CME

Smoking Cessation: The Role of the Anesthesiologist

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Smoking increases the risk of postoperative morbidity and mortality. Smoking cessation before surgery reduces the risk of complications. The perioperative period may be a "teachable moment" for smoking cessation and provides smokers an opportunity to engage in long-term smoking cessation. Anesthesiologists as the perioperative physicians are well-positioned to take the lead in this area and improve not only short-term surgical outcomes but also long-term health outcomes and costs. Preoperative interventions for tobacco use are effective to reduce postoperative complications and increase the likelihood of long-term abstinence. If intensive interventions (counseling, pharmacotherapy, and follow-up) are impractical, brief interventions should be implemented in preoperative clinics as a routine practice. The "Ask, Advise, Connect" is a practical strategy to be incorporated in the surgical setting. All anesthesiologists should ask their patients about smoking and strongly advise smokers to quit at every visit. Directly connecting patients to existing counseling resources, such as telephone quitlines, family physicians, or pharmacists using fax or electronic referrals, greatly increases the reach and the impact of the intervention. (Anesth Analg 2016;122:1311–20)

Smoking is a risk factor for several perioperative complications,[1–5] which is a major concern because smokers comprise a substantial proportion of surgical patients.[6,7] Stopping smoking before surgery has been shown to improve surgical outcomes. In addition, surgery is a "teachable moment" for smoking cessation.[7] Therefore, preoperative interventions for smoking cessation may reduce surgical complications and improve long-term health. Despite the available evidence suggesting the benefits of these interventions, anesthesiologists do not implement them routinely in their practice. The main objective of this narrative review was to provide a practical and multidisciplinary strategy for implementing a perioperative smoking cessation program. We (1) examine available data on the relation between preoperative smoking status and postoperative complications; (2) provide an overview of previous preoperative interventions for tobacco use and current smoking cessation programs; (3) discuss strategies that can be practically applied in the preoperative clinics; and (4) highlight the opportunities for anesthesiologists as perioperative physicians, to play an important role in improving surgical outcomes and public health.

SEARCH STRATEGY

In collaboration with a research librarian, we conducted a literature search for studies on perioperative smoking cessation using Medline (January 1946 to May 2015) and EMBASE (January 1974 to May 2015). The following text-word terms were used in our search strategies: smoking cessation*, smoking quit*, tobacco dependence cessation*, tobacco use disorder cessation*, nicotine cessation*, perioperat*, postop*, preoperat*, intraoperat*, operation?, operative*, surgical*, anesthes*, anaesthes*, preintervention*, randomized controlled trial, clinical trial, placebo, metaanaly*, metaanaly*, and systematic review. The exploded index-word terms in our search strategy included "tobacco use cessation," "electronic cigarette," "tobacco use cessation product," "perioperative care," "preoperative period," "surgical procedures, operative," "anesthesiology," and "anesthesia" (Appendix 1). We manually searched the bibliographies of retrieved articles to identify additional published or unpublished data relevant to our review. This search was limited to English-language articles on human subjects. The search strategy yielded 1717 articles. After we removed duplicate publications and evaluated the title, abstract, and full-text of studies, 95 articles were included in this review (Fig. 1).

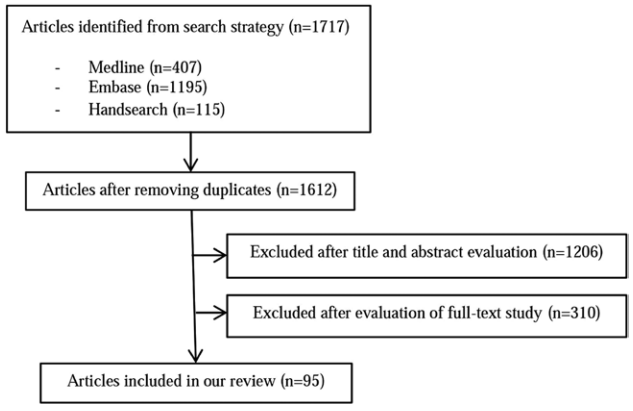

Figure 1. Flowchart for study selection.

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SMOKING AND PERIOPERATIVE COMPLICATIONS

The pathophysiologic consequences of smoking on surgical outcomes relate to both the toxic effects of recent smoke inhalation and the cumulative chronic effects of tobacco exposure.[2] Cigarette smoke contains >250 toxic chemicals with nicotine, carbon monoxide (CO), hydrogen cyanide, and nitric oxide being the 4 main harmful components.[8] These chemicals work in a synergistic manner to reduce tissue perfusion and oxygenation, impair inflammatory cell function, and affect synthesis and deposition of collagen.[8,9] The net effect of these interactions is ultimately responsible for the greater incidence of postoperative complications in smokers[9] (Table 1).

EFFECTS ON SPECIFIC ORGAN SYSTEMS

Pathophysiologic Impact of Smoking on Wound and Bone Healing

In the setting of surgical wounds, these effects can manifest as wound healing delay and dehiscence (odds ratios [OR] = 2.07; 95% confidence interval [CI], 1.53–2.81), hernia (OR = 2.07; 95% CI, 1.23–3.47), necrosis of wound and tissue (OR = 3.60; 95% CI, 2.62–4.93), and surgical-site infection (SSI) (OR = 1.18; 95% CI, 1.13–1.24).[2,9,10] Bone healing is also impaired in smokers. Smoking inhibits neovascularization and osteoblast differentiation, contributing to delayed bone healing and bone fusion[11,12] (Table 1).

Pathophysiologic Impact of Smoking on the Cardiovascular System

Three large multicenter studies reported increased odds of postoperative mortality and cardiovascular events in current smokers.[2,3,5] Smoking has both short-term and long-term harmful effects on the cardiovascular system. In the short term, nicotine increases the sympathetic activity, leading to increased arterial blood pressure, heart rate, and myocardial contractility. CO decreases oxygen availability by shifting the oxygen-hemoglobin curve to the left. The effects of nicotine and CO in common create an imbalance between oxygen demand and delivery.[13] In the long term, smoking increases oxidative stress and inflammation, promotes endothelial damage, increases hypercoagulability, and reduces fibrinolysis. These effects lead to the progression of atherosclerosis and thrombosis in the vasculature.[14] Surgery and anesthesia place additional demands on the heart and circulation and result in a greater risk of cardiovascular complications such as cerebrovascular accidents (OR = 1.55; 95% CI, 1.36–1.76) and myocardial infarction (OR = 1.77; 95% CI, 1.57–1.99) in smokers[3] (Table 1).

Pathophysiologic Impact of Smoking on the Respiratory System

In the respiratory system, tobacco use damages cilia and mucus transport, stimulates goblet cell hyperplasia and mucus overproduction,[15] impairs pulmonary macrophage function,[16] and increases bronchial airway reactivity.[17] Exposure to tobacco causes delayed bacterial clearance and increased susceptibility to infection.[18] Smokers are predisposed to postoperative pulmonary complications (PPCs), such as pneumonia (OR = 1.77; 95% CI, 1.66–1.90) and prolonged mechanical ventilation (OR = 1.55; 95% CI, 1.43–1.68)[2] (Table 1).

Reversibility of Smoking-Induced Pathologic Changes

Smoking cessation can reverse some but not all smoking-induced pathologic changes that lead to an increased risk of perioperative complications.[19] Although current smokers with more than a 20 pack-year exposure are most likely to have postoperative morbidity and mortality, former smokers, even those with an extensive history, may not be at greater risk of postoperative mortality.[2,3] For some morbidity, the duration of abstinence necessary for benefit is not known, but for most, abstinence for at least 1 year before surgery reduces the risk of postoperative mortality and

Table 1. Odds Ratios of Postoperative Outcomes Among Current and Former Smokers Compared with Patients Who Never Smoked

	Smoking status before surgery, OR (95% CI)		
Postoperative outcomes	**Never**	**Former**	**Current**
Wound healing delay and dehiscence (10)	1[a]	—	2.07 (1.53–2.81)
Hernia (10)	1	—	2.07 (1.23–3.47)
Necrosis of wound and tissue (10)	1	—	3.60 (2.62–4.93)
Sepsis (5)	1	—	1.38 (1.11–1.72)
Septic shock (5)	1	—	1.40 (1.33–1.47)
Surgical-site infection[b] (2)	1	1.11 (1.05–1.17)	1.18 (1.13–1.24)
Long bone fracture nonunion (12)	1	—	2.32 (1.76–3.06)
Cerebrovascular accident/stroke[c] (3)	1	1.10 (0.96–1.26)	1.55 (1.36–1.76)
Myocardial infarction[c] (3)	1	1.28 (1.14–1.44)	1.77 (1.57–1.99)
Ventilation for longer than 48 h[b] (2)	1	1.26 (1.16–1.38)	1.55 (1.43–1.68)
Unplanned reintubation for respiratory/cardiac failure[b] (2)	1	1.36 (1.26–1.47)	1.67 (1.55–1.79)
Pneumonia[b] (2)	1	1.22 (1.13–1.31)	1.77 (1.66–1.90)
30-day postoperative mortality[b] (2)	1	1.17 (1.09–1.27)	1.29 (1.20–1.39)
One-year postoperative mortality[b] (2)	1	1.14 (1.10–1.19)	1.55 (1.50–1.61)

CI = confidence interval; OR = odds ratio.

[a]Using 1 as basic reference in patients who never smoked.

[b]Results are adjusted for fixed effects of age, race/ethnicity, surgical specialty, complexity of the operation, ASA classification, year, and a random effect of hospital division. Surgical-site infection additionally adjusted for wound classification.

[c]Results are adjusted for fixed effects of age, sex, race (white, black or African American, or other), ASA classification, alcohol consumption,diabetes mellitus, obesity, pregnancy, hypertension, renal failure, chronic obstructive pulmonary disease, dyspnea, congestive heart failure, angina, myocardial infarction, previous percutaneous, coronary intervention, previous cardiac surgery, peripheral vascular disease, rest pain, transient ischemic attack, cerebrovascular accident, disseminated cancer, and tumor involving the central nervous system.

morbidity[3] (Table 1). Given that 1-year mortality of smokers after surgery has been shown to be mediated by immediate postoperative complications, preoperative smoking cessation may reduce both morbidity and mortality in smokers.[20]

Impact of Abstinence on Wound and Bone Healing

Histologic studies on wound healing demonstrate that 4 weeks of abstinence from smoking may improve inflammatory cell migration[21] and oxidative bacterial-killing mechanisms.[22] In contrast, the impaired proliferative phase of wound healing is not reversed within 3 months of abstinence. These findings provide a potential mechanism for why short-term smoking cessation may reduce SSIs but not wound dehiscence.[21] Preoperative abstinence for at least 3 to 4 weeks reduces the risk of SSIs.[10,23] Postoperative abstinence is of paramount importance for orthopedic and spine surgery. In a randomized controlled trial by Nåsell et al.,[24] the patients who quit smoking right after fracture surgery had a lower risk of postoperative complications at 6 weeks' follow-up. Postoperative smoking cessation has also been shown to improve the outcome after spinal fusion surgery.[25]

Impact of Abstinence on the Cardiovascular System

The role of smoking cessation in improving cardiovascular health is well-recognized. Smokers who smoke up to the time of surgery have a greater rate of ST-segment depression during general anesthesia than patients who avoid smoking on the day of surgery.[26] Nicotine and CO have short half-lives (approximately 1 and 4 hours, respectively),[27] and thus, short-term smoking abstinence is beneficial by improving oxygen availability to the vital organs. Only a few studies have investigated the postoperative cardiovascular outcome after short-term abstinence. Review of the limited available data shows no significant differences in risks for postoperative cardiovascular complications among current smokers, former smokers (<8 weeks of abstinence), and never smokers.[23,28]

Impact of Abstinence on the Respiratory System

Prolonged abstinence from smoking decreases the risk of PPCs.[29] Our 2012 meta-analysis demonstrated that at least 4 weeks of abstinence is needed to reduce the risks of PPCs. Abstinence from smoking for more than 4 and 8 weeks before surgery reduced the risk of PPCs by 23% and 47%, respectively. The risk of PPCs in those who stopped smoking 8 weeks before surgery was similar to those who had never smoked. There is a time-related decrease in the risk of postoperative complications, that is, the relative risk of PPC decreases as the duration of preoperative smoking cessation increases.[23]

HEALTH CARE COSTS OF SMOKING IN THE PERIOPERATIVE PERIOD

Smoking increases health care costs in the perioperative period. One reason for the higher costs is the increased use of surgical interventions for smoking-related diseases. Furthermore, smokers are more likely to experience perioperative surgical complications, and thus, they may need longer hospital stays, longer intensive care unit stay, and more readmissions.[30] Indirect costs incurred by smoking at the time of surgery include the value of lost productivity because of morbidity, disability, and premature mortality.[31] In the United States, smoking at the time of admission for surgery is associated with approximately $10 billion annual excess postoperative costs within the first year after surgery.[30] This figure may be greater in countries such as China, Russia, and Indonesia, with an estimated smoking prevalence of 50% in men.[32] In countries such as the United States and Canada, which have had long-standing tobacco-control programs, the remaining smokers may be becoming "hardened" to quit.[33] In contrast, a large proportion of smokers in countries that do not have long-standing tobacco-control programs may be more likely to be influenced by interventions for preoperative smoking cessation because they may have never attempted to quit.[34]

PERIOPERATIVE INTERVENTIONS FOR SMOKING CESSATION

In addition to the short-term benefits of abstinence in the perioperative period, surgery serves as a teachable moment and provides smokers with an opportunity to engage in long-term smoking cessation.[35] Undergoing surgery is associated with an increased likelihood of abstinence, and surgical patients are more likely to be receptive to advice offered by health care providers.[36] The intensity of the surgical procedure, as well as its association with tobacco-related diseases, correlates with its power as a teachable moment for long-term abstinence.[7] The health and cost benefits of long-term smoking cessation are unquestioned. Globally, smoking causes nearly 6 million deaths annually,[37] and in the United States alone, the total economic cost of smoking is more than $300 billion a year.[31] Given that a large number of smokers will need surgery at some time in their lives, preoperative care is an excellent opportunity for anesthesiologists to improve not only short-term surgical outcomes but also long-term health outcomes and costs.[38]

A number of randomized controlled trials have evaluated interventions for smoking cessation at varying times before surgery. The interventions have included different forms and intensity of behavioral counseling along with[39–46] or without pharmacotherapy.[47,48] Two trials, offering weekly face-to-face counseling and nicotine-replacement therapy (NRT), reported significantly fewer postoperative complications and greater long-term quit rates in the intervention groups.[39,49] One intensive intervention initiated at 6 weeks before surgery reduced the relative risk of surgical complications by 65%, with the greatest effect on wound-related complications (5% in the intervention group versus 31% in the control group).[39]

A systematic review of 13 trials concluded that a combination of intensive behavioral support and pharmacotherapy initiated as late as 4 weeks before surgery reduced postoperative complications and increased the likelihood of long-term abstinence.[50] Brief interventions provided shortly (<4 weeks) before surgery are likely to increase abstinence but have not demonstrated a significant effect on postoperative complications.[50] However, brief advice has been shown to increase abstinence on the morning of surgery.[51]

One concern has been that interventions shown to be effective in controlled trials may not be feasible in actual practice. To address this concern, one trial used a simple preoperative intervention including brief counseling, brochures on smoking cessation, a free 6-week supply of transdermal NRT, and a fax referral to a national telephone quitline.[46] A significant increase in the abstinence rate was found in the intervention group versus the control group on the day of surgery (14% vs 4%), at 30 days (29% vs 11%), and at 1 year after surgery (25% vs 8%).[52] The results of this study demonstrated that the interventions do not need to be labor-intensive to be beneficial.[53] Sachs et al.[54] compared implementation of brief and intensive interventions in the preoperative clinics. There was no significant difference in terms of reach and effectiveness between these interventions. Both interventions increased long-term abstinence from smoking. Nevertheless, only 22% of patients in the intensive intervention group eventually received NRT because of some implementation problems. Brief interventions are practical and feasible to implement in the preoperative setting.

STRATEGIES FOR PERIOPERATIVE INTERVENTIONS

Several strategies have been offered to facilitate the delivery of smoking-cessation treatment in health care settings. The most notable one is the 5 As approach (i.e., Ask, Advise, Assess, Assist, Arrange) recommended by the US Public Health Service (Table 2).[55] Some of the barriers to implementation of this approach by anesthesiologists include the lack of time in the busy preoperative clinics and the lack of ability to provide follow-up support after surgery.[56,57] Thus, it seems more practical to use a referral system to community-based counseling.

The American Society of Anesthesiologists modified the 5 As approach to Ask, Advise, and Refer (AAR). With this approach, smokers are identified, briefly advised, and referred to resources such as tobacco telephone quitlines for counseling and follow-up.[57] However, many smokers who are given the telephone number of quitlines fail to call for assistance. Successful implementation of the AAR approach needs a reliable referral strategy.[58] A new approach, Ask, Advise, and Connect, has demonstrated that directly connecting smokers to counseling resources such as quitlines using an electronic connection system within the patient health record (electronic referrals) results in a 13-fold increase in the treatment enrollment compared with the AAR approach. Ask, Advise, and Connect greatly increases the reach and impact of the intervention and shifts the burden of intensive counseling away from physicians (Table 2).[59]

The experience of the Ottawa Model for Smoking Cessation emphasizes that the effective interventions can be incorporated into routine practice with the use of clinical staff. In this program, smokers are identified systematically and documented, provided with brief counseling and pharmacotherapy, and followed up with the use of a unique interactive voice response-mediated telephone follow-up. Implementation of the Ottawa model has led to an absolute increase of 11% in the long-term abstinence rates among hospitalized patients.[60]

In previous studies, delivery of interventions, particularly in-hospital counseling and NRT, was uneven because of factors such as patient or physician attitudes toward NRT and some logistical barriers. These findings highlight the need to increase awareness to both hospital staff and smokers about effectiveness of pharmacotherapy for smoking cessation.[54,61]

ELEMENTS OF EFFICACIOUS INTERVENTIONS

Tobacco use is both a learned behavior and a physical addiction to nicotine, and thus the combination of behavioral support such as physician advice or counseling and pharmacotherapy yields higher quit rates than either one alone.[62]

Behavioral Therapy

Brief, simple advice given by physicians to their smoking patients has been shown to promote smoking cessation, and increased intensity (frequency or duration) of such advice is associated with an additional benefit.[63] During the preoperative visit, anesthesiologists should briefly counsel their patients about the benefits of quitting and support smokers' self-efficacy by focusing on their strengths and previous successes.[34,64] Patient involvement in the decision-making process by the use of simple practical tools such as decision aids not only facilitates clinician-patient conversations about smoking but also reduces a patient's uncertainty in decision making.[65] One widely used behavioral approach is the transtheoretical model, suggesting that smokers progress through 5 stages of change before they succeed in quitting (Fig. 2).[66] In this model, brief counseling that is based on the smoker's readiness to quit may help the smoker progress through the stages and produce greater eventual abstinence.[67] The Fagerstrom test may be used in the preoperative clinic to evaluate the intensity of the addiction to nicotine. The questionnaire has 6 items with a maximum

Table 2. Current Strategies for Preoperative Tobacco Use Interventions

Five As	AAR	AAC
Ask to identify all tobacco users at every visit	**Ask** to identify all tobacco users at every visit	**Ask** to identify all tobacco users at every visit
Advise tobacco users in a clear and personalized manner to quit at every visit	**Advise** tobacco users briefly to quit and offer cessation assistance via the quitline	**Advise** them briefly to quit and offer cessation assistance via the quitline
Assess their willingness to make a quit attempt	**Refer** tobacco users to quitline delivered counseling and provide them with quitline numbers	**Connect** tobacco users directly with quitline delivered counseling through an automated connection system
Assist them through offering medications and providing counseling		
Arrange for follow-up meetings beginning the first week after the quit date		

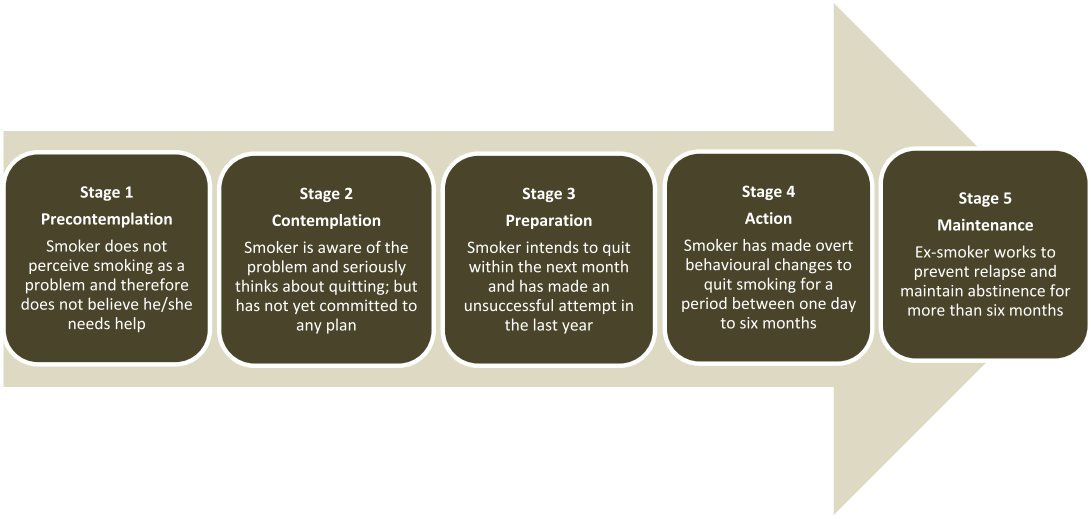

Figure 2. One widely used behavioral approach is the transtheoretical model, suggesting that smokers progress through 5 stages of change in readiness before they succeed to quit. In this model, interventions are tailored to match each patient's level of readiness to quit smoking.

score of 10. A score of 6 or more identifies high nicotine dependence.[68]

In many countries, smokers have free access to telephone counseling, and physicians can refer their patients for follow-up support. Telephone quitlines have demonstrated real-world effectiveness and are more convenient for patients than face-to-face counseling.[69] Proactive telephone counseling in which calls to smokers are initiated by a counselor has been shown to be more effective than reactive counseling, in which the first call is made by smokers.[70] In the United States and Canada, health care providers can refer their patients to a quitline by fax using a quit connection referral form.

Because surgical patients have multiple contacts with health care providers, such as surgeons, anesthesiologists, family doctors, and pharmacists, the cumulative effect of brief but consistent advice may lead to a progression in a smoker's readiness to quit and eventually long-term abstinence. Current evidence suggests that unsuccessful quit attempts in the preoperative period lead to forward progression in the stages of change and provide learning opportunities in which self-efficacy is enhanced for abstinence in the future.[43]

Pharmacotherapy

First-line medications for smoking cessation include nicotine replacement, bupropion, and varenicline (Table 3).[8,71–73] NRT was the first proven effective pharmacotherapy for smoking cessation, increasing quit rates by 50% to 70% when combined with behavioral therapy. NRT is available in various formulations, including the long-acting nicotine patch and the short-acting gum, lozenge, inhaler, and nasal spray. Combining a long-acting nicotine patch with a rapid delivery form of NRT has been shown to improve quit rates significantly in the general population (relative risk = 1.34; 95% CI, 1.18–1.51). However, this has not been studied in surgical patients.[74]

NRT is available over the counter in most countries. A meta-analysis of 150 studies demonstrated that the effectiveness of NRT is largely independent of the intensity of additional support and the medical setting in which it is offered.[74] Therefore, pharmacies may be considered as referral centers for smoking cessation treatment. In Canada, some pharmacists are trained to counsel and prescribe medications for smoking cessation.[75]

NRT has been the most widely studied pharmaceutical agent in studies on surgical patients and is a component of most successful trials of perioperative tobacco interventions.[39–42,46,49,54,76] Given the effects of nicotine on inflammatory wound healing processes, NRT may be expected to have a detrimental effect on healing complications. Surgeons may have concerns regarding the potential deleterious effects of nicotine on wound healing. Some preclinical studies suggest that nicotine in high doses, which exceed those produced by NRT, decreases the viability of skin flaps.[21] Although the available data are limited, there is no evidence from human studies that NRT increases the risk of healing-related or perioperative cardiovascular complications.[19] Individual clinical trials of interventions for smoking cessation that include NRT show either no effect or a reduction in complication rates. Thus, any potential harm to health by NRT is likely smaller than the harm of continued smoking.[74] The amount of nicotine in NRT may be less than that in cigarettes,[77] and exposure to the toxic chemicals in cigarette smoke is avoided.

Bupropion is a weak dopamine and norepinephrine reuptake inhibitor. Sustained-release bupropion is the first non-nicotine pharmacotherapy approved for smoking cessation. One placebo-controlled trial testing the efficacy of bupropion in the perioperative setting showed that patients receiving 7 weeks of bupropion before surgery were more likely to stop smoking or reduce their cigarette consumption at the time of surgery and 3 weeks after surgery.[78]

Varenicline is a nicotinic acetylcholine receptor partial agonist, and it works by reducing withdrawal and blunting the pleasurable effects of smoking.[79] In a multicenter, randomized controlled double-blinded trial, 286 surgical

Table 3. Pharmacotherapies for Smoking Cessation

Medication	Benefits	Precautions	How to use
Nicotine gum[a]	Can help prevent overeating; can provide an additional help to reduce severe cravings	Difficult to use correctly (the rate of chewing affects nicotine delivery); no eating or drinking 20 min before or during use	1 piece every 1–2 h for 6 wk, followed by gradual reduction over 6 wk -If <20 cigs/d: 2 mg -If >20 cigs/d: 4 mg
Nicotine lozenge[a]	Can help prevent overeating; can provide an additional help to reduce severe cravings	Difficult to use correctly in practice; no eating or drinking 20 min before or during use	-Weeks 1–6: 1 every 1–2 h -Weeks 7–9: 1 every 2–4 h -Weeks 10–12: 1 every 4–8 h
Nicotine patches[a]	Easy to use; automatically gives the right dose in 24-h period; reduce early morning cravings	Nocturnal nicotine may disturb sleep (vivid dreams or insomnia); not recommended in severe eczema and psoriasis	One patch per day -If >10 cigs/d: 21 mg 4 wk, 14 mg 4 wk, 7 mg 4 wk (total 12 wk) [can start with >21 mg if >20 cigs/d] -If <10 cigs/d: 14 mg 4 wk, 7 mg 4 wk (total 8 wk)
Nicotine inhaler[a]	Helps smokers in whom smoking-associated behavior is strongly conditioned; can help prevent overeating	Feels and looks like a cigarette; may precipitate bronchospasm	6–16 cartridges per day for 6 wk, followed by gradual reduction over 6 wk
Nicotine nasal spray[a]	Gives fast relief (the most rapid pharmacokinetics among all NRT formulations); particularly useful for heavy smokers	May cause nasal irritation; risk of nicotine overdose and long-term addiction	1–2 sprays/h for 12 wk (not more than 48 sprays per day)
Bupropion (Zyban)	Easy to use; noticeable reduction in withdrawal symptoms and rewarding effects	Possible insomnia and dry mouth; contraindicated in patients predisposed to seizures, or with eating disorders; FDA warning regarding suicidality	Start 1–2 wk before quitting; 150 mg o.d. for 3 d, followed by 150 mg twice a day for 12 wk
Varenicline (Chantix)	Easy to use; noticeable reduction in withdrawal symptoms and rewarding effects	Possible nausea and insomnia; FDA warning regarding suicidality, seizure, and operating heavy machinery while using varenicline	Start 1–2 wk before quitting; 0.5 mg o.d. for 3 days, followed by 0.5 mg twice a day for 4 days, and then 1 mg twice a day for 12 wk

cigs = cigarettes; FDA = Food and Drug Administration; NRT = nicotine-replacement therapy.
[a]May be used for longer than 12 weeks as needed.

patients were randomized to receive varenicline or placebo for 12 weeks. Both groups received two 15-minute in-hospital counseling sessions and brief monthly telephone follow-up support for 1 year after discharge.[45] Varenicline increased the likelihood of abstinence by 45% compared with placebo at 12 months after surgery. There was also a significant reduction in the number of cigarettes smoked per day by those who continued to smoke. Given that decreased nicotine dependence predicts a greater abstinence rate, future quit attempts in these patients may lead to complete abstinence.[45]

In the most recent meta-analysis of interventions for smoking cessation in the general population,[80] bupropion therapy (bupropion versus placebo OR = 1.82; 95% CI, 1.60–2.06) was shown to have the same efficacy as the single-form NRT (NRT versus placebo OR = 1.84; 95% CI, 1.71–1.99) when tested against placebo. Varenicline doubles to triples the likelihood of long-term abstinence when compared with pharmacologically unassisted attempts (OR = 2.88; 95% CI, 2.40–3.47) and is associated with greater rates of quitting compared with single-form NRT (varenicline versus single-form NRT OR = 1.57; 95% CI, 1.29–1.91) and bupropion (varenicline versus bupropion OR = 1.59; 95% CI, 1.29–1.96). This meta-analysis did not find any additional risk of neuropsychiatric or cardiovascular adverse events among patients receiving varenicline or bupropion.[80] The most common adverse event associated with varenicline is nausea, which subsides in most cases.[81] Varenicline and bupropion can be regarded as alternative medications when smokers are not willing to try NRT or have failed to quit with NRT.

Electronic nicotine delivery devices (e-cigarettes) have recently become popular. These devices are similar to cigarettes in terms of visual, sensory, and behavioral aspects and, thus, helpful to reduce cravings in whom smoking behavior is strongly conditioned.[82] Recently, an American survey showed that a substantial proportion of patients undergoing surgery would be willing to use e-cigarettes in the perioperative period.[83] However, the review of longitudinal studies on electronic nicotine delivery devices suggests that electronic cigarettes are not more effective than other medications for smoking cessation.[84]

Timing of Perioperative Smoking Cessation Interventions

During the past 2 decades, anesthesiologists have been reluctant to advise their preoperative patients to quit

smoking because of the uncertainties about the benefits of short-term smoking cessation.[85] Surgeries are sometimes scheduled within a few weeks of the diagnosis when longer periods of preoperative abstinence may not be an option. There has been an erroneous belief that smoking cessation shortly before surgery increases postoperative complications. This idea was based largely on the overinterpretation of a study,[86] assuming that a brief period (<8 weeks) of abstinence leads to loss of the cough-promoting effect of cigarettes and subsequently a greater risk of sputum retention and PPCs.[87] The current evidence does not support these transient changes in either cough or sputum production shortly after abstinence.[88] In addition, our meta-analysis has found no significant increase in PPCs after brief (<4 weeks) preoperative abstinence.[23]

As well, anesthesiologists may think that the preoperative period is not a good time for their already stressed patients to deal with the additional stress of quitting smoking. There is no evidence, however, that smoking cessation increases psychological stress in the perioperative period.[89]

Furthermore, even postoperative interventions have been found to improve the surgical outcomes in smokers who smoked up to the time of their surgery.[24,25] Therefore, although smokers gain a greater benefit from a longer duration of preoperative abstinence, those not able to maintain long-term abstinence before surgery should be encouraged to stop smoking at any time in the perioperative period.[90]

THE ROLE OF ANESTHESIOLOGISTS IN PERIOPERATIVE INTERVENTIONS FOR SMOKING CESSATION

Providing interventions for smoking cessation is one big step toward the perioperative surgical home and an opportunity for anesthesiologists to move beyond the operating room and play a critical role in the long-term health of their patients.[91] Surgeons and primary care providers have longer relationships with patients, and their advice has been shown to be more effective in influencing a patient's decision to quit.[92] However, anesthesiologists have an opportunity to assume a leading role in coordinating a multidisciplinary approach involving anesthesiologists, surgeons, and family physicians. Interventions for smoking cessation have the greatest potential to impact both short-term outcomes and long-term health and are an intervention that anesthesiologists can participate in.[93] Indeed, some anesthesiologists have suggested that anesthesiologists should recommend postponing elective surgery to implement these interventions.[94–96]

Most anesthesiologists ask their patients about smoking but frequently do not advise smokers to quit.[56,97] Despite recognition of the adverse effects of smoking on postoperative outcome, no attempt is normally made to assist smokers to quit. In a 2010 survey of anesthesiologists,[56] the main reason for this failure was the lack of expertise and low self-efficacy in providing interventions for smoking cessation. Another American survey demonstrated that a majority of anesthesiology residents were not taught how to assist patients to quit.[98] It is important to address this gap in training in the residency program curriculum.

The preoperative clinic is an ideal setting to initiate interventions for smoking cessation. Provision of brief advice and free smoking-cessation aids within the preoperative clinic should be promoted routinely. The preoperative clinic staff should be trained to offer brief but consistent advice to patients, and smoke-free hospital policies need to be enforced. The costs associated with support and implementation of these interventions may be recovered by the decrease in surgical complications and long-term consequences of smoking.

Although interventions in the preoperative clinics may be optimal, anesthesiologists often have their first encounter with patients only shortly before surgery. The time pressure makes the implementation of the current guidelines challenging. Nevertheless, a brief (3-minute) counseling session focusing on the health benefits of preoperative smoking cessation and tailored for the patient's readiness to quit is possible without imposing additional burden on the limited staff availability and time restraints. If a patient is willing to stop smoking, consideration may be given to postpone elective surgeries. A quit date should be set, and appropriate pharmacotherapy may be recommended on the basis of the patient's preference, experience, and medical history. The patient should be connected to counseling resources such as a telephone quitline, family physicians, or pharmacists to receive follow-up support.

Implications for Future Research

Our review points to several future research priorities. The effectiveness and long-term effects of e-cigarettes and pharmacotherapeutic agents other than NRT in the setting of surgery should be studied. As well, there is a lack of conclusive evidence about the safety of NRT before surgery. We also need to establish whether postponing surgeries for implementing interventions improves postoperative outcomes and long-term abstinence rates. Given that in previous studies, a substantial proportion of patients were not compliant with the physician's advice, a better understanding of the factors affecting smokers' preoperative and postoperative behaviors and barriers to cessation is needed. As well, further studies are needed to determine the best strategies for adoption and implementation of interventions into routine practice.

CONCLUSIONS

Given the large volume of surgery worldwide and the evident power of surgery as a teachable moment, anesthesiologists can play a leadership role in the area of smoking cessation. Anesthesiologists are well-positioned as perioperative physicians to take full advantage of this opportunity to improve both short-term outcomes and the long-term health of surgical patients. They should ask their patients about smoking, advise the smokers to quit, and connect them directly to counseling resources.

Appendix 1. Search Strategy

No.	Searches
1	"tobacco use cessation"/
2	smoking cessation/
3	"tobacco use cessation products"/
4	electronic cigarettes/
5	electronic cigarette*.mp,kw.
6	(ecigaret* or e-cigaret*).mp,kw.
7	tobacco-free??.mp,kw.
8	exp Smoking/ and (stop* or end??? or ceas??? or cessation* or quit*).mp,kw.
9	(smok??? adj3 (stop* or end??? or ceas??? or cessation* or quit*)).mp,kw.
10	(smoke* adj3 (stop* or end??? or ceas??? or cessation* or quit*)).mp,kw.
11	tobacco/ and (stop* or end??? or ceas??? or cessation* or quit*).mp,kw.
12	(tobacco* adj4 (stop* or end??? or ceas??? or cessation* or quit*)).mp,kw.
13	tobacco dependence/ and (stop* or end??? or ceas??? or cessation* or quit*).mp,kw.
14	nicotine/ and (stop* or end??? or ceas??? or cessation* or quit*).mp,kw.
15	(nicotine? adj4 (stop* or end??? or ceas??? or cessation* or quit*)).mp,kw.
16	(cigar* adj4 (stop* or end??? or ceas??? or cessation* or quit*)).mp,kw.
17	exp Tobacco/ and (stop* or end??? or ceas??? or cessation* or quit*).mp,kw.
18	exp "tobacco use disorder"/ and (stop* or end??? or ceas??? or cessation* or quit*).mp,kw.
19	or/1–18
20	exp perioperative care/ or intraoperative care/ or postoperative care/ or preoperative care/
21	exp Anesthesia Recovery Period/
22	perioperat:.mp.
23	peri-operat:.mp.
24	peroperat:.mp.
25	postop:.mp.
26	post-op:.mp.
27	preoperat:.mp.
28	pre-operat:.mp.
29	intraoperat:.mp.
30	intra-operat:.mp.
31	(before adj2 surgery).mp.
32	(before adj2 operat????).mp.
33	(prior adj2 surgery).mp.
34	(prior adj2 operat????).mp.
35	operation?.mp.
36	operative*.mp.
37	(surgery or surgeries or surgeon? or surgical*).mp.
38	su.fs.
39	exp surgical procedures, operative/
40	exp Specialties, Surgical/
41	Surgeons/ [new MeSH as of 2015]
42	exp Anesthesiology/
43	anesthes*.mp.
44	anaesthes*.mp.
45	exp Anesthesia/
46	(before adj3 procedur*).mp.
47	(prior adj3 procedur*).mp.
48	pre-procedur*.mp.
49	preprocedur*.mp.
50	periprocedur*.mp.
51	peri-procedur*.mp.
52	preintervention*.mp.
53	pre-intervention*.mp.
54	or/20–53 [Periop Postop Preop Surgery or Anesthesia]

(*Continued*)

Appendix 1. Continued

No.	Searches
55	19 and 54
56	randomized controlled trial.pt.
57	exp Randomized controlled trial/
58	exp Randomized Controlled Trials as Topic/
59	clinical trial.pt.
60	Double-Blind Method/
61	"double blind:".mp.
62	Placebos/
63	placebo:.mp.
64	random:.mp.
65	meta-analysis/
66	META-ANALYSIS AS TOPIC/
67	Pragmatic Clinical Trials as Topic/
68	PRAGMATIC CLINICAL TRIAL/
69	(systematic adj3 review?).mp,kw.
70	(overview? adj3 review?).mp,kw.
71	meta-analy*.mp,kw.
72	metaanaly*.mp,kw.
73	metanaly*.mp,kw.
74	or/56–73 [RCTs or SRs or MAs]
75	55 and 74
76	limit 75 to (english language and humans)
77	remove duplicates from 76

DISCLOSURES

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