Tobacco and Asthma

Asthma is considered a concern when it comes to fitness to dive because of associated airway reactiveness and obstruction of small airways, which may cause pulmonary barotrauma or drowning during diving. Preparticipation screening specifically addresses asthma; when divers admit to signs or symptoms, a medical evaluation by a physician is suggested. Guidelines for medical evaluations are provided by diving medical societies.

On the other hand, tobacco smoking, which is a major cause of chronic obstructive pulmonary disease, is less stringently addressed in the Recreational Scuba Training Council (RSTC) screening questionnaire, and no specific guidelines are provided. Recently we have received questions about how respiratory function in people with asthma compares to respiratory function in people who smoke tobacco and how this affects the assessment of fitness to dive.

Obstructive Lung Disease

Both asthma and smoking are associated with narrowing and inflammation of the small respiratory airways, which result in reduced airflow through pulmonary airways. However, the reduced airflow with asthma occurs intermittently and is reversible whereas with chronic smoking airflow progressively and irreversibly deteriorates and usually doesn't reveal itself until older age. With aging, about 20 percent of smokers and 23 percent of patients with asthma manifest chronic obstructive pulmonary disease (COPD) characterized by fixed airflow obstruction.

Asthma most often presents at a young age as recurrent episodes of increased airway obstruction that may vary in frequency and intensity. In adulthood asthma attacks become less frequent. Adult-onset asthma occurs in individuals 20 years or older. This type of asthma is frequently caused by allergies. An asthma attack may be provoked by exercise, cold and dry air or inhalation of hypertonic aerosols (normal saline used diagnostically to provoke a reaction). The respiratory airways are affected by inflammation, hyperproduction of mucus and the contraction of muscles around them. Respiratory flow may be reduced by 10 to 20 percent in mild cases and 40 percent in severe cases. In some cases respiratory function appears normal, but challenge tests cause hyperresponsiveness and reduced expiratory air flow. Narrowing of airways may be reversed by medications such as anti-inflammatories and bronchodilators. Anti-inflammatory medications such as inhaled steroids reduce swelling and mucus production in the airways. This relieves symptoms, improves airflow and makes airways less sensitive to provocative factors (cold, dry air, etc.). Asthma attacks may be stopped by bronchodilators — short-acting beta-agonists that relax bronchial muscles and open airways for easier air flow. Exercise-induced asthma may be prevented by long-lasting beta-agonists. People whose asthma is well controlled may lead normal lives that include exercise; they are less likely to experience an asthma attack while diving.

Tobacco smoking affects breathing both chronically and acutely. Acute effects of smoking include increased carbon monoxide and reduced oxygen levels in the blood as well as paralysis of cilia in the airways, which impairs removal of mucus. Mucus can block terminal airways and cause overexpansion of alveoli during ascent from a dive, which puts a diver at risk for arterial gas embolism (AGE). In smokers as in asthmatics, airway hyperresponsiveness (as detected by a metacholine test) may be present even at a young age. In teenagers with a short history of smoking, a dose–response relationship was found between smoking and decreased respiratory flow measures (FEV1/FVC and FEF 25-75). Boys that smoked 15 cigarettes or more per day had an average reduction in respiratory flow with a reduced volume of air in the lungs (FEF 25-75) of 4.0 percent and in some cases up to 7 percent. The effect on lung function of smoking

one pack of cigarettes per day for a year (one pack-year) was a 0.36 percent annual loss of FEV1 for men and a 0.29 percent annual loss for women. In smokers as young as 30 to 40 years, clinical and pathologic manifestations resembling early-stage COPD may be present. However, only divers 45 and older who smoked are prompted to undergo medical evaluation by a physician if they acknowledge their habit in the RSTC form.

When assessing fitness to dive one should keep in mind that asthma is a condition that affected subjects have to live with, and thus they should not be unnecessarily excluded from scuba diving if they wish to dive and the risks are reasonably low. On the other hand, smoking tobacco is a matter of choice; divers are discouraged from it but some still do. How risky is it, and what interventions, if any, are necessary?

Is there evidence that asthma or tobacco smoking increases the injury rates (such as barotrauma and AGE) in scuba diving?

Claus-Martin Muth: Although it is reasonable to consider that smoking increases the risk for decompression-related injuries in diving, there is no clear evidence. Researchers from Duke University Medical Center could show that when decompression injury occurs, smoking is a risk factor for increased severity of symptoms.

In addition, we have to keep in mind the effects of tobacco smoking on the cardiovascular system, specifically vasoconstriction which decreases cardiovascular tissue perfusion. There is scientific evidence that this has an influence on the rate of nitrogen elimination after the dive. Again, this may increase the risk for a decompression injury. It is justified to advise against smoking and diving.

With regard to asthma the answer is “it depends.” Each asthma case is different, and evaluation of fitness to dive in people with asthma requires a thorough examination and must be evaluated on an individual basis. Divers with asthma should be instructed on how to behave and how to use a peak-flow meter for airway testing before planned dives.

Tom Neuman: Although it’s tempting to hypothesize asthma would increase the risk of AGE in sport scuba divers, there is really no reliable evidence that well-controlled and properly treated asthmatics are at increased risk for AGE. The most comprehensive publication addressing this issue, “Are Ashtmatics Fit to Dive?,” was from a workshop held by the Undersea and Hyperbaric Medical Society. The conclusion of that workshop was that asthmatics who had normal pulmonary function test results (whether or not they were on medication) were candidates for diving. Tobacco smoking incurs the theoretical risk that damage to the airways (both reversible and irreversible airway obstruction) could cause sufficient outflow obstruction that air embolism might occur even on a normal ascent. Currently there is no evidence that smokers with normal airway function have an increased risk of air embolism compared to nonsmokers.

Regarding the respiratory effects of asthma and tobacco, are there any differences in how these conditions affect the respiratory system and the potential diving hazards that may result?

Muth: The key points were already mentioned in the introduction to this article. In addition to the inflammation smokers exhibit, the clearing mechanism of the airways is impaired. The thick bronchial mucus may create an air-trapping mechanism in the form of a partial obstruction with a valvelike function that allows air to get into the affected segment but not to come out. In asthmatics the problem is more general: if the respiratory tract reacts to a certain stimulus such as dry and cold air (which is common in diving), air-trapping can occur all over the lung.

Neuman: Asthma is most frequently characterized by partial airway obstruction due to mechanical constriction of the airways, increased mucus production and edema. This is a process that generally is completely reversible and preventable with appropriate treatment. On the other hand, damage from the inhalation of tobacco smoke has both reversible and irreversible components. Thus once structural damage to the airways has occurred from the use of tobacco , the effects on the lung are frequently not completely reversible, leaving the individual with an ongoing obstructive defect that might result in an increased risk of AGE. However, well-done studies that clearly indicate this theoretical risk is real are still to be done.

Is diver preparticipation screening regarding smoking status adequate, or does it need to be changed or updated?

Muth: Although there is strong evidence that smoking has an impact, the number of diving injuries and even fatalities is rather low and the number of divers that smoke rather high. I think it is more useful to publish articles like this one and to tell smokers that smoking and diving is not good idea at all. Smokers who dive should abstain from smoking immediately before and after the dive. On the other hand, testing of lung function should be part of every examination of fitness to dive; when lung function is impaired, depending on the degree, there should be advice against diving. There is more than strong evidence that smoking will impair lung function over time, and smokers may have to retire from diving at a younger age than they would like to.

Neuman: The question about appropriate preparticipation screening for an asthmatic is fairly straightforward. The prospective asthmatic diver should have normal spirometry both before and after exercise. No further testing is needed. For long-term smokers with a quantitatively significant smoking history such a strategy is also probably appropriate. For the occasional smoker who is asymptomatic and who has a normal physical exam, pulmonary function testing is not warranted. From a numerical point of view, the greatest underlying medical risk to middle-aged divers is previously undiagnosed coronary artery disease. Anyone who is going to be involved in diving activities should undergo a clinical evaluation for the risk factors for coronary artery disease. If clinically important risk factors for coronary artery disease are present, a more thorough evaluation looking for occult coronary artery disease should be considered.

Acronyms

FVC — Forced vital capacity: the volume of air that can be exhaled from the lungs after maximal inhalation with maximal expiratory effort.

FEV1 — Forced expiratory volume in first second: the volume of air exhaled from the full lungs in the first second of expiration with maximal force.

FEV1/FVC — The ratio of FEV1 to FVC; normally it’s greater than 0.8.

FEF 25-75 — Forced expiratory flow that occurs while the volume of air in the lungs is between 25 and 75 percent of FVC.

Meet the Experts

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