Lesson S19: Preanesthetic Assessment of the Heavy Smoker

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Read this article, reflect on the information presented, then go online and complete the lesson post-test and course evaluation before the termination date below. (CME credit is not valid past this date.) You must achieve a score of 80% or better to earn CME credit.

TIME TO COMPLETE ACTIVITY: 2 hours
RELEASE DATE: July, 2011
TERMINATION DATE: July 31, 2012

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Needs statement

Strict regulation has led to a reduction in smoking in the United States while it has increased in many other countries. Major health issues associated with smoking were addressed at a global conference held in Uruguay in November, 2010. Nicotine remains the most addictive abused substance today with far-reaching health consequences. Smoking interferes with the responsiveness of the respiratory tract creating perioperative risks. Anesthesiologists should be knowledgeable about the smoking epidemic and be cognizant of steps that are essential for safe outcome in all patients.
Learning Objectives

At the end of this activity, the participant should be able to:

1. Appreciate the addictiveness of tobacco
2. List the adverse effects of tobacco on the respiratory tract
3. Cite the frequency of tobacco use worldwide
4. Explain the cardiovascular effects of tobacco use
5. Outline how tobacco is cultivated
6. Describe the metabolism of nicotine
7. Briefly outline the history of tobacco use
8. List the components of tobacco smoke
9. Identify carcinogens in tobacco smoke
10. Prepare an anesthetic plan for the smoker, emphasizing potential complications

Case History

A 63 year old man presented for a total knee replacement. He was obese (BMI 42.1) with a history of hypertension controlled intermittently with amlodipine and hydrochlorothiazide. On admission, his blood sugar was 178mg/dl, although he reported that he had never been diagnosed with diabetes despite a family history. Other medications included acetaminophen. He reluctantly admitted that he smoked one pack of cigarettes daily since he was a teenager, sometimes more on weekends. He has a productive morning cough. Previous surgery consisted of cataract lens replacement and colonoscopy.

Introduction

Because of its highly addictive nature and ready availability, tobacco is the most abused drug in our society today. Abuse of tobacco remains the primary preventable cause of morbidity and mortality in the United States despite aggressive antismoking campaigns, laws in many states banning smoking in public places, enormous fines against the tobacco companies and dramatic increases in taxation.1

The Plant, Tobacco and Nicotine

Tobacco is an agricultural product processed from the leaves of plants in the genus Nicotiana, named after Jean Nicot, the French ambassador to Portugal, who in 1559 sent it as a medicine to the court of Catherine de Medici.2 She became an early convert.

Tobacco is most commonly used for recreation but can also be used as an organic pesticide and for medicinal purposes in the form of nicotine tartrate. It is a valuable cash crop for countries such as Cuba, China and United States. Tobacco may be smoked, chewed, snuffed or made into a paste that can be sucked against the gum. Because of the addictive properties of nicotine, tolerance and dependence develop quickly. Absorption quantity, frequency, and speed of consumption are believed to be directly related to the degree of nicotine dependence, addiction, and tolerance. Tobacco is used by approximately 1.1 billion people worldwide, and by up to 1/3 of the adult population. The World
Health Organization World Health (WHO) estimates that tobacco use currently causes 5.4 million deaths per year and is the leading preventable cause of death.³

Rates of smoking have leveled or declined in economically stable countries, but continue to rise in many developing countries especially those in the Middle East. In 2008, approximately 1 in 5 American adults (totaling 46 million) was a regular cigarette smoker. This was a significant decrease from the peak in 1964 when 40% of Americans smoked, and the 28% prevalence of smoking in 1988. It was not a significant decrease from the 21.6% figure obtained through a survey conducted by the Center for Disease Control and Prevention in 2003 (reporting that 50 million adults smoked > 100 cigarettes in their lifetime or smoked daily).⁴

Tobacco is cultivated similarly to other agricultural products. Seeds are sown in cold frames or hotbeds to prevent insect attacks, and then transplanted to fields. It is an annual crop, harvested mechanically or by hand. After harvest, tobacco is stored for curing to permit the slow oxidation and degradation of carotenoids which allows the product to take on properties that are usually attributed to the "smoothness" of the smoke. It is then packaged for consumer use as cigars, cigarettes, chewing tobacco and pastes.

### History

The Spanish word "tabaco" is thought to have its origin in the Arawakan language, particularly in the Taino subgroup of the Caribbean.⁵ In Taino, it was said to refer either to a roll of tobacco leaves (according to Bartolommeo de Las Casas, 1552), or to the tabago, a kind of Y-shaped pipe for snuffing tobacco smoke with the leaves themselves being referred to as cohiba. However, similar words were found in Spanish and Italian dating from 1410 to define medicinal herbs. These words originated from the Arabic “tabbaq”, used as early as the 9th century to describe various herbs.

Tobacco began growing in North America about 8 millennia ago. Christopher Columbus was offered dried tobacco leaves as a gift from the American Indians in 1492. European settlers in America introduced the practice of smoking to Europe, where it became popular as a means to cure cancer among many other maladies. In 1610, Sir Francis Bacon noted the difficulty in giving up

<table>
<thead>
<tr>
<th>YEAR</th>
<th>EVENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>6000BC</td>
<td>Tobacco growing in the Americas</td>
</tr>
<tr>
<td>18C</td>
<td>American Indians use tobacco for religious &amp; medicinal reasons</td>
</tr>
<tr>
<td>1492</td>
<td>Europeans arrive and tobacco exported to Europe</td>
</tr>
<tr>
<td>1571</td>
<td>Dr Nicolas Monaredes writes that tobacco cures 36 illnesses</td>
</tr>
<tr>
<td>1588</td>
<td>Thomas Harriet of Virginia states daily dose of tobacco essential</td>
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<tr>
<td>1600s</td>
<td>Tobacco as money</td>
</tr>
<tr>
<td>1610</td>
<td>Safety of tobacco is questioned</td>
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<tr>
<td>1632</td>
<td>Illegal to smoke publicly in MA</td>
</tr>
<tr>
<td>1760</td>
<td>P Lorillard established</td>
</tr>
<tr>
<td>1776</td>
<td>Tobacco helps finance the Revolution</td>
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<tr>
<td>1826</td>
<td>Nicotine discovered</td>
</tr>
<tr>
<td>1836</td>
<td>Samuel Green states tobacco is an insecticide</td>
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<tr>
<td>1847</td>
<td>Phillip Morris established</td>
</tr>
<tr>
<td>1849</td>
<td>J E Liggert established</td>
</tr>
<tr>
<td>1847</td>
<td>RJ Reynolds established</td>
</tr>
<tr>
<td>1900</td>
<td>Cigarettes are the major tobacco product</td>
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<tr>
<td>1902</td>
<td>Phillip Morris established in NY and distributes Marlboro</td>
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<tr>
<td>1913</td>
<td>RJ Reynolds distributes Camel</td>
</tr>
<tr>
<td>1914-8</td>
<td>WW II promotes smoking among soldiers</td>
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<tr>
<td>1923</td>
<td>Camel controls 45% of market</td>
</tr>
<tr>
<td>1923</td>
<td>Phillip Morris: Marlboro is termed &quot;mild as May&quot; for women</td>
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<tr>
<td>1923</td>
<td>Lucky Strike marketed for women</td>
</tr>
<tr>
<td>1939</td>
<td>American Tobacco Co distributes Pall Mall. Largest US company</td>
</tr>
<tr>
<td>1939-45</td>
<td>WW II - sales at all time high with cigarettes free to soldiers</td>
</tr>
<tr>
<td>1950s</td>
<td>Lung cancer correlation with smoking</td>
</tr>
<tr>
<td>1952</td>
<td>P Lorillard distributes Kent</td>
</tr>
<tr>
<td>1953</td>
<td>El Wundors correlates tar on mice causes tumors</td>
</tr>
<tr>
<td>1954</td>
<td>Salem is marketed with filter tipped menthol cigarettes</td>
</tr>
<tr>
<td>1964</td>
<td>Surgeon General's report, &quot;Smoking and Health&quot;</td>
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<tr>
<td>1965</td>
<td>No TV ads in the UK</td>
</tr>
<tr>
<td>1966</td>
<td>Health warnings on packages</td>
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<tr>
<td>1969</td>
<td>Companies diversify with beer</td>
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<tr>
<td>1971</td>
<td>TV ads for cigarettes are prohibited in the US</td>
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<tr>
<td>1977</td>
<td>Great American Smoke Out national campaign</td>
</tr>
<tr>
<td>1980s</td>
<td>Personal injury lawsuits initiated against tobacco companies</td>
</tr>
<tr>
<td>1982</td>
<td>Evidence that second hand smoke kills</td>
</tr>
<tr>
<td>1987</td>
<td>Smoking prohibited on all domestic airline flights</td>
</tr>
<tr>
<td>1980s-90s</td>
<td>Marketing outside the US. Marlboro most popular worldwide</td>
</tr>
</tbody>
</table>
the habit of smoking. By 1632, it was declared illegal to smoke in public in Massachusetts because of moral concerns. The Pierre Lorillard Company was established in New York City to process tobacco, cigars and snuff in 1760 and remains the oldest tobacco company in the US. Table 1 provides a concise history of tobacco.

Tobacco was deemed a health hazard in the mid-1900s as scientific evidence of the deleterious effects mounted. It became identified as a cause for cancer, as well as other respiratory and circulatory diseases.

In 2003, in response to the growth of tobacco use in developing countries, the World Health Organization (WHO) successfully rallied 168 countries to sign the Framework Convention on Tobacco Control. The Convention (or Conference of the Parties) was designed to push for effective legislation and its enforcement in all countries to reduce the harmful effects of tobacco. Tobacco cessation products were developed. The Family Smoking and Prevention and Tobacco Control Act was signed in June, 2009, and granted the Food and Drug Administration extensive authority to regulate tobacco products. The tobacco industry countered by filing suit in August, 2009, challenging the constitutionality of the advertising and promotion restrictions of the law. The fourth session of the Conference of the Parties (now with 171 members) was held in November, 2010, in Punta del Este, Uruguay.

On July 22, 2010, a law was introduced that prohibited the tobacco industry from distributing or introducing into the US market any tobacco products for which the labeling or advertising contained the descriptors “light”, “low”, or “mild” or any similar word irrespective of the date of manufacture. The ruling stems from the conclusions made by the Center for Disease Control that there is no convincing evidence to indicate that low-yield cigarettes are safe. Cigarette design changes have not resulted in a decrease in the diseases caused by smoking or other consumption of tobacco.

**Components of Tobacco**

Chemical analysis of tobacco smoke has identified approximately 4,000 compounds including 43 proven carcinogenic compounds along with hundreds of other toxins such as nicotine, tar, carbon monoxide, polynuclear aromatic hydrocarbons, B-naphthylamine, benzopyrene, nitrosamines, vinyl chloride, trace metals, hydrogen cyanide, arsenic and DDT to name a few. Tumor accelerators include indole and carbazole. Cigarette filters are primarily made of cellulose acetate tow which can reduce the amount of tack and nicotine by 40 – 50% but do not remove ciliotoxins such as ammonia and formaldehyde.

Cigarette smoke can be separated into components by passing it through a glass fiber filter capable of retaining particulate matter > 0.1 um in diameter. This occurs in two phases. Material retained in the filter is known as the tar or particulate phase. Material that passes through the filter is referred to as the gas phase and represents about 90 - 95% of the total weight of mainstream smoke. Known toxins and carcinogens have been identified in both the particulate and gas phases. These components may act directly on the mucosal surfaces of the mouth, nose, pharynx and tracheobronchial tree or they may be absorbed into the blood stream or dissolved in saliva and swallowed.

Smokeless tobacco products, such as “chewing tobacco”, consist of tobacco or a tobacco blend that can be chewed, sucked on or sniffed. While the available evidence shows that smokeless tobacco may
be less dangerous than cigarettes, long-term use of chewing tobacco and other smokeless tobacco products can cause serious health problems as they contain about 30 cancer-causing substances. Like cigarettes, smokeless tobacco contains nicotine and is addictive. Prolonged chewing and swallowing of oral juices increases the amount of nicotine that is absorbed. Moreover, sugar-based additives increase the risk of diabetes and associated complications caused by nicotine.

Tobacco production requires the use of a large amount of pesticides. Tobacco companies typically perform up to 16 separate applications of pesticides between planting the seeds in greenhouses and transplanting the young plants to the field. Pesticide use has increased in order to produce larger yields in a shorter time because of the decreasing market value of tobacco. Pesticides are harmful to tobacco farmers and all those that must handle the crop. Because tobacco leeches nutrients, such as phosphorus, nitrogen and potassium, from the soil at a rate higher than any other major crops, regular use of fertilizer is imperative.

**Nicotine**

In low concentrations (an average cigarette yields about 1 mg of absorbed nicotine), nicotine acts as a stimulant and is the factor mainly responsible for the dependence-forming properties of tobacco smoking. According to the American Heart Association, nicotine addiction has historically been one of the hardest addictions to break. The pharmacological and behavioral characteristics that determine tobacco addiction are similar to those that determine addiction to drugs such as heroin and cocaine. Nicotine content in cigarettes has slowly increased over the years, and one study found that there was an average increase of 1.6% per year between the years of 1998 and 2005 for all major market categories of cigarettes.

Nicotine crosses the blood-brain barrier about seven seconds after inhalation. The half life of nicotine in the body is around two hours. The amount of nicotine absorbed depends on many factors, including the type of tobacco, whether the smoke is inhaled, and whether a filter is used. For chewing tobacco which is held in the mouth between the lip and gum, or taken in the nose, the amount released into the body tends to be much greater than when tobacco is smoked. Nicotine is metabolized in the liver by cytochrome P450 enzymes (mostly CYP2A6, and also by CYP2B6). A major metabolite is cotinine, which has a half life of about 18 hours. Glucuronidation and oxidative metabolism of nicotine to cotinine are both inhibited by menthol, an additive to mentholated cigarettes, thus increasing the half-life of nicotine in vivo.

**Pharmacodynamics**

Nicotine increases the levels of several neurotransmitters by acting on nicotinic acetylcholine receptors - specifically the ganglion type nicotinic receptor in the adrenal medulla and other sites - and also at a specific receptor within the central nervous system (CNS). Even in small concentrations, nicotine can increase the activity of these receptors. It is thought that increased levels of dopamine in the reward circuits of the brain are responsible for the euphoria and relaxation and eventual addiction caused by nicotine intake. Nicotine has a higher affinity for acetylcholine receptors in the brain than those in skeletal muscle, though at toxic doses it can induce contractions and respiratory paralysis. Tobacco smoke contains the monoamine oxidase inhibitors (MAO) harman, norharman, anabasine, anatabine, and nornicotine. These compounds significantly decrease MAO activity in smokers. MAO enzymes break down monoaminergic neurotransmitters such as dopamine, norepinephrine, and serotonin.
Nicotine also activates the sympathetic nervous system via splanchnic nerves to the adrenal medulla. Acetylcholine released by preganglionic sympathetic fibers of these nerves acts on nicotinic acetylcholine receptors, causing the release of epinephrine (and norepinephrine). Nicotine also has an affinity for melanin-containing tissues and functions as a precursor in melanin synthesis. The irreversible binding of melanin and nicotine may explain the increased nicotine dependence and lower smoking cessation rates in darker pigmented individuals.

By binding to ganglion type nicotinic receptors in the adrenal medulla, nicotine increases cell depolarization and an influx of calcium through voltage-gated calcium channels. Calcium triggers the exocytosis of chromaffin granules and thus the release of epinephrine (and norepinephrine). The result is tachycardia, hypertension, hyperglycemia and hyperpnea.

**Psychoactive effects**

Smokers often report that cigarettes help relieve feelings of stress. Contrary to this belief, it has been found that the stress levels of adult smokers are slightly higher than those of nonsmokers. Adolescent smokers report increasing levels of stress as they develop regular patterns of smoking, and that smoking cessation reduces stress. Nicotine dependency can exacerbate stress, with normal moods during smoking and worsening moods between cigarettes. The perceived relaxant effect of smoking may simply reflect the reversal of the tension and irritability that develops during nicotine depletion.

At low doses (achieved by short quick puffs), nicotine potently enhances the actions of norepinephrine and dopamine causing a stimulant effect. At higher doses (achieved by deep inhalation), nicotine enhances the effect of serotonin and augments opiate activity, producing a calming, pain-killing effect. Nicotine is unique in comparison to most drugs as its profile may change from stimulant to sedative/pain killer in increasing dosages and use.

Nicotine administered alone does not have significant additive properties. When it is co-administered with an MAOI, such as those found in tobacco, nicotine produces significant behavioral sensitization, with effects similar to amphetamine. This action may explain why application of nicotine patches may help in relief of smoking addiction.

**Immunology and Other Preventions**

To assist with breaking the cycle of addiction, several vaccination models have been developed. By binding an antibody to a nicotine molecule, the molecule is prevented from diffusing through the capillaries, thus making it less likely to bind to nicotinic acetylcholine receptors in the brain. Attaching the nicotine molecule to a hapten, such as keyhole limpet hemocyanin, or a safe modified bacterial toxin, can elicit an active immune response. It is often added with albumin. Additionally, because of concerns that the immune system may be prompted to produce antibodies against endogenous hormones and over the counter drugs, monoclonal antibodies have been developed for short term passive immune protection. Half-lives vary from hours to weeks and depend on an ability to resist degradation from pinocytosis by epithelial cells.

Several studies have been undertaken to assess the benefit of referring patients preoperatively to telephone quit lines. While many of these reports involve small study groups, there is a benefit in advising pre-surgical patients on the adverse effects of tobacco and referring them for further help,
especially by facilitating referral of smokers for counseling and follow up.

**Systemic Effects of Tobacco**

The risks associated with tobacco use include diseases affecting the heart and lungs, with smoking being a major risk factor for heart attacks, strokes, chronic obstructive pulmonary disease (COPD), emphysema, and cancer (particularly lung, cancers of the larynx and mouth). The United States Centers for Disease Control and Prevention has described tobacco use as "the single most important preventable risk to human health in developed countries and an important cause of premature death worldwide." A recent review of 635,265 patients from the American College of Surgeons National Surgical Quality Improvement Program identified 103,795 smokers. Of these, 82,304 were matched with nonsmoker controls. Those who smoked pipes or chewed tobacco were excluded. Smokers were 38% more likely to die than nonsmokers. They also had a significant increase in the risk of pneumonia (209%), unplanned intubation (89%) and mechanical ventilation (53%), myocardial infarction (80%), and stroke (73%). The incidence of superficial and deep infections and septic shock were also all significantly increased. Each relative 10 pack years (one pack of cigarettes per day for 10 years) was associated with increased odds of complication equal to 4%.

Tobacco is known to affect organ systems as follows.

**Pulmonary System**

Chronic obstructive pulmonary disease is ranked as the 4th leading cause of death in the United States. A relatively small percentage of smokers develop COPD but cigarette smoking remains the major cause of COPD mortality. The risk of death is directly proportional to the amount and duration of smoking. Detrimental effects of tobacco on the structure and function of the lungs are summarized in Table 2.

**Table 2: Pathophysiologic effects of smoking**

*(Adapted from Sherman CB. The health consequences of cigarette smoking. Pulmonary Diseases Med Clin North Amer 1992; 76; 357-75)*

| Peripheral Airway | Inflammation, atrophy  
| | Goblet cell metaplasia, increased secretions  
| | Squamous metaplasia  
| | Smooth muscle hypertrophy  
| | Peribronchial hyperplasia  
| | Increased hyperresponsiveness  
| Central Airway | Ciliary loss  
| | Mucus gland hyperplasia  
| | Squamous hyperplasia, carcinoma in situ  
| | Bronchogenic permeability  
| Alveoli and Capillaries | Destruction of peribronchial alveoli  
| | Loss of small arteries  
| | Increased macrophages and neutrophils  
| | Bronchoalveolar lavage fluid abnormalities  
| Immune Function | Increased leukocyte count  
| | Elevation in peripheral eosinophils  
| | Serum IgE increased, elevated IgAS, IgG  
| | Lower skin allergy test reactivity  
| | Reduced immune response to inhaled antigens |
Airway hyperresponsiveness is defined as the sensitivity of the bronchi and trachea to pharmacologic and physical stimuli that induce bronchoconstriction in some or all individuals. Stimuli that induce this hyperreactivity include aerosols of histamine or cholinergic agents, hyperventilation, cold or dry air and exercise. Cigarette smoking heightens this hyperreactivity and accelerates decline in pulmonary function as measured by forced expiratory volume in 1 second (FEV1). Possible mechanisms for the development of this effect of smoking include:

1. smoking-associated reduction in prechallenge levels of pulmonary function,
2. chronic airway inflammation, and
3. airway epithelial damage increasing epithelial permeability and impairing other epithelial functions.

Moreover, cigarette smoking increases protease enzyme action and decreases antiprotease activity. In the bronchoalveolar lavage of smokers, there are increased numbers of macrophages and neutrophils that secrete various proteases such as elastase, collagenase and proteinase 3.25 These proteolytic enzymes act on connective tissues including collagen and elastin. They are normally kept in check by antiproteases such as a1 antitrypsin and a2macrogobulin. Smoke induced oxidants in the lungs decrease antiprotease activity leading to alveolar destruction and airflow obstruction.

Clinically, current smokers have a higher prevalence of chronic cough, phlegm production, wheeze and dyspnea than nonsmokers. Compounding these respiratory abnormalities is impaired clearance of secretions secondary to decreased ciliary function. Using technetium 99m-labelled macroaggregated albumin, Konrad et al showed that, during general anesthesia, smokers have a slower bronchial mucus transport than do nonsmokers, which may lead to a greater likelihood of postoperative complications.26 Even asymptomatic smokers with grossly normal spirometry present with abnormalities in small airway function when tested by the single breath nitrogen test. They demonstrate increased closing volume and closing capacity and also an increase in postoperative complications such as atelectasis, hypoxic episodes and pneumonia. Other changes include decreased diffusing capacity (6%-20% lower than in age matched nonsmokers) and altered pulmonary surfactant.29 An observational cohort study indicated increased susceptibility to influenza infection among persons exposed to tobacco smoke.27

**Cardiovascular System**

Smoking is a major cause of generalized atherosclerosis, a risk factor for coronary artery disease, cerebrovascular disease, peripheral vascular disease and aortic aneurysms. Injury to the vascular intima can foster the development of atherosclerosis in young people with no other risk factors and accelerate the progression of the disease in others. Carbon monoxide increases smooth muscle cell proliferation via derived platelet growth factor that is released when platelets adhere to the site of intimal injury. This can increase the effects of nicotine and lead to cardiomyopathy. Cigarette smoking is synergistic with other risk factors, particularly high levels of low density lipoprotein cholesterol and low levels of low density cholesterol.28 Acute physiologic effects include sympathetic stimulation resulting in hypertension and tachycardia and increased carboxyhemoglobin levels. Over time, hypertension may become sustained. The cardiovascular system is also adversely impacted by the acute and chronic effects of smoking on the hematologic and metabolic systems. Table 3 summarizes the effects of smoking on the cardiovascular system.
Table 3: Effects of cigarette smoking on the cardiovascular system

| Pathologic Results | Smooth muscle cell proliferation  
|                    | Atherosclerosis progression  
|                    | Cardiomyopathy  
|                    | Intimal damage  
| Physiologic Effects | Tachycardia, hypertension, peripheral vasoconstriction,  
|                    | Myocardial demand increased/oxygen delivery reduced  
|                    | Threshold for ventricular fibrillation decreased  
|                    | Dysrhythmias  
|                    | Impaired coronary artery flow regulation (vasoconstriction)  
| Hematologic Consequences | Release of platelet factors that activate atherosclerosis  
|                        | Viscosity increased  
|                        | Thromboxane release, platelet aggregation  
|                        | Prostacyclin release decreased  
|                        | Red cell deformities  
|                        | Thrombosis increased  
| Metabolic Effects | Altered metabolism of drugs  
|                    | Serum free fatty acids, LDL cholesterol increased  
|                    | Serum HDL cholesterol increased  
|                    | Growth hormone, cortisol, glucose, lactate, pyruvate increased, estrogen decreased  

Carbon monoxide (CO) constitutes about 3 – 6% of tobacco smoke and is produced by incomplete combustion of the organic material found in cigarettes. While nicotine is the prime initiator of atherosclerosis, CO also has a detrimental effect. The affinity of hemoglobin for CO is 200 times greater than that for oxygen. This property results in elevated levels of carboxyhemoglobin up to 15% and reduces the oxygen carrying capacity of blood. CO shifts the oxyhemoglobin dissociation curve to the left, making it more difficult for hemoglobin to release oxygen to the tissues. CO may also have weak direct negative inotropic cardiac effects. The combined effect of nicotine and CO is to increase myocardial oxygen demand and reduce oxygen delivery. Peripheral resistance is increased, including that of the coronary vessels. The imbalance thus caused may be further compounded by polycythemia and increased blood viscosity caused by chronic hypoxia.

Smoking reduces the effects of antianginal medications in patients with chronic stable angina and decreases the effects of thrombolytic therapy. Moreover, angina may occur at lower work levels and be more intense after smoking in patients who already have coronary artery disease.

An association between cerebral aneurysms and smoking has long been recognized as approximately 66% of patients who present with ruptured aneurysms are presently smoking. Smoking may be the most modifiable risk factor for the formation and rupture of intracranial aneurysms. The cause may be related to repeated episodes of hypoxia that weakens the cerebral vasculature, especially at junctions where aneurysms are most likely to develop.

As noted, hematologic changes that result from tobacco consumption promote thrombus formation. Smoking enhances platelet aggregation by reducing endothelial production of prostacyclin, an inhibitor of platelet aggregation. Smoking increases production of thromboxane, a platelet agonist and vasoconstrictor. Plasma viscosity and fibrinogen levels are increased; and red cell deformability and plasminogen levels are decreased. Also, the effect of aspirin on platelets is partially inhibited. Postoperatively, these effects can adversely impact revascularization procedures, as graft patency...
might be limited. A higher proportion of limb loss in femoral popliteal bypass has been reported in smokers; and the risk for flap necrosis after face lift is 10 times greater in smokers as compared to nonsmokers.31,32

**Drug Metabolism**

Smoking can affect the pharmacokinetics and the pharmacodynamics of many drugs. Some components of tobacco smoke cause hepatic enzyme induction thereby increasing the metabolism of certain drugs such as pentazocine, heparin, warfarin, theophylline, phenylbutazone. As such, these drugs may require higher doses to maintain effectiveness. Nicotine does not have a pharmacokinetic effect on drugs like propranolol and pindolol but does directly interfere with their pharmacodynamic action. Smoking is also associated with decreased absorption of subcutaneous insulin and, in patients that smoke, adjustment of the dose is often required.

**Perioperative Management**

Complete abstinence from tobacco intake for several weeks prior to surgery is ideal to allow regeneration of lung function but this is rarely possible. Times required for regeneration of various functions are approximated in Table 4.

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<thead>
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<tbody>
<tr>
<td><strong>Table 4: Estimated times for return of lung function after quitting smoking</strong></td>
<td></td>
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<tr>
<td>Elimination of nicotine</td>
<td>12 hours</td>
</tr>
<tr>
<td>Elimination of carboxyhemoglobin</td>
<td>1 - 3 days</td>
</tr>
<tr>
<td>Return of ciliary function</td>
<td>6 - 7 days</td>
</tr>
<tr>
<td>Decrease of sputum production</td>
<td>6 - 8 weeks</td>
</tr>
<tr>
<td>Normalization of immune system</td>
<td>&gt; 8 weeks</td>
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A carboxyhemoglobin level of 15% can reduce the availability of oxygen by up to 25%. While this level may not be significant in asymptomatic patients, it may present a considerable risk for patients with coronary artery disease in whom a favorable myocardial balance is critical. While pulmonary function tests are not usually helpful in predicting postoperative pulmonary events or the need for mechanical ventilation, a low preoperative oxygen room air saturation or low partial pressure of arterial oxygen may identify patients at higher risk. Other important factors in determining postoperative pulmonary complications include the site and duration of the surgical procedure and the amount of blood lost. Preoperative pulmonary therapy might be useful, if only to acquaint the patient with the tools that may be used in the postoperative period to maintain oxygenation.

Clinical studies suggest that smoking is a risk factor in the progression of kidney disease, especially diabetic nephropathy. Nicotine promotes mesangial cell proliferation and fibronectin production and smoking may promote the progression of diabetic nephropathy by increasing the expression of
profibrotic cytokines such as transforming growth factor and the extracellular matrix proteins fibronectin and collagen 1V.33

Nicotine is a significant risk factor for the development and progression of periodontal disease.34 This will be evident when performing airway examination. The drug can decrease gingival blood flow, increase cytokine production and adversely affect the immune system to cause loosening of teeth and tooth loss. The high sugar content of chewing tobacco also causes tooth decay. Oral cancers and leukoplakia can interfere with intubation or oral airway placement due to bleeding or ulceration.

Hyperactive airway is a major cause of postoperative complications. Bronchospasm can be triggered by cholinergic drugs or drugs that cause histamine release. It can also be caused by hyperventilation prior to intubation or the presence of an endotracheal tube or supraglottic airway. Smokers, with or without a history of reactive airway disease, may be very sensitive to any airway manipulation. While some aerosols may provoke airway spasm, premedication with albuterol or with combined corticosteroids and salbutamol have been shown to reduce the possibility of intubation-evoked bronchospasm.35 Airway reactivity can also be decreased by intravenous lidocaine (1mg/kg).

Glycopyrrolate has minimal cardiovascular effects and is probably the best choice to reduce excess oral secretions associated with smoking. The addition of humidified fresh gas through the breathing circuit may be helpful, though occlusion may still occur from thick mucus secretions. High inspiratory pressures intraoperatively can indicate the presence of a mucus plug.

The choice of anesthetic technique depends on the site of surgery and patient choice. Patients are often very anxious as nicotine levels decrease and antianxiolytics are usually indicated. If regional or neuraxial techniques are possible they may be preferable to general anesthesia as the risk of bronchospasm is avoided. High spinal levels (above T6) which may interfere with the ability to cough postoperatively should be avoided. Adequate postoperative pain therapy is critical for the patient who has undergone major surgery. While narcotics remain the mainstay for analgesia, respiratory depression is a concern as smokers require the ability to deep breathe and cough to clear secretions. Pain associated with attempts to breathe could decrease expansion and result in atelectasis and pneumonia. Chest physiotherapy must be initiated early. Epidural analgesia with local anesthetics is a good alternative to intravenous narcotics. Humidification of oxygen postoperatively is essential and ventilatory support with continuous positive pressure should be available.

Management of the Case

The patient stated that he wanted to be “asleep”. His room air O2 saturation was noted to be 95%. The patient was informed that a regional technique requires less anesthetic and provides greater postoperative pain relief, lessening the need for narcotics which can cause respiratory depression. He agreed to neuraxial block as long as he could receive anxiolytics and some intraoperative sedation. Subarachnoid block was accomplished with midazolam 2mg. Propofol, 40ug/per kg/min was given for the duration of the case. Postoperatively he was started immediately on incentive spirometry. He was also given information regarding nicotine addiction and referred to a smoking withdrawal clinic.
Conclusion

Although smoking is declining in this country, it remains a major cause of morbidity and mortality. There are widespread physiologic and pathologic effects, especially impacting the cardiorespiratory system. Abstinence from smoking for some days before surgery would mitigate potential complications but such actions are not always obtainable. Perioperative care is determined in part by the magnitude of the alterations caused by smoking, the site and duration of surgery and the coexistence of medical issues.

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REFERENCES


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Post-test

1. A true statement regarding tobacco use:
   
   a. Abuse of tobacco is now the 3rd preventable cause of morbidity and mortality in the U.S.
   b. Tobacco is highly addictive and readily available
   c. Use remains on the increase in the United States
   d. Little has been done in the United States to curb its use

2. Cultivation of tobacco:
   
   a. Is similar to that of other agricultural crops
   b. Requires storage for curing
   c. Uses large doses of pesticides
   d. All of the above

3. The effects of nicotine on the airway are least likely to include:
   
   a. Periodontal disease
   b. Increased gingival blood flow
   c. Oral cancers
   d. Leukoplakia

4. Bronchospasm:
   
   a. Is rarely associated with smoking alone
   b. May be triggered by placement of an endotracheal tube
   c. Cannot be relieved by albuterol
   d. Does not occur in asymptomatic smokers

5. Regarding nicotine:
   
   a. Administered alone it is highly addictive
   b. It has a depressant effect when combined with MAOIs
   c. At low doses, it enhances the actions of norepinephrine and dopamine
   d. Dependency lowers the stress response
6. **Cigarettes labeled as “light” or “mild”:**
   a. May be lawfully advertised as such in the US
   b. Are safer than other forms of tobacco
   c. Have resulted in a decrease in diseases caused by smoking
   d. None of the above

7. **Ciliotoxins:**
   a. Can be removed by filters
   b. Include ammonia and formaldehyde
   c. Are part of the particulate phase of cigarette smoke
   d. As part of the gas phase, represent about 40% of the total weight of mainstream smoke

8. **Toxins and carcinogens:**
   a. Have been identified in particulate and gas phases
   b. Act indirectly on the oral mucosal surface
   c. Make up about 20 of the 4,000 compounds identified in tobacco smoke
   d. Do not dissolve in saliva

9. **After quitting smoking:**
   a. Nicotine is eliminated in 24 hours
   b. Ciliary function returns in 2 days
   c. Sputum production is reduced in 7 days
   d. The immune system may take more than 2 months to recover

10. **Components of tobacco smoke may:**
    a. Decrease the metabolism of heparin
    b. Affect the pharmacokinetics but not the pharmacodynamics of propranolol
    c. Decrease the absorption of subcutaneous insulin
    d. Have little or no effect on hepatic enzyme induction