TOBACCO CESSATION FOR SURGICAL PATIENTS

David O. Warner, M.D.
Department of Anesthesiology and Perioperative Medicine
Mayo Clinic Rochester
warner.david@mayo.edu

Introduction

The public health consequences of cigarette smoking are well-known and cannot be overstated. Despite this fact, the prevalence of cigarette smoking in the U.S. population continues to be significant (approximately 12%). Many smokers require surgery and anesthesia, either to treat the consequences of smoking-related disease (e.g., lung cancer) or for other pathology.

It would seem obvious that smoking cessation in the perioperative period would be beneficial. In fact, current policies in most health care facilities demand some period of forced abstinence, at least while on the grounds of the facility. There are at least two reasons why perioperative cessation may be desirable. First, smoking (and diseases caused by smoking) increases the frequency of postoperative complications. Smoking cessation may decrease the frequency of these complications. Second, the perioperative period may represent a "teachable moment" to convince smokers to permanently quit, so that strategies to promote cessation might be particularly effective at this time. This would provide a long-term benefit to the patient and to society.

Effects of Smoking and Cessation on Physiology and Perioperative Outcomes

Cardiovascular system—Cigarette smoking is a major risk factor for cardiovascular disease. It may promote atherosclerosis by effects on blood lipid profiles, promotion of endothelial damage, oxidant injury, neutrophil activation, and changes in blood properties such as viscosity (secondary to increased red cell mass) and fibrinogen level. In addition to these chronic changes of atherosclerosis, cigarette smoking may also contribute to acute vascular events by inducing a hypercoagulable state (which promotes acute coronary thrombosis), increasing myocardial work (both while smoking and between cigarettes), reducing the oxygen-carrying capacity of the blood, inducing coronary vasoconstriction, and causing catecholamine release.

There are over 3000 components of cigarette smoke that may contribute to these effects. The two that have attracted the most attention are carbon monoxide and nicotine. CO levels in smokers average ~5%, but may exceed 10%. CO avidly binds hemoglobin and thus reduces the ability of the blood to carry oxygen. Nicotine appears to mediate many of the acute hemodynamic effects of cigarette smoking (increases in mean arterial pressure [~5-10 mmHg] and heart rate [~10-15 beats min^{-1}]), increasing myocardial contractility and producing constriction in some vascular beds (e.g., skin). Nicotine may also cause coronary vasoconstriction, either directly or via nicotine-mediated catecholamine release. Some animal studies suggest that nicotine may also contribute to the above factors promoting atherosclerosis through actions such as alterations in platelet function and prostaglandin metabolism. However, human studies utilizing doses of nicotine typical of those provided by nicotine replacement therapy have generally not detected evidence of such effects.

Some of the effects of smoking on the cardiovascular system can be reversed with smoking cessation, although processes such as smoking-induced atherosclerosis cannot. Carbon monoxide is eliminated through the lungs with a half life of ~4 hours, and carboxyhemoglobin levels fall to near normal within 3 half-lives (~12 hour) in most subjects, such that the oxygen-carrying capacity of the blood should be restored. The half-life of nicotine, which is metabolized in the liver, lung, and kidney to cotinine and nicotine-N-oxide, is ~1 hour. As a result, the acute cardiovascular effects of smoking should be readily reversible with 12 hours of abstinence, as shown by improvements in maximal oxygen consumption over this time.

Surprisingly, there is not strong evidence that cigarette smoking itself is an independent risk factor for perioperative cardiac morbidity. Rather, it contributes to conditions such as coronary artery disease that are themselves risk factors. There are few studies examining how smoking cessation affects the risk of perioperative cardiac events. Available evidence in patients undergoing coronary artery bypass grafting suggests that patients that smoked at the time of surgery do not have elevated risk for cardiac events compared with non-smokers, although the resumption of smoking after surgery does increase risk of postoperative ischemic events.

Respiratory system—Smoking is the primary cause of chronic obstructive pulmonary disease (COPD). However, the majority of smokers do not develop COPD for reasons that are unclear, although most asymptomatic smokers have detectable abnormalities in pulmonary function, beginning at the level of the small airways. Smoking appears to incite an inflammatory reaction in the airways which may contribute to emphysema in some patients. As a result, smoking accelerates the normal age-related decline in forced-expiratory volume in one second (FEV_1) in all patients, with some progressing beyond the threshold necessary to produce symptomatic airway obstruction. In addition to these structural changes, smoking chronically depresses mucociliary clearance, especially in patients with chronic bronchitis, a depression that persists during anesthesia. Nicotine and other components of cigarette smoke produce airway hyperreactivity and bronchoconstriction, activating sensory endings in central airways.

Smoking cessation halts the accelerated decline in FEV_1 but does not produce lasting increases in FEV_1. Cessation will partially improve mucociliary clearance, although several weeks may be required for this effect to become apparent, and it may not recover in smokers who have developed chronic bronchitis. Of interest, many patients report that the volume of mucus production increases for several weeks after quitting, perhaps as transport is restored and smoking products are transported out of the lung. The effect of cessation on airway reactivity is not known.

Cigarette smoking is clearly an independent risk factor for the development of postoperative pulmonary complications (PPCs) such as atelectasis and pneumonia, with an odds ratio of ~3 compared with non-smokers. Of interest, some studies find that recent cessation or reduction of smoking (within approximately two months before surgery) may actually increase the risk of PPCs. However, these studies are not conclusive because of selection bias, with the sickest patients being more likely to reduce smoking. Thus, the optimal timing of cessation is not known, although it appears that 6-8 weeks is required for benefit.

Immune system—In general, smoking depresses immune function, with reported effects including depression of T cell responses, impaired antibody production, decreased natural killer cell activity, and many others. These changes appear to produce an increased susceptibility to infection. The contribution of nicotine compared to other components of smoke is not defined, although nicotine

itself may be contributory. On the other hand, exposure to the particulate and gaseous components of cigarette smoke itself can produce an inflammatory reaction, especially in the lung. The number of alveolar macrophages recovered from bronchoalveolar lavage increases, and their functional behavior changes to reflect an impaired metabolic response. The time-related decrease in the phagocytotic activity of alveolar macrophages that accompanies surgery and anesthesia is accelerated in smokers.

Smoking cessation appears to reverse at least some of the observed changes in immune function. However, these changes may require several months to occur. For example, excess particulate matter can be detected in alveolar macrophages for over one year after cessation, suggesting that at least this length of time is required to clear the residue of tobacco smoke from the lung.

The effect of smoking-related changes in immune function on perioperative complications is not known, except as it may contribute to the pathogenesis of postoperative pneumonia and wound infections (as discussed elsewhere).

Wound healing—Several clinical studies have suggested that wound and bone healing is impaired in smokers, although most were not controlled for smoking-related diseases such as atherosclerosis that may also affect healing. Experimental studies have implicated the ability of nicotine to reduce peripheral blood flow as causative. However, most of these experimental studies utilize nicotine doses far in excess of those consumed by even heavy smokers, so that other components of smoke may also contribute to this clinical observation.

There is now excellent evidence that smoking cessation reduces the frequency of wound-related complications. The duration of abstinence necessary for benefit is not known, but is less than 4 weeks, possibly much less.

Effects of environmental tobacco smoke—The effects of environmental tobacco smoke (ETS) have attracted considerable attention as a public health issue and are the subject of heated debate. The possible contribution of ETS to perioperative outcomes is unknown except in the case of respiratory events in children. There is a strong association between the passive inhalation of tobacco smoke from parents and airway complications in children receiving general anesthesia. ETS is also associated with several other respiratory diseases such as asthma in children.

Strategies for Smoking Cessation in the Perioperative Period

With this as a background, the following addressing several questions regarding smoking cessation in the perioperative period.

Is it harmful for smokers to quit immediately before surgery?—Both patients and physicians may have concerns that brief preoperative abstinence may actually be harmful for at least two reasons. First, many smokers report that respiratory symptoms such as cough and sputum production actually increase over the first few weeks after quitting. This may explain why it takes several weeks of abstinence before a reduction in postoperative pulmonary complications is observed. However, abstinence within a few weeks of surgery does not significantly increase the rate of complications, as shown by a meta-analysis of several studies. Thus, fear of worsening pulmonary outcomes should not discourage physicians from urging their patients to quit, regardless of the anticipated duration of

preoperative abstinence. Second, many smokers view cigarettes a tool to manage stress, and they may be reluctant to abstain at a time when they face the considerable stresses associated with surgery. Furthermore, nicotine is highly addictive, and nicotine withdrawal can manifest several unpleasant symptoms, including irritability, restlessness, sleep disturbances, and depression that could potentially complicate postoperative recovery. However, recent work demonstrates that smokers report no greater increases in psychological stress over the perioperative period than do non-smokers, nor do they consistently develop symptoms of nicotine withdrawal. Thus, patients (and their physicians) can be reassured that craving for tobacco will not routinely hamper their recovery if they remain abstinent. In addition, nicotine replacement therapy can be used to help manage any withdrawal symptoms that do occur.

Is surgery a good opportunity for smokers to quit permanently?—A "teachable moment" is an event that motivates individuals to adopt health behaviors that reduce risk. There is strong evidence that the concept applies to smoking cessation, as events such as pregnancy, disease diagnosis, and hospitalization are associated with increased rates of spontaneous smoking cessation compared with that present in the general population. In hospitalized patients, it appears that the chances of quitting increase with the intensity of medical interventions. For example, one study found that of smokers undergoing cardiac interventions, 55% of those undergoing coronary artery bypass grafting, 25% of those undergoing angioplasty, and 14% of those undergoing only angiography were abstinent one year after the intervention, a significant difference that persisted even after adjustment for severity of disease. For patients scheduled for elective surgery, those undergoing more extensive interventions (for example, those undergoing inpatient vs. outpatient procedures) have a greater likelihood of spontaneously quitting after surgery. Thus, elective surgery can serve as a teachable moment as defined. In addition, due to smoke-free policies in US heathcare facilities, some period of abstinence is mandatory, such that all smokers must at least temporarily address their tobacco dependence.

What methods to help smokers quit are effective?—Most smokers want to quit, but find it very difficult to do so. Approximately 70% of smokers report wanting to quit, and over 50% of them make a quit attempt each year, but most attempts are not successful. Nonetheless, millions of people have succeeded in quitting, usually after multiple attempts. A recent meta-analysis sponsored by the United State Public Health Service screened over 8,700 articles and was used to formulate practice recommendations based on expert panel opinion. The efficacy of several interventions are supported by multiple randomized clinical trials. Most of these trials have involved the general ambulatory population, and very few have specifically examined surgical patients. However, several trials have examined the role of tobacco interventions in hospitalized patients, and find similar principles. These interventions can be categorized as employing counseling (i.e., information exchange with patients) or pharmacotherapy.

Several principles are apparent from the evidence regarding the role of counseling in promoting smoking cessation. Physician advice to stop smoking increases quit rates. Although the evidence supporting the role of non-physician clinicians (such as nurses) is less available, it appears that advice from these providers is also effective. Thus, even if clinicians do nothing else, smokers should be advised to quit at every opportunity. Brief counseling (less than 3 min) regarding smoking cessation provided by clinicians will further increase the rate of abstinence. More intensive interventions are even more effective, and there is a dose-response relationship between the total time spent in interventions and efficacy. These interventions can be delivered by a variety of providers with equal effectiveness. Many different formats of interventions are effective, including telephone counseling, group counseling and individual counseling, and in fact the use of multiple

formats increases efficacy. Components of efficacious interventions include assisting the patient in devising a personalized quit plan, providing practical problem-solving skills, helping the patient obtain social support (e.g., from a spouse), and providing supplemental materials (e.g., brochures, etc.). Therapy is efficacious in both genders, and across age groups and different racial and ethnic minorities.

Pharmacotherapy is an important element of strategies to help smokers quit. The use of these medications will approximately double the rate of abstinence. Nicotine derived from tobacco use can be replaced using several different delivery systems, including gum, inhalers, nasal spray, patches, and lozenges. All systems are effective in promoting cessation and each has potential advantages. For example, patches need only be applied once daily, compared with other formulations which need to be administered several times throughout the day. On the other hand, some patients prefer to titrate their nicotine levels more precisely using the other delivery systems. Nicotine replacement therapy (NRT) is generally well-tolerated, with the predominant side effect consisting of local irritation at the site of delivery. Nicotine gum, patches, and lozenges are currently available without a prescription in the US. Other medications also are efficacious in promoting cessation. Sustained release bupropion, also used as an antidepressant, is approved by the Food and Drug Administration (FDA) for this purpose. Side effects include insomnia and dry mouth. Unlike nicotine replacement, patients should begin taking bupropion for one to two weeks before they quit smoking. Clonidine is also efficacious, although it has not been FDA approved for this indication and side effects may limit its application.

Is it safe to use nicotine replacement therapy in surgical patients?—There are two primary concerns with using NRT in surgical patients: the effects of nicotine on cardiovascular function and its effects on wound and bone healing.

Although the effects of NRT on cardiac function has not been studied specifically in surgical patients, much is known about the safety of NRT in ambulatory patients with coronary artery disease. NRT does not increase the frequency of cardiac events in cigarette smokers with coronary artery disease, even if they continue smoking. NRT may even reduce cardiovascular risk if smoking rate is reduced. For example, NRT significantly decreases the extent of exercise-induced myocardial ischemia assessed by exercise thallium imaging in smokers with coronary artery disease. These results suggest that the benefits of NRT to aid patients with coronary heart disease stop smoking outweigh the risk of continued smoking, and support the concept that other components of cigarette smoke other than nicotine, such as CO, contribute to adverse cardiac effects.

Animal experiments support the clinical observation that cigarette smoking can impair wound and bone healing. For example, the survival of skin flaps that require wide undermining is decreased in animals exposed to smoke-filled chambers compared with smoke-free control animals. In these studies, it is not possible to determine which constituents of cigarette smoke are responsible for these effects. Several studies have shown that nicotine itself can impair wound healing in experimental animals. However, most studies use nicotine doses far in excess of that provided by NRT in humans, doses often sufficient to cause anorexia and weight loss. An important recent study showed that quitting smoking dramatically decreased the incidence of surgical wound infection in humans; this benefit was observed whether or not the subjects used NRT to promote cessation. Thus, as in the case of cardiovascular function, avoidance of the other constituents of cigarette smoke is beneficial, even when nicotine is continued.

Thus, although more studies need to be performed specific to the surgical setting, available evidence does not support a detrimental effect of NRT in surgical patients, especially when compared with the consequences of continued smoking.

How can surgical providers help smokers quit?—Given factors such as the time pressures associated with current practice, often associated with limited preoperative patient contact with a surgical provider, implementation of tobacco interventions poses very real challenges. Ideally, interventions provided by a single surgical provider should be just one component of a comprehensive approach that includes systemic approaches such as collaborations with other healthcare providers.

Although more research is needed regarding how best to implement systems to help surgical patients quit smoking, in the meantime there are steps that all surgical providers can take today to help their patients quit. For primary care physicians, components of clinical interventions have been codified as the "5 A's": *A*sk about tobacco use, *A*dvise to quit, *A*ssess willingness to make a quit attempt, *A*ssist in quit attempt, and *A*rrange followup. Even with limited preoperative patient contact, surgical providers can perform these first three intervention elements as part of their preoperative visit.

Ask—All written or electronic medical records used to document patient history as part of the preoperative evaluation should have a prominent system for consistently identifying current and past tobacco use. In addition, all surgical providers should verbally query for tobacco use as a part of the preoperative interview, including the time of last tobacco use.

Advise—Every smoker should be strongly urged to quit. This message should be tailored to take advantage of the unique circumstances of surgery. All patients can be told that continued smoking may hinder their recovery from surgery, so that they should try to stay off cigarettes for as long as possible after their operation. This should be advised to all patients, even those who do not plan on stopping permanently or those who do not express receptivity to interventions. If seen at least one day prior to surgery, patients should be advised to "fast" from cigarettes beginning the evening before surgery, using nicotine gum or lozenges if desired the morning of surgery. Then, taking advantage of surgery as a "teachable moment", they can be told that this is an excellent time to consider permanently quitting, and that the forced abstinence associated with their visit to a healthcare facility will be an opportune time to initiate and extend a quit attempt.

Refer—During a brief preoperative visit, options for personally providing assistance may be limited. However, there are now numerous sources to refer patients who want help in quitting. Many health systems have specialized nicotine dependence treatment centers that provide a wide range of services. Many, but not all, health plans will cover these services. Everyone living in the US has access to telephone counseling services, referred to as "quitlines". These are offered free of charge by many health plans, national organizations such as the National Cancer Institute, and by many states (see www.smokefree.gov for a listing of quitlines and other resources). There are also many resources available for both clinicians who care for surgical patients and patients themselves. These materials can be accessed at

www.quitforsurgery.com

Depending on practice settings, there may be other opportunities to intervene. Surgeons routinely see patients both before and after surgery, providing prime opportunities to intervene. Other surgical providers such as anesthesiologists and perioperative nurses also have opportunities to reinforce the

stop smoking message, and ensure that referral to appropriate resources is made. These multiple reinforcing messages could have a powerful effect on smoking behavior, both in the immediate perioperative period and long-term.

Summary

Surgical providers do not hesitate to insist that patients change their behavior when they believe that such changes will be beneficial. For example, we consistently force our patients to deprive themselves of food for a certain preoperative interval. Growing evidence suggests that smoking in the perioperative period is harmful. Even limited perioperative abstinence may be beneficial, and should be strongly recommended by surgical providers. In addition, if providers can take the next step and help their patients take advantage of the excellent opportunity to quit permanently, they can make a significant difference in the lives of their patients that extends far beyond the relatively brief perioperative encounter.

Suggested Readings

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