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Smoking and Scuba Diving why it is dangerous

I have listed below several bullet points which relate to smoking and scuba diving. They are interesting to read and understand why smoking and diving is along the same lines as drinking and driving. Over time and distance, someone will get injured or killed, and many times it is the insistent ones.

A few things to think about if you are a diver who smokes or your dive buddy is a smoker, why take the risk?

All the bullet points are written out in the two articles below, take the time and read the articles…….you may find them interesting.

- In diving, carbon monoxide poisoning generally originates from a contaminated air supply, where it may be unnoticed by a diver because carbon monoxide lacks both odor and taste.
- Hemoglobin bonds with carbon monoxide more than 200 times more readily than with oxygen, but does not unbond as easily. Once carbon monoxide enters the bloodstream, it can take 8-12 hours for the circulatory system to eliminate it. In addition, carbon monoxide bonds with enzymes in the blood.
- As a diver breathes air contaminated by carbon monoxide, blood hemoglobin reaching the alveoli bonds with the carbon monoxide, forming carboxyhemoglobin; this locks the hemoglobin molecule, making it incapable of carrying oxygen
- Physiologists have found that smoking raises normal carbon monoxide levels in the blood 3-12 times, which impairs oxygen transport and carbon-dioxide elimination. Circulation increases so uncontaminated red blood cells can meet tissue gas exchange requirements, raising blood pressure and heart rate. This is why smoking stimulates the heart. It takes 10-12 hours for gas exchange to return to normal after smoking
- Poor circulatory efficiency can have dangerous impacts on inert gas elimination and oxygen delivery to needy muscles, greatly effecting a diver's personal safety.

- The standard measure of lung function is the forced expiratory volume in one second or FEV1. This is the amount of air that can be exhaled in one second.
- The Framingham study showed the FEV1 to be decreased to 80 percent of expected values in smokers.
- Higher concentrations of carbon dioxide in the blood cause the body to react as if there is poor ventilation and a greater need for oxygen. This environment initiates the release of more oxygen to the tissues. Under these conditions the hemoglobin affinity for oxygen is reduced, making it easier for oxygen to be released
- First it binds to hemoglobin 250 times better than oxygen, making a compound called carboxyhemoglobin
- The increased affinity of hemoglobin for oxygen results in a decrease in oxygen carrying capacity and impaired release of the oxygen once it reaches the tissues
- Furthermore, chronic hypoxia (reduced oxygen) results from the smoking induced impairment of oxygen transport and causes the production of more red blood cells. The red blood cells are the containing mechanism for oxygen transport in the hemoglobin
- Therefore, the simple act of smoking initiates circulatory reactions that place divers in harm's way. Whether from decompression illness risk or ineffectual response to stressful environments, the smoker intentionally places himself and his team at greater risk.
- Smokers and those who choose to dive with them should consider not only the long-term health impacts, but the immediate implications of smoking and diving.
- All dives are decompression dives

Carbon Monoxide and how it affects you in diving (smoking)

In diving, carbon monoxide poisoning generally originates from a contaminated air supply, where it may be unnoticed by a diver because carbon monoxide lacks both odor and taste.

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As a diver breathes air contaminated by carbon monoxide, blood hemoglobin reaching the alveoli bonds with the carbon monoxide, forming carboxyhemoglobin; this locks the hemoglobin molecule, making it incapable of carrying oxygen. The strong bond between the carbon monoxide and hemoglobin keeps carbon monoxide bonded as the blood circulates through the tissues, unlike oxygen. As the diver continues to inhale carbon monoxide, more and more hemoglobin bonds with it, so as circulation continues, fewer and fewer uncontaminated red blood cells are available to carry oxygen. Unchecked, this causes hypoxia despite continuing circulation and respiration because the blood can no longer supply oxygen to the tissues.

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Carbon monoxide poisoning may cause a victim's lips and nail beds to turn bright red. Hemoglobin bonded with oxygen appears red, and hemoglobin bonded with carbon monoxide appears even redder than usual. Contaminated blood is highly visible as it flows through capillaries of the lips and nails, which are close to the surface of the skin. Although carbon monoxide rarely contaminates a diver's air supply, it should be noted that smoking is another source. Physiologists have found that smoking raises normal carbon monoxide levels in the blood 3-12 times, which impairs oxygen transport and carbon-dioxide elimination. Circulation increases so uncontaminated red blood cells can meet tissue gas exchange requirements, raising blood pressure and heart rate. This is why smoking stimulates the heart. It takes 10-12 hours for gas exchange to return to normal after smoking

The Impacts of Smoking on Diving

BY ART RANZ, DDS

Cigarette smoking is one of the largest preventable health and death risks in the United States. It receives enormous amounts of negative media attention and yet millions of people start smoking every year. Unfortunately, it is frequently difficult to have a prudent, scientific discussion about the risks of smoking with someone who is addicted to nicotine. The addiction leads smokers to rationalize or deny the risks of smoking. However, this "head in the sand" response allows them to ignore the obvious impact that smoking has upon their bodies and the more subtle ways it effects many aspects of their lives, such as scuba diving.

The effects of smoking are especially significant for persons who participate in scuba diving. A review of scientific literature about the body's reaction to smoking and nicotine addiction illustrates how smoking can effect diving performance. While the diving and health limitations imposed by tobacco use vary according to the degree of use, tobacco always has some impact on individual health.

The most extensive, long-term, prospective study on smoking and other health issues is the Framingham study. This ongoing study has followed 5,000 people for more than 34 years, providing a wide range of statistical information. For instance, the 30-year-old who smokes 15 cigarettes a day - or less than one pack - shortens his life by five years. Smokers experience a 20-fold increase in lung cancer and greatly increased cancer rates in other organs, including skin, bladder, pancreas, mouth and throat. Smokers have twice the risk of cardiovascular disease, 2.2 times the number of strokes and 3.5 times more intermittent claudication expressed as leg cramping due to a lack of circulation. At any given age, the risk of dying for any reason is twice that of a non-smoker. Smokers have seven times the normal incidence of airway damage and respiratory distress. Children who smoke beginning at age 14 only develop 92 percent of the lung function, on average, that a non-smoking child does. This loss of function is permanent. Obviously, efficient lung function is essential to managing stressful situations and promoting efficient inert gas removal from a diver's blood. Poor circulatory efficiency can have dangerous impacts on inert gas elimination and oxygen delivery to needy muscles, greatly effecting a diver's personal safety. Atherosclerotic plaques in blood vessels form twice as fast when smoking is added to a high fat diet.

There are great increases in the LDL ("bad cholesterol") that reduces circulatory efficiency and complicates inert gas removal. Inert gas (especially nitrogen) appears to lodge in fatty deposits, creating likely sites for bubble congregation and growth. Furthermore, 90 percent of patients with infections after spinal surgery are smokers and bone marrow density in men is decreased almost 20 percent and in women 25-30 percent, while the incidence of back pain from a work related injury increases from one in five to one in two for smokers. Hyperbaric bone damage (osteonecrosis) has gained increasing concern among medical professionals as researchers strive to demonstrate the cause of occasional bone degradation. To be sure, reduced bone density due to smoking aggravates the problem and some researchers are suggesting a more careful analysis of the relationship between hyperbaric damage and tobacco smoking.

How does tobacco cause such dangerous repercussions?

There are four groups of dangerous substances present in cigarette smoke:

1. Carcinogens and co-carcinogens are mostly polycyclic aromatic alcohols that directly initiate cancer formation. These affect areas in direct contact with the smoke and also distant organs through absorption into the bloodstream.

2. Irritants cause immediate coughing and broncoconstriction, inhibit cilliary action in the lung and stimulate mucus secretion.

3. Chronic exposure to nicotine induces an increase in the number of nicotinic cholinergic receptors in the brain, causing structural and functional changes in the brain and nervous system. It induces tolerance and physical and psychological changes upon withdrawal. These are classic developments from an addictive drug.

4. Toxic gases are inhaled, including carbon monoxide, hydrogen sulfide and hydrogen cyanide.

Smoking related cancer is tragic, costly and largely preventable, but the direct impact to diving is often less obvious. By way of illustration, the irritants present within smoke induce a chronic inflammation of the alveoli causing the body to produce proteolytic enzymes that eat away at the alveolar wall. Cilia are microscopic hairs that fan and carry harmful particles out of the lung. The irritants present in smoke impede these cilliary actions. With the addition of increased secretions, the lung has now lost a significant part of its defenses from outside agents. Chronic bronchitis develops, making smokers more susceptible to emphysema, viral and bacterial infections. As this process continues over the years and more alveolar damage occurs, there is a loss of capillaries in the walls which causes "ventilation-perfusion abnormalities."

This damaging chain of events leads to a reduction in the area of alveolar membrane available for gas exchange and also to perfusion of unventilated areas and ventilation of unperfused areas. In simple terms, gas exchange is compromised and air (or other gases) is not reaching the blood for exchange. General lung function is often severely compromised in the smoking population as is evidenced by several clinical measurements in the lung. The standard measure of lung function is the forced expiratory volume in one second or FEV1. This is the amount of air that can be exhaled in one second.

The Framingham study showed the FEV1 to be decreased to 80 percent of expected values in smokers. This decrement in lung function creates less efficient ventilation on exertion and decreases the force of the cough (a vital protective mechanism for the lung) and may indicate a general degradation of lung health. The forced vital capacity (FVC) is another common measure of lung function and measures the amount of air one can expel from a full inhale to a full exhale. On average, smoking reduces FVC by 10 percent in moderate smokers. A 10 percent reduction in vital capacity is a significant indication of lung dysfunction and an obvious deterrent to pulmonary exchange in decompression.

Nicotine is not only a powerfully addictive drug, but a potent pharmacological agent. Nicotine promotes platelet aggregation and fibrinogen formation, which are precursors to the clots that obstruct small blood vessels. An obstruction initiates negative repercussions that increases the risk of diving and decompression. The heart rate increases, elevating oxygen consumption and the shrinking of small blood vessels increases total peripheral resistance. The resistance, in turn,

causes more problems such as increased blood pressure and poor circulation in the periphery of the body. Peripheral circulation involves the miles of very small blood vessels all over the body. The vessels are problematic in efficient inert gas elimination. For example, the extremities contain numerous areas of reduced circulatory efficiency such as the joints (responsible for the majority of decompression sickness). When divers begin to get chilled, a natural reduction in blood circulation to the peripheral system occurs to maintain a reasonable core temperature. Smoking exacerbates this problem as studies show that the circulation in small blood vessels is reduced 19 percent after just two cigarettes. Poor gas exchange and increased risk of decompression sickness results.

The Problem with Carbon Monoxide

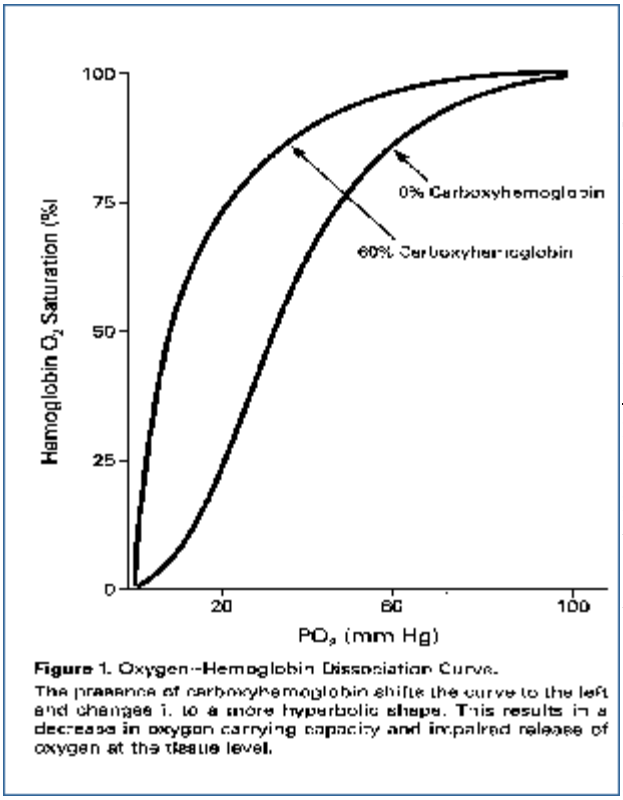

Figure 1. Oxygen–Hemoglobin Dissociation Curve.
The presence of carboxyhemoglobin shifts the curve to the left and changes it to a more hyperbolic shape. This results in a decrease in oxygen carrying capacity and impaired release of oxygen at the tissue level.

It is important to understand the Oxygen Dissociation Curve when reviewing the impact of smoking on oxygen transport mechanisms. This curve illustrates the assimilation of oxygen in large amounts even with low oxygen pressures in the lungs. Hemoglobin picks up the oxygen from the lungs and transports it to the tissues where it is released. Several factors control how easily the oxygen is released from its hemoglobin carrier. Higher concentrations of carbon dioxide in the blood cause the body to react as if there is poor ventilation and a greater need for oxygen. This environment initiates the release of more oxygen to the tissues. Under these conditions the hemoglobin affinity for oxygen is reduced, making it easier for oxygen to be released. In reference to the Dissociation Curve, this condition is sometimes referred to as a "shift to the right" and results in a greater supply of oxygen to the tissues. However, a "shift to the left" prevents oxygen from being released to the tissues. This condition is prominent with the carbon monoxide accumulation that results from smoking.

The primary mechanism behind the risk of carbon monoxide impact is twofold. First it binds to hemoglobin 250 times better than oxygen, making a compound called carboxyhemoglobin. This compound replaces the oxygen in the hemoglobin molecule and prevents the leftward shift of the Oxyhemoglobin Dissociation Curve. The increased affinity of hemoglobin for oxygen results in a decrease in oxygen carrying capacity and impaired release of the oxygen once it reaches the tissues. Non-smokers have about one percent carboxyhemoglobin while smokers have close to 15 percent. To illustrate the severely harmful effects of CO in the blood, imagine that an individual has 50 percent of their hemoglobin bound to CO. Compare this individual with another person who has lost half of their hemoglobin (due to severely bleeding ulcers, chronic gastrointestinal bleeding or massive injuries, for instance).The individual who has 50 percent of

their hemoglobin bound with CO will die. But, the person who has a 50 percent loss of hemoglobin will still not experience hypoxia while in a resting state.

Furthermore, chronic hypoxia (reduced oxygen) results from the smoking induced impairment of oxygen transport and causes the production of more red blood cells. The red blood cells are the containing mechanism for oxygen transport in the hemoglobin. The Framingham study has shown that smokers have a significant increase in the percentage of red blood cells in the blood (increased hematocrit). Normally the red blood cells are about 35-40 percent of the blood by volume. Smoking can cause this to increase by 20 percent, making the blood much more viscous, inducing obvious complications to efficient circulation. This problem is further aggravated by the pressures found below the surface and causes sludging of the red blood cells in the small capillaries, damaging the cells lining the blood vessels (endothelium).

The transport of hydrogen cyanide to the lungs during smoking creates additional decrements to health and diving safety. This noxious gas directly prevents use of oxygen by the cells by interfering with the cellular engine- the mitochondria. Even small amounts of hydrogen cyanide are deadly. The presence of this toxic substance causes direct injury to the lung by interfering with the alveolar enzymes normally responsible for maintaining the integrity of the alveolar membranes. Hydrogen sulfide is another dangerous substance in cigarette smoke and is a direct toxin to most all cell life, especially to tissues it directly contacts such as the lungs. The numerous impediments to a healthy circulatory and respiratory system establish an insidious cycle of unacceptable risk to safe diving practices.

For instance, when increasing environmental demands require the delivery of more oxygen, the smoker is at a serious disadvantage. An increased supply of oxygen in the inspired air does not help delivery of more oxygen to the tissues where it is needed. There are two ways to increase oxygen delivery with increased demand: increasing blood flow through the tissue and raising the coefficient of oxygen usage. The former is compromised by the inferior cardiovascular condition of the smoker (consider the number of serious atheletes who smoke). The latter is increased by two things that happen automatically: greater partial pressure of oxygen between blood and tissue (resulting from the increase in oxygen consumption in the tissues) and the rise in carbon dioxide as a byproduct of increased metabolism. This increase in carbon dioxide causes the hemoglobin curve to shift to the right and allow more release of oxygen. This typically beneficial reaction is countered by the smoker's CO poisoning and the shift back to the left. The really adverse effect of smoking is the 20-30 percent rise in peripheral resistance (closing or restriction of small blood vessels) caused by the presence of nicotine. Small blood vessels are where the exchange of gases takes place and a reduction of circulatory efficiency in this area may be significant. Reduced blood flow and impeded oxygen release prevent efficient oxygenation especially when it is needed most. Therefore, the simple act of smoking initiates circulatory reactions that place divers in harm's way. Whether from decompression illness risk or ineffectual response to stressful environments, the smoker intentionally places himself and his team at greater risk.

Understanding Smoking's Short Term Impact on Diving

Smokers and those who choose to dive with them should consider not only the long-term health impacts, but the immediate implications of smoking and diving. Consider the increase in sudden cardiac death, the reduced ability to absorb and deliver oxygen to the cells, the obvious cognitive impairment, the likely increased risks of decompression illness, the increased likelihood of lung overpressurization injuries and the many other dangerous effects of smoking and diving. With all of the damage and risk associated with smoking and diving, what possible justification (save addiction) can there be to continue? Individuals with drug addictions, which is clearly what smoking is, must be encouraged to seek assistance and be freed from this damaging habit.

Consider that many "diving deaths" are thought to be cardiovascular in nature: cardiac arrhythmias, myocardial infarcts and strokes just to name a few. The smoker's incidence of these maladies is much higher. With this in mind, can a smoker be a responsible diving buddy? Can they help other divers out of trouble or are they merely likely to create problems? With increased anxiety, the heart beats faster and the breathing rate increases. Increased heart rate is the number one cause of increased oxygen use by the heart muscle and the heart of a smoker has a reduced ability to deal with the increased demand for oxygen. As a result, pulmonary exchange is poorer and utilization of breathed gases is compromised, leading to greater gas consumption and reduced ability to assist other divers. All dives are decompression dives. The list is long on how smoking causes decreased gas exchange and potential for decompression sickness. The ability of the lungs to filter bubbles is a major reason that every dive does not result in clinical decompression injury. The lungs are directly damaged by smoking. Ventilation, monitored by FEV1, is decreased, and the Forced Vital Capacity, or FVC, is decrease by at least 10%. With decreased pulmonary function, the lungs' function as a big bubble trap is compromised and the risk of decompression illness is increased.

Nicotine causes significant peripheral constriction, further compromising elimination of gas in the areas most difficult to get the inert gases out — the small vessels and the area they perfuse. It causes increased platelet aggregation and fibrinogen production which only gives the body a head start on the same process that bubbles produce in occluding vessels and damaging vessel walls. One prominent theory of decompression illness suggests that bubbles in the bloodstream cause damage to the endothelium, the lining of the blood vessel walls, setting off a cascade of body reactions to repair itself. With nicotine in the body this process is aggravated and accelerated, causing platelets and blood clots to clog the small blood vessels. This reduces the body's ability to get rid of inert gasses. Nicotine gives the body a head start on the bad things that happen with bubble formation. The smoker has increased numbers of red blood cells per volume, or increased hematocrit, which sounds good, but actually makes the blood "thicker." Increased atmospheric pressure from diving causes sludging of red blood cells in small vessels and the clogging of these vessels is aggravated by the increased hematocrit of the smoker. This is more bad news for perfusing the small vessels in the decompression part of the dive. Increased hematocrit may be directly involved with the endothelial damage which has been implicated in DCS. Carbon monoxide inhibits the transportation of oxygen mostly in its effect upon the hemoglobin and the hemoglobin disassociation curve. Smoking directly reduces pulmonary blood volume and the number of open capillaries in the lung, causing a ventilation to perfusion impairment with the obvious impairment of gas transfer at a time when every little bit is vital.

Acute nicotine withdrawal causes severe performance degradation, memory impairment, confusion, impulsiveness and slowed reaction time, just to name a few. Any of these are serious problems when simple decisions become life or death decisions under water. In a recent study of "undeserved hits" (a dive where supposedly all decompression limits are met and ascent rates are appropriate, but the diver still suffers from decompression illness), smoking and lung damage from smoking seemed to play a key role. Two groups emerged, those with intra-cardiac shunts and those without. Those with shunts had more brain symptoms and none smoked, while those without shunts, 50 percent smoked, a remarkable number. These divers experienced mostly spinal neurological sequelae and had deficits identical to divers with rapid ascents and pulmonary barotrauma. This implies that the smokers had occult lung disease that precipitated the pulmonary barotrauma giving more evidence of hindrance on the body's bubble filter. This makes perfect sense when considering the damage caused by smoking on the small airways and the alveolar walls which allow bubble to pass though the system instead of being filtered. Please think about these facts before picking up that next cigarette or diving with someone who smokes. If you smoke, see your doctor for help with overcoming the addiction. Make your diving safe and fun.

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