Caution First

Why Cigarette Smoking and Diving Don't Mix

By Dr. Jim Caruso

Far too many divers smoke, but I would not characterise it as a majority. In fact, during the 15 years I have been involved in recreational diving, I have seen a decrease in tobacco use among divers. Many dive boats have restrictions on smoking while onboard.

However, it is still not uncommon to see divers smoke before the dive, after the dive, and even during the surface interval. I have known many dive instructors who were addicted to cigarettes.

In my "day job" as a forensic pathologist, I am constantly reminded of the negative impact cigarette smoking has on an individual's health. Smokers' lungs have a distinct appearance and consistency: some of these lungs are in such a condition that I am actually amazed that they are able to exchange gas at all. Additionally, the contribution of cigarette smoking to development of atherosclerosis (narrowing of the blood vessels by hard plaque and cholesterol deposits) of the peripheral and coronary arteries is significant.

Despite the recent publicity in both medical journals and the lay press emphasising the contribution obesity is making to premature death, cigarette smoking is the number-one cause of preventable disease and early death in many western countries. For example, it has been reported that 18.1 percent (435,000) of deaths that occurred in the United States in the year 2000 were related to tobacco. Poor diet and physical inactivity were responsible for 16.6 percent (400,000) of deaths. In contrast, microbial agents such as influenza and pneumonia resulted in 75,000 deaths and motor vehicle-related deaths numbered 43,000.

Why Smoking Is Not Recommended

1) Carbon Monoxide

From a medical viewpoint, it's difficult to imagine why anyone engaging in an activity like scuba diving, where efficient gas exchange and proper oxygenation of tissue play such an integral role, would smoke. Smoking can and does interfere with this exchange.

Cigarette smoke contains a number of toxic substances that are harmful to the body, including carbon monoxide (CO). CO is produced by incomplete combustion of any organic substance and interferes with the ability of the red blood cells to carry oxygen to body tissues.

All diving revolves around effective gas exchange, and anything that

Cartoon by Dr. Bart McKenzie.
Reprinted from *Diving Medicine for Scuba Divers.*

interferes with this process places unnecessary risk on the diver. If carbon monoxide is bound to your red blood cells, your blood's ability to carry oxygen is compromised. While a nonsmoker typically has a carbon monoxide level (reported as a measurement of carboxy-hemoglobin) of under 2 percent, levels as high as 10 percent can be seen in smokers, particularly in heavy (frequent) smokers.

2) Lung Irritation

The toxins in cigarette smoke irritate the lining of the respiratory tract. One important type of cell on the mucosal surface of the airway contains cilia that propel mucus and foreign material up and out of the respiratory tract. Cigarette smoke harms these cells, impairing the body's ability to clear foreign material from the airway. This contributes greatly to the development of chronic bronchitis; it is also the main

reason for "smoker's cough" and the fact that long-term smokers bring up abundant secretions after sleeping.

Irritation of the airways may also predispose the smoking diver to episodes of acute bronchospasm. A diver experiencing this phenomenon would have an increased risk for pulmonary barotrauma and gas embolism.

3) Emphysema

Except for a small number of individuals with rare genetic disorders, emphysema is almost nonexistent in nonsmokers. The lungs are made up of tiny air sacs called alveoli. Each of these air sacs is lined by cells that facilitate the transfer of oxygen to capillaries that are intimately associated with the alveoli.

The alveoli maintain their structure as air sacs through seven or more decades of use in nonsmokers. In smokers, however, the toxins contained in cigarette smoke damage the connective tissue skeleton that keeps the alveoli intact. Emphysema destroys the walls of the alveoli, reducing the ability of the lungs to exchange gas: the alveoli no longer have the ability to fill and empty properly.

In fact, destruction of the walls creates larger airspaces with thin walls that may balloon out from the lung surface. These are known as bullae and may place a diver at risk for pulmonary barotrauma and arterial gas embolism. Under the microscope, the walls of the alveoli in a smoker's lung are fragmented; when this occurs, the normal histology (tissue structure) of the lung is lost.

Emphysema is a chronic disease that is incurable, although medications such as asthma inhalers and steroids can help relieve symptoms. Oxygen therapy often is necessary at some point. For very advanced stages of emphysema, lung transplantation may be recommended.

4) Nicotine

Nicotine is a drug that is introduced into the body with cigarette smoking and other types of tobacco use, including chewing tobacco and snuff (pulverised tobacco that is either dissolved in the mouth or sniffed through the nose — hence its name).

Nicotine temporarily causes blood vessels to constrict, elevates blood pressure, and with chronic use contributes to the development of atherosclerosis. A disease such as atherosclerosis can eventually lead to problems in getting the necessary amount of blood, and therefore oxygen, to the tissues.

If the blood vessels in the neck or those at the base of the brain are involved, the end result can be a stroke. If the arteries on the surface of the heart become diseased, the smoker may have a heart attack. Sudden cardiac death is a common initial sign of coronary artery disease. Suffering a stroke or heart attack during a dive will usually have a catastrophic outcome. Even if the diver makes it back to the boat or to shore, the availability of high-level medical care is often severely limited.

5) Lung Cancer

The most serious consequence of long-term heavy cigarette smoking is the increased risk of lung cancer. The most common types of lung cancer are relatively uncommon in nonsmokers. The link between tobacco use and the development of lung cancer is generally accepted, even by most smokers. Tobacco abuse is not only linked to cancer of the lung, throat, and oral cavity, but to many other organs in the body.

Cancer is the result of cells losing some of their normal growth properties and self-regulating mechanisms. Cigarette smoke contains many toxic substances that have carcinogenic (cancer-causing) properties. As we already mentioned, the toxins in cigarette smoke cause changes in the cells lining the airway. Chronic irritation results in a change from the cilia-covered and mucus-secreting cells to a cell type that is more resistant to the effects of these toxins. Normal cells have regulating mechanisms that control growth as well as how cells interact with neighboring cells.

Youth is a stage of life where many individuals feel indestructible. Unfortunately, I also see the end result of that mindset in my medical practice: high-risk behavior is the norm in many young persons.

The consequences of self-destructive behavior are too far in the future to be of any concern to them. Most young smokers have enough cardiorespiratory reserve to overcome any impairment in gas exchange that smoking may cause.

The older smoker will not have this luxury, and at some point cessation of smoking will not result in complete reversal of the pathology (deviations from normal, i.e., the impaired ability to deliver oxygen to tissue) tobacco abuse has caused.

In the accompanying article, Dr. Buch highlights the DAN study that indicated there might be a link between heavy cigarette smoking and the development of serious symptoms after a decompression accident. If a diver did not already have enough reasons to be a nonsmoker, this should help tip the scale. □

About the Author

In addition to being a DAN consulting physician, Jim Caruso is a pathologist, Diving Medical Officer, and Flight Surgeon for the United States Navy. The opinions expressed here are his own and may not necessarily reflect the official policy of the United States Navy, Department of Defense, or the government of the United States.

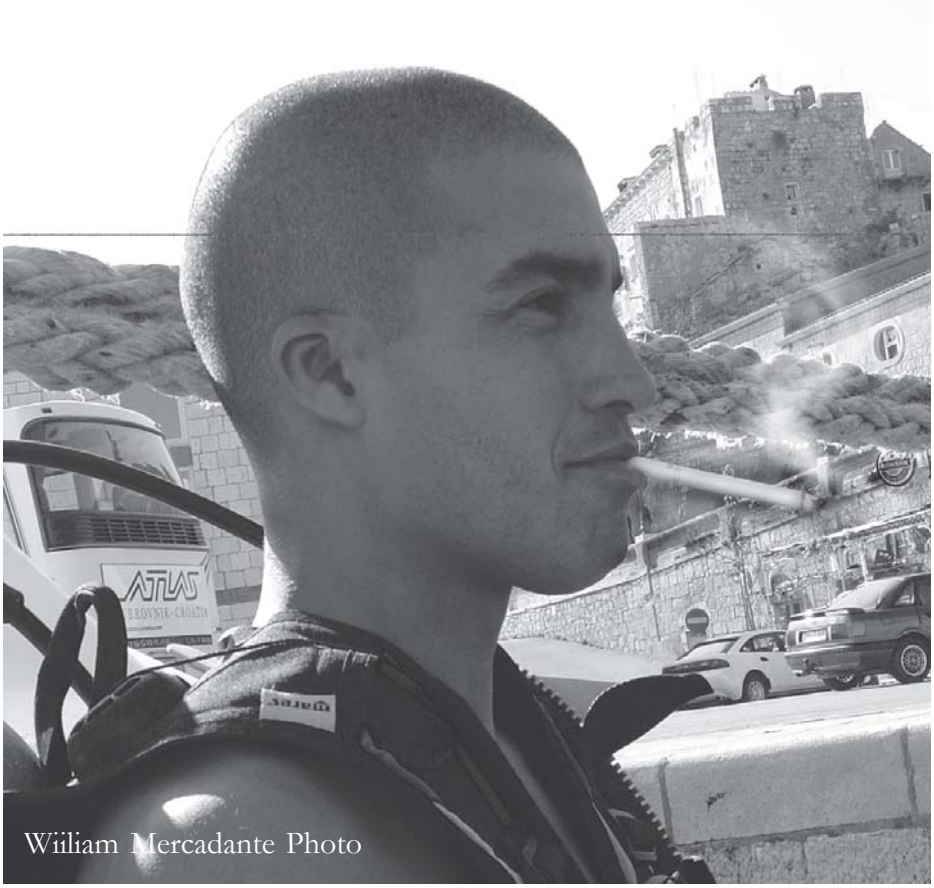
Smoking & Diving

Do the Two Make A Risk Factor For Decompression Illness?

By Dr. David Buch

Most scuba divers know that consuming alcoholic beverages prior to diving could cause dehydration. This in turn can increase the risk for decompression illness (DCI), also known as "the bends" or "caisson disease." During basic open-water training, divers are commonly taught to avoid alcohol until after the day's diving is complete, and even to consider avoiding alcohol until the entire dive vacation is over. Even when diving in economically developing countries, many dive operations will not serve alcohol to divers until after the dive. But what about tobacco?

Smoking seems to be much less taboo among divers. I have observed divemasters and other experienced divers smoke cigarettes just before diving, during the surface interval, and after completing the dive series.



Wiiliam Mercadante Photo

Most smokers are likely aware of the health implications of consuming tobacco but choose to smoke despite the risks. However, divers who smoke are likely not aware of its possible effect on DCI.

Does Smoking Increase the Risk of DCI?

A review of the medical literature as it pertains to scuba diving and tobacco use provides very little information on whether smoking increases the risk of DCI. There is reason to believe that medical conditions caused by cigarettes (e.g., emphysema or atherosclerosis, a narrowing of the blood vessels by hard plaque and cholesterol deposits) could predispose a diver to a serious dive injury such as arterial gas embolism or decompression sickness, the two forms of DCI. Some of these smoking-related diseases can be present without the diver's knowledge. It is conceivable, then, that seemingly healthy smokers might be at greater risk for DCI.

An internet search using two popular search engines (Google and Yahoo) returns some information, but consists largely of opinion articles that typically recommend against smoking and diving for the reasons cited above. Until recently, there have been no studies specifically addressing the possible relationship between cigarette smoking and DCI.

The Smoking & Diving Study

Data collected by Divers Alert Network (DAN) on divers with DCI include information on the severity of divers' symptoms and their smoking history. Between the years 1989 and 1999, more than 4,000 records of DCI were obtained. These records were carefully reviewed and analyzed by researchers at Duke University and DAN. The conclusions, which have been recently published in the December 2003 edition of Aviation, Space and Environmental Medicine (volume 74, page 1271), suggest that smoking cigarettes, independent of other risk factors, may cause divers with DCI to manifest more severe symptoms than non-smokers.

DCI encompasses a range of symptom severity, from mild itching and / or joint pain to convulsions, unconsciousness and death. The above-mentioned study, entitled "Cigarette Smoking and Decompression Illness Severity: A Retrospective Study in Recreational Divers," revealed that heavy smokers (more than 15 pack-years) tended to develop more severe symptoms of DCI than lighter smokers, who in turn had more severe symptoms that nonsmokers. A pack-year is defined as smoking a pack of cigarettes per day for a year.

Heavy Smokers See A Difference

When heavy smokers (i.e., divers who smoked a lot, not overweight smokers) were compared to nonsmokers, the heavy smokers who manifested DCI were almost twice as likely to have more severe symptoms than mild symptoms. Approximately 37 percent of injured heavy smokers showed severe symptoms, whereas only about 24 percent of nonsmokers manifested severe symptoms. About 20 percent of the injured nonsmokers showed only mild symptoms of DCI, while 14 percent of heavy smokers presented with mild symptoms.

This study did not prove that smoking predisposed divers to DCI. It did show, however, that if a diver develops DCI, the severity tends to be greater in smokers. Smoking could be a direct cause of this, perhaps by way of changes in blood vessels or the lungs.

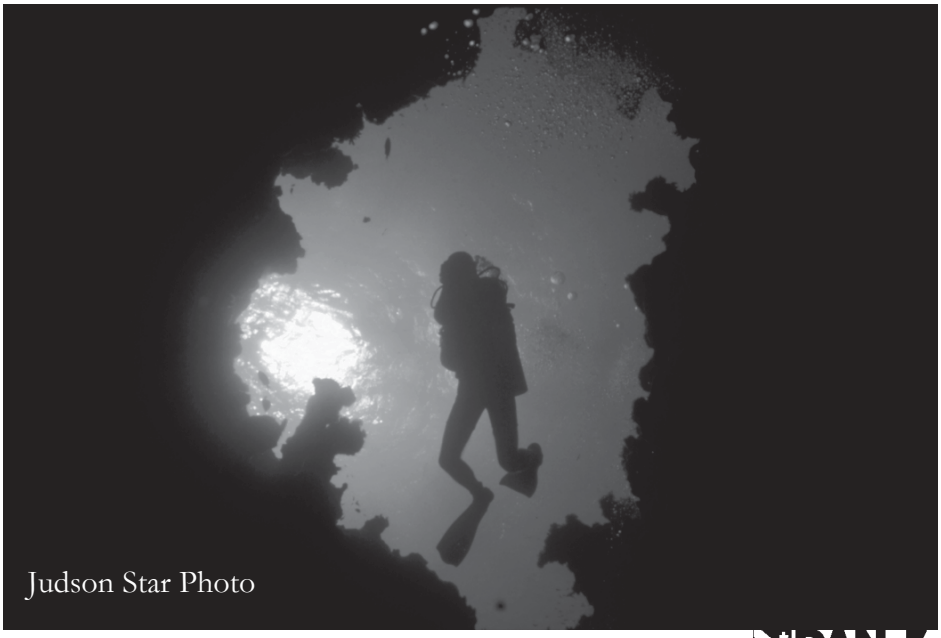
Smoking Associated With Other Risks?

While statistical methods were used to adjust for almost all conceivable risk factors for DCI, an alternative explanation is that smoking may be linked to some other risk factor. Further research and data are needed to confirm the theory that divers who smoke cigarettes have an increased risk of DCI. To obtain this information, one would need to know the percentage of both smokers and nonsmokers who develop DCI, information that is not yet available.

Divers may be willing to accept the long-term risks of smoking on their overall health. Perhaps the risks of cancer, lung disease or heart disease seem so remote that smokers assume that they will quit eventually before developing these diseases. With regard to diving, the notion that smoking cigarettes may be associated with more severe DCI symptoms could provide yet another reason not to smoke. □

About the Author

Dr. David Buch is currently a certified rescue-level diver. During his final year of medical school he completed a research elective at Duke University in Durham, N.C., home of DAN. At this facility he examined data from thousands of scuba divers with decompression illness. This research led to a publication in Aviation, Space and Environmental Medicine.



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