not observed neurological decompression illness that appears to be the result of paradoxical embolism in sport divers after dives to that depth. We have observed neurological decompression illness associated with a large shunt in a professional diver who did a working dive at 18 metres, which required in-water stops that were performed correctly (5).

It therefore seems reasonable that sport divers known to have an intracardiac shunt should be allowed to dive shallower than 15 metres, provided no other cardiac contraindication exists. If a diver with a shunt wishes to go deeper than 15 metres the options include use of nitrox with an air decompression table (to reduce bubble liberation and tissue nitrogen-load) and use of a table such as the DCIEM table which is believed to result in little or no bubble nucleation. It will also be possible for some individuals to return to unrestricted diving after transcatheter closure of the defect (5). It is hoped that, with further understanding of the mechanisms involved it may be possible to vary this advice at a later date.

2. Haemodynamically important shunts

A small proportion of the population have large and haemodynamically important shunts (e.g. large ASD, large VSD or PDA). In those cases other factors, including haemodynamic consequences of the shunt (e.g. predisposition to pulmonary oedema), will also need to be considered.

3. Small pure left-to-right shunts

Small ventricular septal defects, in individuals with otherwise normal hearts, only shunt left-to-right and have little haemodynamic effects. Asymptomatic individuals with a small ventricular septal defect can be allowed to dive without restriction.

References:


November 1996
CARDIOVASCULAR SYSTEM
PREVIOUS MYOCARDIAL INFARCTION AND DIVING

Individuals who have suffered a myocardial infarction are permitted to resume diving by the BSAC Medical Committee if they satisfy the following criteria:

1. They have no cardiac symptoms or evidence of silent ischemia when off all cardiac medication (although lipid lowering drugs and antiplatelet agents are permitted). Use of beta-blockers will be considered on an individual basis provided they are used for secondary prevention and there is no evidence of resulting airway obstruction.

2. They can satisfactorily perform a treadmill exercise test, achieving a good workload (for age, sex and build) with a normal heart rate and blood pressure response, without evidence of ischaemia on a 12-lead ECG.

3. There is little residual myocardial dysfunction.

4. They will not be permitted to dive with novice divers in future, but must dive with experienced companions who should be aware of the condition and who can render assistance if required.

5. Limitations on depth, severity and conditions of dives may be imposed.

6. Fitness to dive will be reviewed annually irrespective of the diver’s age, but should symptoms recur between medical examinations, the diver must cease diving until reviewed.
CARDIOVASCULAR SYSTEM
PROSTHETIC CARDIAC VALVES AND DIVING

It is assumed at the outset that no other cardiac or non-cardiac contraindication to scuba diving exists. It is important to rule out conditions which may be related to cardiac disease (e.g. arrhythmias or cardiac muscle dysfunction) or cardiac surgery (e.g. post bypass lung or neurological damage).

It is also felt advisable that the individual should also have had the prosthetic valve in place and functioning satisfactorily for a period of time prior to any consideration of fitness to dive. A one year period of satisfactory valve function is thought advisable, particularly since those with significant left ventricular hypertrophy from conditions such as aortic stenosis are known to have a significant one year mortality from sudden (presumed arrhythmic) deaths.

The problem then arises, which prosthetic valves, if any, are acceptable. In considering this, we need to consider the different problems that may be experienced with prosthetic valves.

Potential Risks:

1. Embolisation

(a) Right Heart Valves. Embolisation from right heart prosthetic valves are unlikely to cause incapacity in the water, but could cause chest discomfort similar to chokes - but this seems of very low risk.

(b) Left Heart Valves. Embolisation from left heart valves could cause neurological symptoms and unconsciousness which might cause incapacity underwater or mimic diving related illness after surfacing. The risk of systemic embolisation for the various valve types are approximately 4%/year for mitral prostheses (either mechanical prosthesis in a patient on anticoagulants or bioprosthesis in a patient not on anticoagulants) and approximately 2%/year for aortic prostheses (mechanical prosthesis with anticoagulants or bioprosthesis without anticoagulants). Patients with atrial fibrillation, large left atrium, known left heart thrombus or previous history of systemic embolisation are at higher risk whilst those without these factors are at slightly lower risk.

2. Anticoagulation. Mortality 0.2%/year, Morbidity 2%/year from sudden bleeds. (See separate discussion sheet on anticoagulants).

3. Mechanical Failure of Prosthetic Valves

(a) Right Heart Valves. Failure does not usually produce catastrophic problems.

(b) Left Heart Valve. Failure usually produces catastrophic pulmonary oedema/cardiogenic shock with a 30-50% mortality on land. Such an event underwater would be almost certainly fatal and could endanger the buddy. The failure rate varies with different prosthesis but is approximately 1-2 per 1000/year.

4. Degeneration of Bioprostheses. This results in a restenosis or regurgitation but can be assessed at annual review of fitness to dive.

5. Mechanical Haemolysis causes chronic anaemia. Can be excluded by blood test.

6. Pulmonary and Neurological Injury can complicate open heart surgery. There should be no evidence of this.

Decisions about advisability of individuals diving with prosthetic valves will be made on an individual basis by medical referees/medical committee.
GENERAL MEDICAL
ANTICOAGULANTS AND DIVING

Anticoagulants are used to reduce the risk of pulmonary or systemic thrombosis or embolisation. Clearly some of the conditions requiring use of anticoagulants are in themselves an absolute contraindication to diving whatever treatment is given. This may be because of the serious nature of the disease itself or because even with the use of anticoagulants further episodes are not entirely prevented.

However, some people receiving anticoagulants will be entirely asymptomatic on treatment without any symptoms referable to the cardiovascular system. Obvious examples are individuals given anticoagulants for deep venous thrombosis/pulmonary embolism or because of the presence of prosthetic cardiac valves.

As far as scuba diving is concerned, in such individuals the only real risk to them is from haemorrhage, if we ignore the risk of any asymptomatic individual having further episodes of their presenting condition whilst anticoagulated. This however, assumes that adequate anticoagulation of that individual is maintained. It also assumes that there is no interaction between anticoagulation and the diving environment (e.g. altered partial pressures of gases). No such interaction is known, but it is known that decompression per se reduces platelet count and may even cause thrombocytopenia, which would aggravate any bleeding diathesis. (This is believed to result from platelet consumption by adherence to bubbles).

There are a number of situations which could cause haemorrhage when diving. Clearly trauma is likely to result in significantly more haemorrhage in an anticoagulated individual than in another individual. Whether auditory barotrauma will result in greater haemorrhage and hence produce greater residual problems, whether bleeds into sinuses and mask squeeze present greater problems in those anticoagulated and whether pulmonary barotrauma is more likely to result in major haemoptysis than in those not anticoagulated is unclear.

In addition, the postmortem findings of decompression sickness include haemorrhage in the spinal cord. It is possible that anticoagulation will increase the risk of major haemorrhage and resulting serious neurological problems.

Furthermore, in anticoagulated individuals spontaneous haemorrhage or haemorrhage after trivial trauma may occur. Heavy nose bleeds are common. This could result in impairment of vision because the mask is filled with blood and confusion in diagnosis of pulmonary barotrauma by producing spurious haemoptysis. Cerebral haemorrhage is much less common but can cause neurological deficits which could be mistaken for diving related illness.

Overall the annual mortality and morbidity for sudden haemorrhage in those anticoagulated are 0.2% and 2% respectively.

The present policy of the BSAC is that use of anticoagulants is not permissible in new recruits but may be acceptable in established divers, provided no other contraindication exists and they appreciate and accept the risks involved. In such cases, decisions will be made on an individual basis and a limit on depth and number of ascents may be imposed to reduce the risk of spinal haemorrhage from decompression sickness.

This sheet is for information only and it is recommended that any case seen by a referee is referred to the Medical Committee.
GENERAL MEDICAL
DIABETES MELLITUS AND DIVING

A diver with diabetes mellitus may have a hypoglycaemic attack while in the water, which may be fatal to himself or to his diving partner. The hypoglycaemic attack may be brought on by poor control of the diabetic condition or by an increase in physiological stress due to exercise, cold, etc.

The BSAC Medical Committee has decided that diabetics may be allowed to dive provided that they are able to pass the standard BSAC medical examination and in addition, satisfy the following criteria:

1. The diabetic has not experienced any hypoglycaemic attack within the last year.

2. The diabetic has not been hospitalised for any reason connected with diabetes in the last year.

3. The physician in charge of the diabetic at the diabetic clinic must consider the level of control to be satisfactory. This implies that the long-term control of the diabetic condition must be good. A guide to this may be obtained from the HbA or fructosamine level. The physician must also be able to state that he/she considers the potential diabetic diver to be mentally and physically fit to undertake the sport of diving.

4. There must be no microalbuminuria present. Any degree of retinopathy beyond background retinopathy is not allowed. There must be no evidence of neuropathy (sensory, motor or automatic), nor of vascular or microvascular disease beyond the background retinopathy in the eye.

The potential diabetic diver should obtain forms A and B from BSAC HQ, together with a leaflet which should be given to the BSAC Branch Diving Officer on successful completion of the medical. Form A must be filled in by the diver on an annual basis. Form B should be filled in by the physician in charge of the diabetic diver and this too, must be done annually. A copy of both forms should be made and returned to Dr C.J. Edge, The Stone Barn, Gravel Lane, Drayton, Abingdon, Oxon OX14 4HY. The physician performing the BSAC medical examination should be satisfied that the diver has a good knowledge of the risks being undertaken when diving, which are due to the diver’s diabetic condition.
GENERAL MEDICAL

DYSBARIC ILLNESS AND DIVING

Individuals who have had pulmonary barotrauma or neurological decompression illness are thought to be generally more susceptible to subsequent episodes as a result of pre-existing abnormal pathology, including lung disease and intracardiac right-to-left shunts (1-7). In addition, subsequent neurological insults in these individuals are thought to be more difficult to treat and are believed to leave greater residual disability (5).

Therefore, any person who has suffered from pulmonary barotrauma or neurological decompression illness, should be carefully assessed to determine whether they should resume sport diving. The assessment will involve enquiry into the circumstances of the incident (including a precise dive history). Particularly when the episode of dysbaric illness occurred within the tables, assessment will often require tests to exclude the presence of an intracardiac shunt and lung disease likely to predispose to pulmonary barotrauma. The tests which may be performed include contrast echocardiography and sophisticated tests of lung function. The case should be examined by a Medical Referee who has obtained information from the treating physician. If the individual is permitted to resume diving, restrictions on depths, times and repeat dives may be imposed.

Further enquiries about testing for physical predisposition to decompression illness can be made to:
Dr Peter Wilmshurst, Consultant Cardiologist, Royal Shrewsbury Hospital, Mytton Oak Road, Shrewsbury, SY3 8XQ. Tel: 01743-261000

References:
2. Leitch DR, Green RD. Recurrent pulmonary barotrauma. Aviation, Space and Environmental Medicine 1986; 1039-43

November 1996
GENERAL MEDICAL
HYPERLIPIDAEMIA AND DIVING

Hyperlipidaemia predisposes to premature coronary and cerebrovascular disease which can cause sudden incapacity. If such incapacity occurred in a diver underwater it would prove hazardous to both the diver and his companion.

Individuals with hyperlipidaemia will therefore only be permitted to dive with the BSAC if they have no symptoms or signs suggestive of vascular occlusive complications and are able satisfactorily, to complete a treadmill exercise test without evidence of myocardial ischaemia. Individuals with hyperlipidaemia may be subject to more frequent medical assessments including exercise testing depending on their degree of hyperlipidaemia, its cause and its assessed prognosis. Often repeat medical assessment annually will be appropriate.
GENERAL MEDICAL

OBESITY AND DIVING

Obesity may exclude a candidate from diving as it frequently betrays a lack of general physical fitness. Increased body fat mass has in the past been said to predispose to decompression illness but there is no evidence of this from decompression illness statistics.

A BMI (Body Mass Index) of more than 30 should normally exclude from diving. Due regard should be taken to weight distribution, obesity concentrated in the abdomen should be less acceptable than evenly distributed fat and due allowance should be given to the individual whose excess weight is visibly muscular. Enquiry should be made as to the amount of exercise taken. The formula tends to discriminate against tall individuals who may be allowed somewhat more than the suggested BMI of 30.

Qualified divers with a borderline BMI may be given a provisional pass for two or three months when they would be required to produce evidence of improvement to have their certificate extended.

\[ BMI = \frac{\text{Weight (kg)}}{(\text{Height (m)})^2} \]

A table of maximum weights for height to keep below BMI = 30 is shown below:

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May 1996.
Underwater Refractive Correction

The two choices that can be made are contact lenses and prescription face masks. If contact lenses are to be worn, soft contact lenses are to be preferred. Hard contact lenses have been shown to cause corneal oedema during decompression and after dives [1-4]. These changes are caused by the formation of nitrogen bubbles in the precorneal tear film which interfere with normal tear film physiology and result in epithelial oedema. With soft contact lenses which do not appear to cause corneal oedema [1,5], the most frequent complication is loss of the lens, which can be minimised by making sure that the mask fits well. This problem may be ameliorated to a certain extent by using the disposable “one day” soft lenses and carrying an extra pair of lenses on board the boat or in the diving kit bag.

Prescription face mask lenses provide the other alternative. These can be expensive, especially if the wearer has a degree of astigmatism. A face mask with corrective lenses bonded onto the face plate of the mask is also a possibility, but may present problems with eventual erosion of, or bubble formation in the bonding substance used.

Ocular Barotrauma

Unless the diver expels gas through the nose into the face mask on descent, a relative negative pressure develops in the air space between the face plate and the face. Marked lid oedema and ecchymosis together with subconjunctival haemorrhage may result. The effects can be disconcerting, but usually resolve without sequelae. Overpressure is generally not a problem as the air escapes around the face mask seal.

Barotrauma may also occur in patients who dive with intraocular gas bubbles in the anterior chamber or vitreous cavity. Pressure-induced changes in the volume of this bubble may result in retinal, uveal, or vitreous haemorrhage, as well as partial collapse of the globe. Diving with any trace of an intraocular gas bubble is therefore contraindicated.

Ophthalmic Decompression Illness

It is worth remembering that the first observations of decompression illness were made by Robert Boyle in 1670 when he observed gas bubbles in the anterior chamber of the eye of a viper which had been experimentally exposed to decreased pressure [6]. Although ophthalmological manifestations of DCI are fairly rare, they may include nystagmus, diplopia, visual field defects, scotomas, and homonymous hemianopias. Fluorescein angiography studies of divers have documented retinal pigment epithelial abnormalities indistinguishable from those seen in eyes with choroidal ischaemia. These changes have been attributed to decompression-induced intravascular gaseous microemboli [7]. The incidence of these lesions was directly related to the length of diving and a history of DCI. No divers suffered a loss of visual acuity from these abnormalities, but the paper notes that the long-term effects of this phenomenon remain to be studied.

Retrochiasmal defects such as hemianopia or cortical blindness are potential ocular manifestations of DCI caused by arterial gas embolism, the commonest cause of which is pulmonary barotrauma.

Treatment of DCI is by prompt recompression.

Decreased Vision after Diving

The following causes should be considered:

- DCI
- Corneal oedema (hard lens users)
- Loss of a lens (soft lens users)
- Antifog keratopathy (resulting from the volatile compounds used in mask antifogging preparations)
- Ultraviolet keratitis
- Contact lens adherence syndrome (contact with sea water can cause soft lenses to become tightly adherent to the cornea).
**Diving After Eye Surgery**

Diving after eye surgery can only be carried out after a suitable time for the wound to heal. A number of factors will increase the risk of post-operative complications:

- The water in which diving is performed may harbour pathogens which can infect non-epithelialised surfaces.
- Such pathogens may enter the eye through non-healed wounds and result in vision-threatening endophthalmitis.
- Gas in the eye resulting from surgery can be affected by changes in pressure and this can give rise to vision-threatening intraocular barotrauma.
- Face mask barotrauma may result in subconjunctival haemorrhage and might cause rupture of incompletely healed wounds.

Unfortunately, there are as yet no controlled studies on the length of time a subject should not dive after different forms of ophthalmic surgery. Therefore the following comments are based on current “best practice”.

**Corneal surgery**: Studies on the rate of full thickness corneal scar healing show little healing in the first week, followed by a rise to approximately 50% of normal by 3-6 months. Procedures such as penetrating keratoplasty should be followed by a lay-off period of 6 months before being allowed to return to diving. Patients who have undergone radial and astigmatic keratotomy which do not involve prolonged steroid therapy, may be allowed to dive after a 3 month rest period. Photorefractive keratotomy in which there are no incisions may allow a return to diving as soon as re-epithelialisation of the cornea is complete and the acute post-operative symptoms subside.

**Cataract surgery**: A three month wait before resuming diving will generally be sufficient after extracapsular cataract surgery. Scleral tunnel incisions as used in phacoemulsification procedures will require a period of one month off diving to allow for healing to take place.

**Glaucoma**

Glaucoma may be treated either medically or surgically to reduce the intraocular pressure. Therefore, there may be concern when it is realised that diving may raise the intraocular pressure to very high levels. However, saturation divers working at depths of 250 metres have intraocular pressures in excess of 19,000 mm Hg without suffering from symptoms of glaucomatous optic neuropathy. Thus, it appears to be the magnitude of the difference between the extraocular and intraocular pressures that is important and during diving this difference should be very low.

There are two possible complications that may arise in patients that undertake diving after glaucoma filtering surgery. These are a). subconjunctival haemorrhage due to face mask squeeze and chemosis that may compromise the operation of the filter and b). late endophthalmitis as a result of pathogens gaining access to the anterior chamber through the conjunctiva. In practice, neither of these complications has been reported as a complication of diving. A two month lay-off period is advised after this form of surgery and patients should be advised to avoid face mask barotrauma.

**Further Reading**


**References**


Simon DR, Bradley ME “Adverse effects of contact lens wear during decompression” JAMA 244(1980)1213-4.

Boyle R. “A digressive experiment concerning the expansion of bloud and other animal juyces” Phil.Trans.Roy.Soc.Lond. 63(1670)2033-44.

GENERAL MEDICAL
PREGNANCY AND DIVING

Scientific studies to determine the safety of scuba diving whilst pregnant are limited (1-5). A definitive study, which would be of statistical significance, examining the effect of diving on the unborn child would require unethical trials to be performed on large numbers of pregnant females.

The results of animal studies conducted in the past have been contradictory and inconclusive in their findings (6-8) and may only be relevant to that species.

Anecdotal evidence exists which suggests that decompression illness (and its treatment in a recompression chamber) may be harmful to the foetus (9). It should be recognised that even shallow water diving can result in pulmonary barotrauma and gas embolism, which might require recompression treatment. There is also some evidence, albeit poor, from small retrospective studies which suggest that deep dives (to depths greater than 30 m) may be associated with foetal abnormalities (2-4). A more recent study (5) has shown that there may be a higher incidence of spontaneous abortion amongst the women who have dived whilst pregnant. They were from women who had made more than one dive a day, and also the respondents of pregnancies that had made dives with decompression stops, though the findings were not statistically significant. It might be argued, however, that there could be an effect but these data are not large enough to detect this factor. The respondents did not average enough dives per pregnancy, therefore if there was a cause and effect it may not show itself owing to this factor.

The committee recognises that some women may be unwilling to follow this advice. Therefore, if they wish to continue diving whilst pregnant, then they should do so with extreme caution with the aim of minimising the gas load.

Women who have dived when pregnant, but prior to becoming aware of their pregnancy, may seek advice. In which case, ultrasound studies and other investigations may be useful, either to allay the fears of the mother, or to help her and her medical advisers decide how the pregnancy should be managed.

As previously mentioned, there is no clear scientific evidence concerning the risk of diving causing foetal abnormalities, neither is there any clear cut scientific evidence which would suggest that there is no risk to the foetus where a mother has dived whilst pregnant. There is no animal or human study that exists which determines the safe depths, limits and timing of a dive whilst pregnant.

It is in the light of our lack of understanding of this subject that the UK Sport Diving Medical Committee recommends that if a woman is trying to become pregnant or is pregnant and wants to be quite sure that any problem with the pregnancy and the child cannot be attributed to scuba diving … don’t do it.

References:

May 1996
NEUROLOGICAL SYSTEM
EPILEPSY AND DIVING

An epileptic attack occurring underwater while using conventional scuba equipment is usually a fatal event, since the mouthpiece is likely to be lost and large quantities of water inhaled during the clonic phase of the fit. It is therefore imperative that no epileptic should dive if there is any serious possibility of an attack occurring underwater.

A second factor which has to be considered is the nature of the drugs used to control epilepsy, which are all, to some degree, sedative in nature and would thus exacerbate nitrogen narcosis or cause it to come on at an unexpectedly shallow depth. For this reason, it is not considered safe for any epileptic to dive if he/she is currently taking any anti-epileptic medication.

Since hyperbaric oxygen is known to provoke convulsions in normal individuals, it was formerly considered that epileptics would be at increased risk when exposed to the raised partial pressure of oxygen in compressed air breathed at depth. However, it is now known that the mechanism of the attack is different, and epileptics are not more susceptible to convulse under pressure. Thus, this factor can be disregarded.

The relapse rate in epileptics who are taken off medication decreases exponentially, with the majority of those relapsing doing so within the first eighteen months of ceasing treatment and the rate of relapse becoming insignificant after three years (1,2).

The suggested requirements for an epileptic to be permitted to dive are therefore set at five years free from fits and off medication. Where the fits were exclusively nocturnal, this can be reduced to three years.

A past history of petit mal should not disqualify, provided that no attacks have occurred for five years and that the condition has not progressed to epilepsy.

Pyrexial convulsions in childhood may be disregarded if not followed by epilepsy.

Post traumatic epilepsy: see BSAC Medical Standard No 12: Head Injury and Diving.

References:

NEUROLOGICAL SYSTEM
HEAD INJURY AND DIVING

Epilepsy occurring underwater is almost always fatal to an amateur diver who will lose his mouthpiece and inhale water during the clonic phase of the attack. It is known that hyperbaric oxygen induces epileptiform fits in susceptible individuals and it is possible that the raised partial pressure of oxygen in compressed air breathed at depth may induce fits in someone susceptible to epilepsy.

Anticonvulsants cannot be used to overcome this problem underwater as they are all sedating and potentiate the effect of nitrogen narcosis, leading to disorientation at unexpectedly shallow depths.

Because head injury may be followed by epilepsy, the fitness of divers who have sustained this type of injury needs to be carefully considered. The following guidelines are suggested.

The length of post traumatic amnesia (PTA) including any period of unconsciousness may be used as an index to the severity of injury. Where PTA has been less than one hour, there should be a three week layoff from diving. With PTA of an hour to 24 hours, there should be a two month layoff. Where the period of PTA exceeds 24 hours, there inevitably has been severe brain damage and there is considerable likelihood of subsequent epilepsy and impaired mental functioning. A minimum period off diving of three months is suggested and cerebral function should have returned to normal.

Where enquiries are being made about an incident in the past, the individual sometimes has difficulty in recalling the period of PTA and in such cases the period of unconsciousness may be doubled as a rough guide.

If epilepsy should have developed as a result of injury then further diving is banned unless it was an isolated fit occurring at the time of injury. Likewise if anticonvulsant medication is being taken as a prophylactic measure, diving should be banned, but may be resumed three months after this is withdrawn if the individual never had a fit.

Operative intervention to raise depressed bone or evacuate haematomas should disqualify for three months but otherwise may be disregarded except insofar as it may be associated with subsequent fits, anticonvulsants treatment or other factors above.

References:

NEUROLOGICAL SYSTEM
MULTIPLE SCLEROSIS AND DIVING

The symptoms and signs of multiple sclerosis (MS) and optic neuritis are very similar to neurological decompression sickness and arterial gas embolism. Any neurological symptom arising within 24 hours of surfacing from a dive must be considered dysbaric in origin and the only method of establishing the diagnosis is by assessing the response to therapeutic recompression. Instances have occurred where new neurological symptoms have arisen following dives in individuals who have had suspected or confirmed multiple sclerosis. These have proved very difficult management problems for the attending diving physicians. However, the medical committee recognises that up to one-third of patients do not develop progressive disability and remain relatively unimpaired many years after the onset of the illness. The committee therefore considers that a prospective diver who has experienced the symptoms and/or signs of MS should wait for a period of at least one year before taking up scuba-diving. During that year, no further symptoms or signs of MS should become evident and there should be no further clinical deterioration in the patient.

If a diver with MS experiences further episodes of MS (in or out of the water) then he/she must cease diving for a period of one year during which time there should be no further signs or symptoms of MS and his/her clinical condition should not deteriorate further.

Consideration of individual cases may be undertaken by the medical committee. Consideration must also be given to the possibility of divers handicapped by MS being trained by the disabled divers associations (e.g. DOLPHIN).

The position with isolated optic neuritis remains unclear, but a recent episode of isolated optic neuritis would also disqualify for a period of one year.

References:

NEUROLOGICAL SYSTEM
NEUROLOGICAL DISEASE AND DIVING

People with neurological illnesses which affect the spinal cord or peripheral nerves must be carefully assessed with regard to their fitness for sport diving. The committee has no case reports of people with pre-existing spinal cord disease which would suggest an increase in susceptibility to spinal decompression but the numbers at risk must be very small. It is accepted that the functional recovery from spinal decompression sickness in sport divers is usually gained by utilising the reserve capacity of the spinal cord. There is an inevitable delay before recompression treatment and tissue damage occurs as a result of hypoxia and the secondary effects of bubbles. Individuals with pre-existing demyelination, tumours, syringomyelia, polio, or surgery, may therefore have a reduced reserve capacity already and it may be impossible to gain a functional recovery back to previous levels if there is an episode of spinal decompression sickness.

There would also be problems in assessing the neurological signs during any treatment for spinal decompression sickness which would make the management of recompression treatment difficult for the hyperbaric physician concerned. Spinal decompression sickness has occurred in sport divers despite using recognised decompression tables and safe diving practice. Cases of this nature should therefore be assessed on an individual basis by the medical committee and the risks of diving activity clearly explained to each individual.
RESPIRATORY SYSTEM
ASTHMA AND DIVING
Asthma may predispose to air-trapping leading to pulmonary barotrauma and air embolism, which may be fatal. An acute asthma attack can also cause severe dyspnoea which may be hazardous or fatal during diving.

These theoretical risks should be explained fully to the asthmatic diver. There is little if any evidence that the mild controlled asthmatic who follows the guidelines below is at more risk.

Asthmatics may dive if they have allergic asthma but not if they have cold, exercise or emotion induced asthma.

All asthmatics should be managed in accordance with British Thoracic Society Guidelines.

Only well-controlled asthmatics may dive.

Asthmatics should not dive if he/she has needed a therapeutic bronchodilator in the last 48 hours or has had any other chest symptoms.

Control

The asthmatic should not need more than occasional bronchodilators, i.e. daily usage would be a disqualifying factor, but inhaled steroids/cromoglycate/nedocromil are permissible.

During the diving season he/she should take bd peak flows. A deviation of 10% from best values should exclude diving until within 10% of best values for at least 48 hours before diving.

The medical examiner should perform an exercise test such as the 18 in (43 cm) step test for three minutes, or running outside (not a bicycle ergometer) to increase the heart rate to 80% (210-age). A decrease in PEFR of 15% at three minutes post exercise should be taken as evidence of exercise induced bronchoconstriction and hence disbars. The patient should be off all bronchodilators for 24 hours before the test.

A $\beta_2$ agonist may be taken pre-diving as a preventative but not to relieve bronchospasm at the time.

References

Standard issued January 1996.
SEA SICKNESS MEDICATION: ADVICE FOR DIVERS
The problem with sea-sickness medication is that some of these tablets may make you drowsy and may therefore predispose you to nitrogen narcosis.

It is strongly advisable to find the medication which best suits your body. First, you should purchase a type recommended by your local pharmacist (e.g. Stugeron), and take a test dose at a time when you are not driving or diving. If you become drowsy, you will know the medication does not suit you, and you must then try another type. This procedure should be repeated until you find one which does not make you drowsy. It is important to note that the one which suits you best may not suit your buddy at all. This is nothing to worry about and is due to differing body metabolism.

Your initial dives on this medication should be shallow and depth should be gradually increased over subsequent dives in order to minimise the possibility of adverse effects on a deep dive. Beware of the possible additive effects of this medication with prolonged use. If any drowsiness is experienced, you should not take a dose on that day.

At the start of a new diving season, prior to diving, it is advisable to retest yourself in this way to ensure that your chosen medication still suits you.

May 1996.
EAR CLEARING: ADVICE FOR DIVERS

If you have problems clearing your ears on descent, then you are having difficulty inflating your middle ear via the Eustachian tube which connects it to the back of the nose. Provided you have normal hearing on the surface, then your Eustachian tubes must be working properly as the air in your middle ear is continually being absorbed and replaced by fresh air coming down the tubes.

There are several things you can do to help make it easier to clear your ears.

Firstly, practice inflating your ears several times a day for three to four days before you intend diving but don’t do this if you have a cold as pushing infected mucus into the middle ear is not a good idea. Regular use tends to open up the Eustachian tubes. Next, when in the water, start inflation from the surface downwards and for the first few metres with each breath. Never wait until there is a pressure on your ears and, if you can’t clear or if there is pain, go back up until the pain and pressure has gone and try again.

Never, whatever happens, go on down in the face of increasing pain or pressure on the ear drum. If you ignore this advice, if you are lucky, you will get seeping of serous fluid into the middle ear, leaving you mildly deaf for a few days. If you are not so fortunate, a burst ear drum may result, or if the worst happens, a ruptured round window or intralabyrinthine membrane with hopefully short term tinnitus, vertigo and almost certainly lifelong high note deafness with inability to hear such things as telephones, doorbells and violins. If you are unfortunate enough to suffer tinnitus, vertigo, and deafness after a dive, and you think that it might be diving related, seek the advice of a diving medical physician immediately - time here is of the essence.

If you are diving from a boat down an anchor line or down a well secured shot line, then it often helps to pull yourself down feet first at least for the first ten metres. That way the column of air in your chest and throat exerts positive pressure to help open the Eustachian tubes.

Medication, in the form of a tablet of Sudafed taken half to three quarters of a hour before entering the water, may help and is safe to take when diving to a depth shallower than about 30 metres. Sudafed is an “over the counter” drug. However, this drug is absorbed into the body and occasionally produces side effects. It is wise therefore to try it out a day or two before diving. Ephedrine 1% nasal drops used before diving may also be helpful and should be available over the counter.

Lastly, if all else fails, there is surgery. Many people with poor Eustachian function have abnormal bony spurs extending into the back of the nasal cavity and removal of these often cures the problem. Others have a crooked nasal septum which can be straightened surgically.