Medical Examination of the Recreational SCUBA Diver

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Abstract

It is estimated that more than 2 million United States (U.S.) citizens regularly participate in sport SCUBA diving and more than 250,000 are newly certified each year.[1,2] Compressed air diving introduces very specific challenges to human physiology, different than from any other of man's endeavors. There are currently no required standards in the U.S. for sport SCUBA diving and sport divers generally assume that such a decision involves only themselves, but that is not true. Fellow divers may be placed in jeopardy trying to rescue a disabled diver and expensive use of medical facilities and personnel are required to care for injured divers. The physician who examines a sport diver and makes recommendations also bears responsibility because generally there will be no review of the doctor's decision. This article reviews the current recommendations for determining fitness to dive.

Introduction

In 2017, there were approximately 2.87 million recreational SCUBA divers in the U.S.[1,2] Health requirements for SCUBA certification vary around the world, but U.S. physicians need to be aware of the potential health risks and complications associated with SCUBA diving in case a student diver presents for a physical exam.

In the United Kingdom (U.K.), the British Sub-Aqua Club (BSAC) requires that divers be examined by a physician recognized in the U.K. as a diving medical expert. In the United States, there is no such requirement. All diver training agencies have a form for divers to self-report their medical conditions, surgeries, and medications. It is up to the dive instructor to determine whether the applicant should be referred to a physician for a physical exam. Not surprisingly, students have been known to "shop" SCUBA shops to ensure they receive medical approval. For instance, if a medical condition is reported and the potential diver is referred to a physician, they could try a different dive shop and not report the medical conditions that caused them to be referred. Knowledge of diving and its related complications is not taught in medical school.

Absence of this knowledge could lead to an inappropriate approval which, in turn, can put the student at risk for complications either related to the underwater (pressure) environment, or by their medical conditions or medications. This can also expose the examining physician to litigation should the diver experience a complication while diving which should have disqualified them from receiving medical approval in the first place.

Florida ranks highest in the U.S. for diving fatalities (20 out of the 169 fatalities in 2017), with California coming in second (7 fatalities) in the same year.[3] The typical profile of a recreational SCUBA diver is listed in Table 1.[2] From this table, it is easy to see the financial and emotional impact of a diving accident or fatality. It is not beyond possibility that a physician who inappropriately clears a student for diving may be held liable for that inappropriate approval.

It is important for physicians to understand the medical symptoms and conditions which may disqualify a person from SCUBA diving, and the medications that are risky or contraindicated.

Physics of Diving

Before performing any medical examinations related to SCUBA, it is important for a physician to understand the physics of diving and a variety of gas laws relating to the sport. One of the most important of these is Boyle's Law, which states that volume of a gas is inversely proportional to its pressure (at a constant temperature). The impact of this law is that the greatest pressure change when going under water is the first 33 feet. (Each change of depth of 33 feet of sea water is equivalent to 1 atmosphere in pressure (14.7 psi)) (Figure 1). This is important for any disease where air trapping is a problem (e.g. asthma, COPD). It is not appropriate in these conditions to tell a diver "you can dive as long as you don't go deep" because the highest incidence of barotrauma occurs within the first 33 feet of sea water.

Another important gas law to understand is Henry's Law (Figure 2). Henry's Law states the amount of gas that will dissolve in a liquid is directly proportional to the partial pressure of that gas.

Since decompression illness (DCI) is essentially a disease of nitrogen bubble formation, the deeper a diver goes, and/or the longer they stay underwater, the more nitrogen will be present as dissolved in solution This is demonstrated in the figure where 1 bar = 1 ATA (atmosphere absolute) = 14.7 psi = 33feet sea water (fsw)). A gas is more soluble the lower the temperature, and since water temperature decreases with depth, the more gas is dissolved in plasma.

DCI can result from the formation of bubbles (in recreational SCUBA diving, that gas is nitrogen) in the tissue or blood following a reduction of environmental pressure and/or from the release of bubbles into the arterial circulation as a consequence of pulmonary overinflation (gas expansion of the lung from ascending to a lower pressure with a closed glottis) or the presence of a right-to-left shunt (patent foramen ovale).[5]

DCI encompasses two conditions: decompression sickness (DCS) and arterial gas embolism (AGE).

Two other important laws to understand are Charles' Law and Gay-Lussac's law. Charles' Law discusses temperature/volume relationships. It states that at a constant volume, the pressure of gas varies directly with absolute temperature. Since water temperatures while diving are typically colder than the outside air, and the friction caused when filling a tank heats up the air inside, a diver may have less gas volume in their tank than they expect.

Gay-Lussac's Law states that there is a direct relationship (variation) between gas pressure and temperature when the volume is held constant. Since a SCUBA tank is a rigid container, any drop in temperature will decrease the gauge psi in the tank, giving the diver less dive time than anticipated. In an 80 ft^3 tank, the average temperature change is 5 psi for every one-degree F. Two important issues with water temperature and the diver are: swimming induced pulmonary edema (SIPE), also called immersion pulmonary edema. It is a form of pulmonary edema that occurs during water sport activity in young, otherwise healthy individuals. It has been reported in surface swimming, snorkeling, scuba diving, and breath-hold diving. SIPE is a form of hemodynamic pulmonary edema caused by an exaggerated increase in pulmonary vascular pressures in response to immersion in water, intense physical activity, and host factors.[4]

The second issue with cold water immersion is that it inhibits anti-diuretic hormone. Immersion, along with a water temperature that is colder than air, causes arterial vasoconstriction in the extremities. This vasoconstriction occurs primarily in the skin and superficial tissues of the body as well as in the muscles of the arms and legs. The result: An increased volume of blood is sent to the central organs of the body such as the heart, lungs, and large internal blood vessels.

The hormone that controls the production of urine by the kidneys is called antidiuretic hormone (ADH). It controls how much urine the kidneys make and when. The increased blood volume to the major vessels is interpreted by your body as a fluid overload. This overload causes ADH production to stop, which in turn allows the kidneys to immediately produce urine to lower the centrally circulating blood volume - the body's automatic response to preserve blood volume. For this reason, it is very important to remain hydrated (especially diving from boats where the hot air temperature increases fluid loss). Any imbibed diuretics would complicate the dehydration (e.g. caffeinated coffee, and alcohol).

Discussion: Medical Conditions & SCUBA

The physician who examines a SCUBA diver must understand both the medical conditions which disqualify someone from diving and the medications that are either contraindicated or pose an increased risk of adverse effect under pressure. SCUBA diving is an enjoyable and safe sport when it is pursued by healthy, well-trained, disciplined, and well-equipped individuals who are comfortable in the water. Since the sport diver is out for recreation, there is no need to take chances or shortcuts with any of these factors.

As mentioned, there are no regulations specifying standards for recreational SCUBA divers. The diver may argue that a decision to dive involves only him/herself, but that is not true. For example, fellow divers may be placed in jeopardy trying to rescue a disabled diver, and use of medical facilities and personnel are required to care for injured divers. In some cases, depending on the dive site, medical care may be hours or even days away from the location of the diving. The pregnant female bears an awesome responsibility to her unborn fetus. The physician who examines the sport diver and makes recommendations also bears responsibility because generally there will be no review of the physician’s decisions. The physician must be aware of the unique potential dangers of diving. Medical conditions which may seem trivial while on land, may prove fatal under water.

Of all the conditions which may put the diver at risk for an untoward event, the two most common are cardiac and pulmonary.

At sea level, water is 784 times denser than air. Diminished exercise capacity in this denser environment could place the diver at increased risk. A family history of cardiovascular events before age 55 is considered a definite risk factor. Hydrostatic pressure has no effect on blood pressure which is always relative to ambient pressure. Evaluation of the hypertensive diving candidate should seek the etiology and end organ effects involving the eyes, heart, or kidney. Diving should not be recommended until blood pressure is controlled. In general, although pacemakers are tested to 2.0 ATA (because medical equipment is autoclaved at a psi between 15 and 27), divers should be disqualified because of their underlying disease.

The potential need to increase cardiac output in response to heavy exercise requires that new candidates for SCUBA who are over age 40 with hypertension, have a family history of heart disease, or are on beta-blockers or drugs which produce significant blockade demonstrate adequate performance on an exercise tolerance test to 13 METS. Those who have left ventricular hypertrophy or dysfunction should not be cleared for diving even if blood pressure is controlled. ACE inhibitors and calcium channel blockers are probably safe for diving.[6]

There are many electrographic abnormalities that would put a diver at risk and are too numerous to mention in this article. Recommendations would be to consult a cardiologist familiar with diving or contact the Divers Alert Network (DAN) Medical Information Line at (919) 684-2948.[6]

Patient foramen ovale (PFO) is mentioned in many diving medicine books as a significant concern for air embolism due to a right to left shunt allowing bubbles to cross from the venous to the arterial circulation. A study totally unrelated to diving found that 25-33% of the population had some degree of PFO.[7] While that percentage of divers might be expected to have a PFO, DCI in recreational divers occurs in only 0.005-0.08% of dives, clearly much lower than the one in 5 or 6 that might be expected if every diver with PFO and venous bubbling developed DCS. The estimated risk of a DCS incident correlated with those with PFO is between 0.002-0.03% of dives. For this reason, routine screening of all divers for PFO is not warranted primarily because the absolute risk of DCS is low and the cost of routine screening is expensive.[8]

Chronic obstructive pulmonary disease (COPD) and asthma are also significant concerns for SCUBA candidates. Divers with either of these conditions are at risk from exercise limitation. In addition, asthmatics could be exposed to entirely different triggering factors underwater (cold temperature, marine life, etc.) than they would on land. All asthmatics wheeze on exercise, and an exercise test does no more than reveal an underlying bronchial hyper-responsiveness.[9] Most test protocols compare either peak flow (PEF) or FEV_1 before and about five minutes after exercise. A fall in either value of more than 20% is diagnostic, but a much more sensitive measure is a comparison of the fall in med-expiratory flow (MEF50%). Also of note, is that as depth increases, gas density increases (Boyle's Law). This makes it more difficult for a diver to inhale the denser gas given the static diameter of the octopus (hoses that come out of the tank to the regulator where the diver breathes).

A 1995 symposium by the Undersea and Hyperbaric Medical Society addressed the question of whether asthmatics are fit to dive. Conclusions from that seminar are:[10]

- Asthmatics who dive are at risk from exercise limitation more than peripheral gas trapping.
- Well-controlled asthmatics face no problems, but an exercise test is required to gauge asthma severity.

- Fall in MEF 50% post-exercise is a more sensitive indicator of asthma than a fall in either PEF or FEV_1.
- Subjects with a post-exercise fall in MEF of more than 50% are at risk.
- Exercise asthma is best controlled with inhaled corticosteroid twice daily.

Metered-dose inhalers cannot be used underwater. The usual pressurization in the inhaler is 40-80 psi (per personal communication with Boeringer-Ingleheim pharmaceutical company). Although they would theoretically expel their contents up to a depth of 5.5 ATA (181 fsw), it is impossible to inhale the contents without concomitant aspiration of water at the same time.

Diabetes is another condition a physician should consider. In short, a patient with type 1 and type 2 diabetes can dive safely However, it is important to ensure the diabetes is well-controlled. Additionally, the physician should ensure the patient has no other health issues as a result of their diabetes. DDRC Healthcare, which delivers a diving and hyperbaric medical emergency service, recommends that a potential diver "must not have had a hypoglycemic event or been admitted to a hospital for a reason related to their diabetes in the last year."[11] It is recommended that a diver with diabetes performs a fingerstick to test blood sugar before each dive. The diver should also carry nutritional bars. If blood sugar is low, the diver should not do that particular dive, eat a nutritional bar, and not go in the water until their blood sugar is normalized.

Table 2 is a recommended information sheet and waiver for a patient with diabetes who requests a recreational diving medical examination.

Discussion: Medications and Diving

Unlike the Federal Aviation Administration (FAA) which has clear guidelines on medications which would disallow a pilot to fly, there are no such guidelines in the diving community. A primary reason is that drugs are not tested under pressure, so the effect of increased pressure on any drug is practically unknown. Table 3 addresses the relative and absolute contraindications to SCUBA diving. It is critical to cross-reference these contraindications with a patient's medication list during an examination related to SCUBA diving.

More important than the actual drug, is the medical condition for which the patient is taking the drug. If you are the examinee's primary physician, it is likely (and hopeful) that their prescriptions are coming from you. Some important questions to ponder are:

- What is the medical indication for the drug in question?
- How long has the patient been taking the medication?
- What are the known side effects and has the patient experienced any (on land)?

Nitrogen is a narcotic gas. In diver's lore, there is something called "The Martini Rule." The meaning of this is that every 1 ATA of depth is equivalent of drinking one martini on an empty stomach. Because of this, any medications (opiates, benzodiazepines, psychiatric medications, etc.) which dull sensorium would put the diver at risk for poor decision making. With regard to psychiatric medications, the condition is of utmost importance. Someone on short-term treatment for mild depression may not be at risk, whereas someone with a major depressive disorder or suicidal attempt could be at significant risk. Because SCUBA diving involves the buddy-system, the risk is not only to the diver taking the medication, but to their dive buddy as well. Once

again, one is referred to the DAN Medical Information phone number for any questions on a particular medication. DAN also offers valuable information online regarding medications and diving including a look at orthopedic pain medications, muscle relaxants, neurologic, gastrointestinal, chemotherapy, and cardiovascular drugs, psychiatric medications, and more.[12]

Treatment and Cost Considerations for DCS and AGE

The treatment of DCS and AGE is relegated to physicians trained in Undersea and Hyperbaric Medicine in facilities capable of treating emergencies. The reference guide most commonly used is the United States Navy Diving Manual, which is currently in Revision 7. The manual is updated every few years. The entire diving manual is nearly 1,000 pages, but the most valuable information on diagnosis and treatment of DCS and AGE can be found in Chapter 5.[13]

While DCS symptoms are peripheral (including neurologic), AGE represents a condition where bubbles either form in the arterial supply or are transferred because of a right-to-left shunt. The main manifestation of AGE is central nervous system and usually occurs while surfacing or within 10 minutes of reaching the surface. DCS, on the other hand, starts many minutes to hours after surfacing.

The costs incurred in treating a diver with DCS or AGE vary widely. With the advent of contract management companies offering hospitals to set up turn-key operations with monoplace chambers (one person), the number of operational chambers in the U.S. willing and able to treat DCS has dropped significantly in the last 30 years. Since many dives are done outside the U.S., different countries have differing billing and reimbursement issues which make prediction impossible. It's possible that treatment costs could easily run into the tens of thousands of dollars depending on how far the diver is from a treatment center (cost of medivac air travel significantly increases the cost of treatment), severity of symptoms, number of treatments necessary, and post-treatment care (rehabilitation, physical therapy, etc.). Although there are approximately 1,400 hyperbaric chambers in the U.S., it is estimated that only about 130 accept emergency cases including divers. In addition to the DAN Medical Information Line, there is a DAN Emergency Hotline that can offer a diver advice regarding diving injury and provide the phone number and location to the nearest hyperbaric chamber that accepts divers. Should a patient contact you with a medical problem as a result of diving, this would be a valuable resource to have on hand. The DAN Emergency Hotline is 919-684-9111 and is available 24/7/365.

Other Considerations

The sport diver can choose the time, place, and water conditions of the dive. On a given day, with a temporary illness which makes diving more hazardous, a sport diver can abort the dive without any repercussions. Strenuous labor is usually not required. The richest marine life and light for photography is at shallow depth. Sport divers need not exceed 60-80 feet to find the best of their sport. It must be emphasized that the most frequent and serious problems due to pulmonary, middle ear, and sinus gas volume changes occur with the first ten feet of depth.

Even when an initial medical examination is performed, no subsequent examinations are required for the rest of the diver's life. Largely, the decisions on return to diving after an illness or injury are left to the judgement of the diver or to a physician who may not be experienced with the diving environment or diving medicine.

While commercial, military, and scientific diving is usually done under strict supervision of a master diver, many sport dives may be done under the supervision of a dive master (usually not the same training as a master diver). This is not required and the diver alone usually decides whether he/she is able to dive on any given day. Sport diving may occur in any location around the world without regard for emergency medical care, hyperbaric chamber access, or emergency evacuation capability.

Conclusion

SCUBA diving is a complex sport. It is important to remember medical examination is not required in the U.S. and no rules exist to define the training or experience of the examining physician. Examining a patient for fitness to dive can be challenging as the physician bears responsibility since there generally will not be a review of their decision. Medical examination regarding SCUBA diving involves knowledge of several gas laws as they relate to human physiology, as well as an understanding of how different medical conditions and medications may impact the performance and safety of a diver. This article attempts to make the examining physician aware of those issues.

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Conflicts of Interest: The author declares no conflict of interest regarding this article.

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Figure Legend:

Figure 1. Boyle's Law

Figure 2. Henry's Law, 1 Bar = 1 ATA (atmosphere absolute) = 14.7 psi

Table 1. Profile of Open Water Divers in the US[2]

Table 2. Guidelines for Recreational Diving with Diabetes*

Table 3. Absolute and Relative Contraindications

Figure 1: Boyle's Law

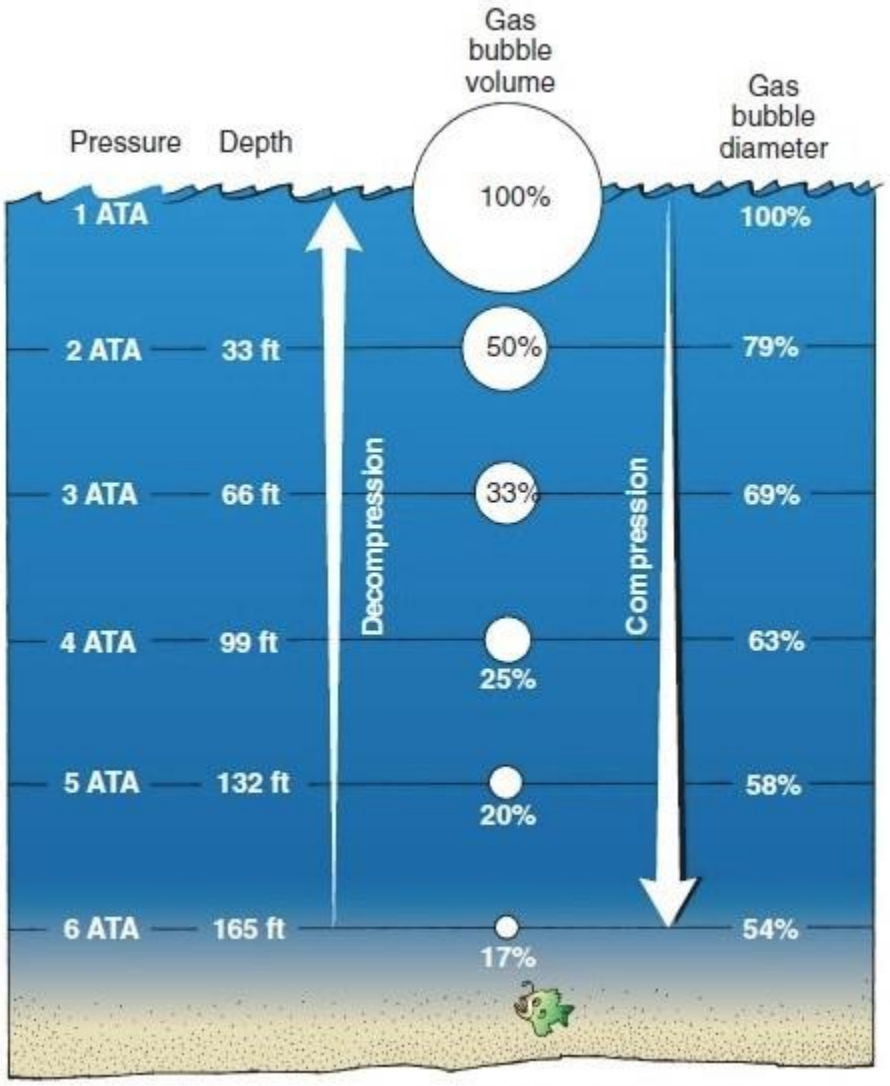

Figure 2: Henry's Law, 1 Bar = 1 ATA (atmosphere absolute) = 14.7 psi

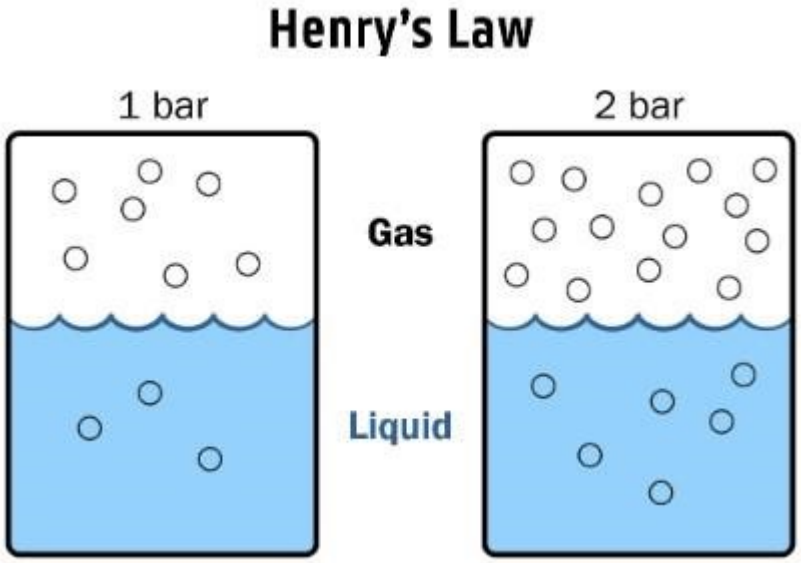
Henry's Law
1 bar
2 bar
Gas
Liquid

Table 1. Profile of Open Water Divers in the US[2]

Mean age:33
Male 65%
Female 35%
Average annual household income: $150,000
60% have completed college or graduate school
92% own their own homes
76% are married
24% have children between the ages of 11 and 17

Table 2. Guidelines for Recreational Diving with Diabetes*

Selection and Surveillance
• Age ≥18 years (≥16 years if in special training program) • Delay diving after start/change in medication - 3 months with oral hypoglycemic agents (OHA) - 1 year after initiation of insulin therapy • No episodes of hypoglycemia or hyperglycemia requiring intervention from a third party for at least one year • No history of hypoglycemia unawareness • HbA_{1c} ≤9% no more than one month prior to initial assessment and at each annual review - values >9% indicate the need for further evaluation and possible modification of therapy • No significant secondary complications from diabetes • Physician/Diabetologist should carry out annual review and determine that diver has good understanding of disease and effect of exercise - in consultation with an expert in diving medicine, as required • Evaluation for silent ischemia for candidates >40 years of age - after initial evaluation, periodic surveillance for silent ischemia can be in accordance with accepted local/national guidelines for the evaluation of diabetics • Candidate documents intent to follow protocol for divers with diabetes and to cease diving and seek medical review for any adverse events during diving possibly related to diabetes
Scope of Diving
• Diving should be planned to avoid - depths >100 fsw (30 msw) - durations >60 minutes - compulsory decompression stops - overhead environments (e.g., cave, wreck penetration) - situations that may exacerbate hypoglycemia (e.g., prolonged cold and arduous dives) • Dive buddy/leader informed of diver's condition and steps to follow in case of problem • Dive buddy should not have diabetes
Glucose Management on the Day of Diving
• General self-assessment of fitness to dive • Blood glucose (BG) ≥150 $mg \cdot dL^{-1}$ (8.3 $mmol \cdot L^{-1}$), stable or rising, before entering the water - complete a minimum of three pre-dive BG tests to evaluate trends ▪ 60 minutes, 30 minutes and immediately prior to diving - alterations in dosage of OHA or insulin on evening prior or day of diving may help • Delay dive if BG - <150 $mg \cdot dL^{-1}$ (8.3 $mmol \cdot L^{-1}$) - >300 $mg \cdot dL^{-1}$ (16.7 $mmol \cdot L^{-1}$) • Rescue medications - carry readily accessible oral glucose during all dives - have parenteral glucagon available at the surface • If hypoglycemia noticed underwater, the diver should surface (with buddy), establish positive buoyancy, ingest glucose and leave the water • Check blood sugar frequently for 12-15 hours after diving • Ensure adequate hydration on days of diving • Log all dives (include BG test results and all information pertinent to diabetes management)

*For full text, see: Pollock NW, Uguccioni DM, Dear Gdel, eds. Diabetes and recreational diving: guidelines for the future. Proceedings of the UHMS/DAN 2005 June 19 Workshop. Durham, NC: Divers Alert Network; 2005.

	ABSOLUTE	RELATIVE	NO CONTRAINDICATION
ENT			
Auditory canal	Blocked canal		
Exostosis, meatal atresia	Blocked meatus	Exostoses, drum visible	Successful meatal surgery
External otitis	Stage 3 (drum not visible)	Stage 2	Stage 1
Traumatic perforation of drum	Perforation	Healed perforation needs to be assessed by ENT	
Septal deviation	Disturbed tube function	Restricted breathing, obstructed sinus passage	3 months post successful surgery; deviation with no obstruction
Nasal infection, sinusitis	If unable to equalize ears, chronic polypous rhinosinusitis	Chronic with normal pressure equalization but inexperienced diver	If all sinuses and middle ear ventilate well
Acute otitis media	Acute phase		Healed
Chronic otitis media	Yes	Healed with normal function; post op with proper counseling and evaluation	
Tympanic perforation	yes	Healed with normal function; post op with proper counseling and evaluation	
Tympanoplasty	Eustachian dysfunction	Atrophic areas – refer	3 months post op if transplant well healed
Radical ear surgery	Any canal wall down operations		
Hearing improvement surgery	All TORP	Exceptions must be cleared by ENT	
Acute balance disturbance	Yes	Acute vestibular dysfunction with normal inner ear function	Alternobaric vertigo in experienced divers; benign paroxysmal vertigo with remission, unil vestibular dysfunction with negative testing
Meniere's	On a completely theoretical basis		
Deafness		Unilateral deafness; impaired close to deafness	Slight to moderate hearing loss; bilateral complete deafness
Oral cavity	Inability to hold mouth piece	other	
Laryngeal	Recurrent laryngeal nerve palsy with about PFT, stenosis, tracheostomy	Subjective complaints without functional aberration	

	ABSOLUTE	RELATIVE	NO CONTRAINDICATION
OPHTHALMALOGIC			
Conjunctivitis, keratitis	Unhealed		Post healing
Open angle glaucoma	None	With functional or morphologic damage	Without damage
Narrow angle glaucoma	With symptoms after attack	Without symptoms	Following iridotomy with YAG laser
Cataract surgery	After 1 mo	1-3 months	More than 3 mo
Corneal surgery	Corneal suture, penetrating keratoplasty, radial keratoplasty until 6-12 mo Lamellar and laser 3 mo		After recovery
Retinopathy	Severe vascular retinopathy		All other forms
Retinal detachment			none
Monocular vision	4 months after loss of one yes	4-12 months post functional loss	12 months after loss
Abn visual field	Based on underlying pathology	Restricted visual field of more than 80 degrees horizontal, 50 vertically	Slight visual field restriction
Refractive abnormalies	Uncorrected hyperopia more than 4 dioptres (ability to read gauges)	Display dependent	Correct to normal
Contact lenses	None	Contact of choice = soft gas permeable	
CARDIOPULMONARY			
CHD, angina	Any form	Following treatment	
CHD, MI	Angina, failure, arrhythmia, Abn ventricular function, abn stress test	1 year post treatment with normal hemodynamics, no exercise intolerance, etc	
CHD, bypass, PTCA	Residua	As above	
CHF	Dyspnea at rest, grade 2-3 exertional for advanced diver, grade 1 for beginner	Grade 1 for experienced divers	
Conduction abnormality	All except where noted		AV block 1st degree, LAH, LPH, RBB, normal performance WPW without tachcardia on no meds
Arrhythmias, Supraventricular	All with myocardial disease, or affecting consciousness	Chronic AF, suprvent extrasystoles	Physiologic sinus brady, symptom free intermittent junctional rhythm

	ABSOLUTE	RELATIVE	NO CONTRAINDICATION
Arrhythmias, Ventricular	Lown clas 1-5, dysfunctional myocardium, long QT	Normal stress test class 3-4	PVC with lown class 1-2 normal exercise capacity, no underlying disease, no meds
Shunt, ASD, VSD	If exercise limited	Implanted model type	
PFO	Hx of undeserved DCI with neurologic hit Major pulm shunts	PFO and small pulm shunts with history of DCI	
Valvular disease	All functional defects, all stenotic defects	Any without functional abn	Asymptomatic MVP or bicuspid aortic valve
Valve replacement or plasty	Prosthetic malfunction, regurg	Normal function no arrhythmia, no LVH	
Endo, myo, pericarditis	For 6 months after	With no loss of function 6 months later	
Cardiomyopathy	Hypertrophic with obstruction of LV outflow tract or arrhythmia	No obstruction, no arrhythmia, normal size of ventricle	
Pulmonary embolism	Within 3 months All cases with pulmonary artery hypertension or respiratory failure	Functionally normal post event; anticoagulation is not an absolute contraindication	
Pulmonary hypertension	Yes		
Arterial hypertension	Poor control or intercurrent ds	Normal stress test and work capacity	
Orthostatic hypotension	Underlying disease		
Peripheral vascular disease	Stages IIb, III, IV	Stage IIa if stress test negative	Stage 1
Varicosities, chronic insufficiency	DVT, florid ulcus cruris		Varicosities Stage 1 or II insufficiency, healed stage III
DVT	Until mobile and good exercise capacity	6 months after	
NEUROLOGICAL			
Epilepsy	Any with attack < 5 yr ago, on meds, and abn EEG	Any but no attack for > 5 yr, normal EEG, no meds Get neuro clearance	Single seizure e.g. drug related or febrile etc and other features normal
Multiple sclerosis	Acute relapse Performance impaired	Slide persisting residua	
Paralysis	Acute central and peripheral	Certain impediments	Residua from disk disesase, polio, minor peripheral paralysis due to injury etc
Cerebrovascular insufficiency	Anatomical abn vessels, recurrent neuro deficits, incomplete recovery from CVA	Single TIA, PRIND, complete recover and normal exam	

	ABSOLUTE	RELATIVE	NO CONTRAINDICATION
Neuropathy	Rapid progressive Unable to swim Sensory deficits	Sensory and pain only neuropathy	Slight deficits, peripheral weakness
Parkinson's	Treatment resistant with rigidity /tremors	Juvenile well compensated	
Aneurysm	Post hemorrhage or surgery	Asymptomatic or successfully treated	
Craniotomy	No yet closed Residua like seizures		Trephination or complete reconstruction p/ 6 mo Grade one head trauma after 10 days Grade 2 trauma p/ 6 mo
DCS, AGE	Panic involved in DCI or AGE; Persistent symptoms delay 6 months	Noresidual symptoms wait 3 months; undeserved hit with PFO	Stable peripheral sx, stable neurological sx after 6 months, with exceptions to right
PSYCHIATRIC			
Hyperventilation	True syndrome With multiple occurrences	Single attack if trigger can be identified	
Panic attack	Single or multiple episodes	One explainable episode	
psychosis	Active or in remission	Stable with normal social function	
Depression	Acute major, in remission on meds, prior suicide attempts	Reactive depression, single episode bereavement depression, mild to moderate on meds	
Bipolar	Acute mania or depression, psychosis	Manic episode with no current impairments, hypo manic	
Anorexia	Clinically manifest	With normal eating behavior now normal BME and psychosocial adjustments	
Substance abuse	Abuse, addiction	Resolved and abstinent for at least 1 year with organic functional impairment	Resolved and abstinent for at least 1 year with no organic functional impairment
ENDOCRINE			
Endocrinolopathy	pheochromocytoma		
Diabetes	With history hypoglycemia Poor control Neurologic abn, severity issues		
HEMATOLOGIC			

	ABSOLUTE	RELATIVE	NO CONTRAINDICATION
Anemia	Acute Hgb < 11 Chronic Hgb < 8 Cryoglobulinemia	Acute and chronic thrombocytopenia	Normal exercise capacity, hemorrhagic conditions without pathologic bleeding, well controlled anticoagulation therapy, familial thrombophilia
MUSCULOSKELETAL			
Degenerative arthritis or trauma	Inability to swim	Swimming with aid or assist Self sufficient under water	Mod disability with preserved swimming ability and able to assist buddy
Dislocations, subluxation	During rehab	Recurrent	Healed without restricted function
Spinal degenerative disease	Recent or unhealed fx, osteoporotic fx, symptomatic disc disease, neurologic sx, thoracic deformity leading to pulm abn VC< 70%, FEV/VC < 0.7	Following surgery Healed fx	Healed with normal swimming ability
Aseptic necrosis	All acute	Symptom free	healed
GI			
Hernia	Non reducible, painful	Asymptomatic	Post repair
GERD, reflux	Acute ulceration	Hiatal hernia	Healed ulcer
Stoma	None except for continent stoma		
Inflammatory bowel	Acute	Symptom free	
GU			
Prostatic hypertrophy	Known retention	Dysuria, retention with cath	Post prostatectomy
Renal failure	Acute ID, dialysis, renal insufficiency	Post transplant Failure with creat cl> 20 ml/min	One kidney
Malformations	None		Based on organ function
Stones	Acute, ureteral even if asymptomatic	Asymptomatic post passing stones	One episode
SURGERY			
Post op abdominal	6 weeks	6-12 weeks	Post 3 mo
Post gyn surgery	6 weeks	6-12 weeks	Post 3 mo
Adhesions	Repeated hospitalization or surgery		Free of symptoms post adhesiolysis
MISCELLANEOUS			
Obesity		BMI over 30	
Skin		Infection, eczema, psoriasis,	
Pregnancy	yes		4-6 weeks post partum, 6-10 after C/S
Medications	Affecting consciousness or mentation	Impairing exercise tolerance	

Medical Examination of the Recreational SCUBA Diver – Post Test

1. The law which states that under pressure more gas is dissolved in solution which explains Nitrogen buildup while diving is:
a. Boyle's Law
b. Guy-Lussac's Law
c. Henry's Law
d. Dalton's Law

2. Diving in cold water inhibits which hormone, that allows for increased diuresis and potential dehydration of a diver?
a. PTH
b. Anti-diuretic hormone
c. Estrogen
d. Testosterone

3. A cardiac exercise tolerance test is recommended for divers with which of the following conditions:
a. Age over 40 with history of hypertension
b. Family history of heart disease before age 55
c. On beta blockers
d. All of the above

4. Since patient foramen ovale is present in 25-33% of the population, screening for PFO is:
a. Recommended for all divers because of serious risk of DCS
b. Recommended for divers who have a history of heart disease
c. Not recommended as screening because of low incidence of DCS and high cost of screening
d. Recommended for divers after their first episode of DCS

5. A fall in which of these post exercise values is most predictive of the severity of asthma which should prevent an asthmatic from diving:
a. PEF
b. FEV1
c. MEF
d. VC

6. Which of these is an absolute contraindication to SCUBA diving?
a. Seizure disorder
b. Diabetes
c. Hypertension
d. Migraine headaches

7. After initial certification, a diver is required to have a physical examination every how many years?
a. 2
b. 5
c. 7
d. Never

8. There is a list of federal guidelines that represent a contraindication to diving.
a. True
b. False

9. Which if the following is true?
a. Manifestations of AGE mainly affect the central nervous system and appear while surfacing or within 10 minutes of reaching surface
b. DCS symptoms can appear longer than 24 hours after surfacing
c. A case of DCS or AGE need not be treated with hyperbaric oxygen if the symptoms are mild
d. DCS and AGE are due to accumulation of excess oxygen in the body while diving

10. The organization which provides medical advice both for examining a diver and for emergency treatment is:
a. OSHA (Occupational Safety and Health Administration)
b. DAN (Diver's Alert Network)
c. US Coast Guard
d. NTSB (National Transportation Safety Board)

EVALUATION:

1. **What will you do differently as a result of this information?**
   _____
   _____

2. **How will you apply what you learned to your practice?**
   _____
   _____

Please evaluate this article. Circle one number using the following scale:

1= Strongly Agree to 5= Strongly Disagree

The article met the stated objectives: 1 2 3 4 5

The article was appropriate to my practice: 1 2 3 4 5

The topic was current and well presented: 1 2 3 4 5