



# Improving Surgical Outcomes and Patient Health: Perioperative Smoking Cessation Interventions

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## Abstract

**Purpose of Review** This review is aimed at discussing the evidence for perioperative smoking cessation interventions and at describing the components of an effective, multimodal smoking cessation intervention.

**Recent Findings** The increased risks associated with smoking around the time of surgery are well established. There is strong evidence for the benefits of perioperative smoking cessation interventions, which include increasing smoking abstinence and decreasing surgical complications. Interventions should aim to start at least 4 weeks preoperatively and provide ongoing support; however, starting any time before or after surgery is beneficial. Collaboration between multiple healthcare providers is important. Accessible patient education tools and appropriate pharmacotherapy are useful adjuvants.

**Summary** Perioperative smoking cessation interventions have proven benefits and should be implemented. This review describes and provides evidence for the various components of a multimodal perioperative smoking cessation program.

**Keywords** Smoking cessation · Perioperative care

## Introduction

In addition to the general health detriments of smoking, smoking during the perioperative period increases the risk of cardiovascular, respiratory, and wound-related perioperative complications [1, 2]. With 60 million smokers undergoing surgery worldwide annually, this is a major public health problem [3]. The goal of the review is to discuss the evidence for perioperative smoking cessation interventions and to describe the components of an effective, multimodal smoking cessation intervention.

## Evidence for Perioperative Smoking Cessation Interventions

Preoperative smoking cessation has been shown to reduce postoperative mortality and morbidity [4], and there is increasing evidence that smoking cessation interventions are effective in the perioperative period for a variety of surgery types [5–7]. A Cochrane review on preoperative smoking cessation interventions showed that interventions can reduce postoperative morbidity and increase abstinence from smoking [7•]. More recent studies where patients were followed for 12 months showed that smoking cessation interventions can increase long-term abstinence [5, 6]. There is also evidence that postoperative smoking cessation can improve recovery and surgical outcomes [8, 9]. Additionally, the perioperative period presents a “teachable moment” where patients are more likely to quit [10].

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## Timing of Interventions

The ideal timing of smoking cessation interventions remains unknown because there are no randomized

controlled trials (RCTs) examining the minimum duration of smoking cessation required to reduce perioperative complications. That being said, two RCTs showed that smoking cessation interventions started 4–8 weeks before surgery improved quitting and reduced complications [11, 12]. Additional evidence from observational studies showed that smokers who quit more than 4 weeks preoperatively have reduced wound healing complications, and those who quit more than 3–4 weeks preoperatively have reduced respiratory complications [13]. Furthermore, even quitting for a day will decrease carboxyhemoglobin levels and improve oxygen delivery to tissues [14], and smoking on the day of surgery is associated with increased surgical site infections [15]. There is an old belief that quitting close to the time of surgery increases respiratory complications. However, there is no high-quality evidence that there is an increase in cough or sputum production [16], nor any increases in postoperative respiratory complications in patients who quit less than 4 weeks before surgery [13]. Quitting in the postoperative period has also shown to improve outcomes [8, 9]. Overall, the evidence suggests that interventions should ideally start at least 4 weeks before surgery; however, if that is not possible, then patients should be counseled to quit at any time before or after surgery.

## Intensity of Interventions

Smoking cessation interventions are heterogeneous and differ in their intensity. In general, high-intensity interventions begin earlier (4 or more weeks before surgery) and include follow-up counseling sessions after the initial encounter. Low-intensity interventions include a brief counseling session with minimal follow-up. Pharmacotherapy may be a part of both high- and low-intensity interventions. A RCT directly comparing a high-intensity intervention against a low-intensity intervention found a 62% increased likelihood of smoking cessation at 12 months amongst those who received the high-intensity intervention versus the low-intensity intervention [17]. In a Cochrane review, high-intensity interventions led to greater smoking cessation on the day of surgery compared with low-intensity interventions [7]. Also, only high-intensity interventions led to reductions in postoperative complications [7]. That being said, low-intensity interventions still led to a 30% increased rate of smoking cessation at the time of surgery and more than double the rate at 12 months [7]. Even simple advice delivered by healthcare providers has been demonstrated to increase smoking cessation in patients [18–20]. As such, low-intensity interventions should still be implemented if high-intensity interventions are not feasible.

## Role of Healthcare Providers

Healthcare providers should provide smoking cessation counseling to patients scheduled for surgery. Counseling sessions can be brief and occur once or when possible can be more extensive and include repeated sessions. Regarding brief counseling sessions, the goal is for healthcare providers to identify smoking behaviors, motivate them to think about cessation, and then provide brief support and referral to other resources. The 5 A's approach is a widely used framework for brief counseling and consists of 5 steps: Ask, Advise, Assess, Assist, and Arrange [21]. To address the implementation barriers associated with the provider's lack of time or knowledge, the Ask, Advise, Refer (AAR) model is an alternative approach that emphasizes referring to other cessation resources [22]. A similar approach is the Ask, Advise, Connect (AAC) model, which utilizes electronic health records to automatically connect patients to tobacco quitlines [23].

Patients planning to undergo surgery will encounter numerous healthcare providers, including surgeons, anesthesiologists, primary care physicians, pharmacists, and other allied healthcare professionals. Each healthcare provider should be involved as each plays a different and complementary role in counseling the patient to quit smoking.

Surgeons should stress to patients that smoking cessation can improve the outcomes of the procedure and reduce the chance for complications. Brief counseling on smoking cessation by surgeons to patients has been shown to increase patient interest in quitting [24]. Another motivator for patients to quit is if the surgeon mentions the possibility of canceling elective procedures if preoperative cotinine tests are positive [25]. For emergency surgeries, it is usually not feasible to counsel patients to quit preoperatively; however, they can be provided with pharmacotherapy while they are in-hospital, be counseled postoperatively to quit, and be provided with other resources and in-patient programs. Quitting after surgery has also been shown to improve outcomes [8, 9].

Anesthesiologists and other preoperative clinic physicians should take advantage of seeing patients in the preoperative clinic. It is an opportune time to counsel patients about the dangers of smoking related to surgery as their visit is centered around optimizing them for their upcoming operation. Unfortunately, it has been shown that many anesthesiologists do not have training in smoking cessation counseling and do not consider it to be their responsibility [26]. However, this belief needs to change because effective interventions can be implemented into the preoperative clinic, which starts with physician counseling followed by referral for telephone support and pharmacotherapy [6, 17, 27, 28]. There may be time constraints depending on when the patient presents to the preoperative clinic; however, patients can be counseled that even

abstaining on the day of surgery and stopping after surgery provide benefits [9, 15].

Primary care physicians are well positioned to assist patients with smoking cessation because they can provide interventions much earlier than surgeons or anesthesiologists, as well as provide longitudinal care for postoperative support. However, primary care physicians may defer smoking cessation counseling in the perioperative context because of lack of knowledge on smoking-related perioperative risks and perhaps fear of delaying surgery for the patient [29, 30]. One study showed that educating primary care physicians on perioperative smoking cessation increased the number of referrals to smoking cessation programs prior to surgery [31]. Primary care physicians should ideally provide counseling and support related to perioperative smoking cessation before surgical referral and provide follow-up postoperatively.

Pharmacists and other allied healthcare professionals provide additional opportunities to deliver smoking cessation counseling. Pharmacists in the USA, Canada, Australia, and the UK may be trained in smoking cessation counseling [32]. Community pharmacies have the advantage of being accessible to most patients. A recent study examined integrating pharmacists into a perioperative smoking cessation intervention provides support for pharmacist involvement [33•]. Cessation was increased 2.9 times at 6 months with the pharmacist intervention compared with usual care [33•]. Nurses in the preoperative clinic trained in smoking cessation can also provide counseling and follow-up. Their involvement has been examined in several studies of effective perioperative smoking cessation interventions [6, 11, 12].

## Patient Education Tools

Even though most patients know about the detrimental health effects of smoking, they are not aware of the added risks in the context of surgery [34, 35]. Pamphlets and e-learning are accessible education tools to inform patients of the dangers of smoking in the perioperative period and should be used as adjuncts in smoking cessation programs. A pamphlet containing cessation advice focused on perioperative risks of smoking sent as a quit pack to patients led to an 8.6% improvement in smokers achieving the target abstinence on the day of surgery [36]. Pamphlets can provide additional reinforcement for physician advice. E-learning or web-based education has also been recently explored as an avenue to provide patient education. One e-learning program, when used as part of a preoperative smoking cessation intervention, led to 22% abstinence at 6 months postoperatively [37]. It described the benefits of quitting smoking before surgery, how to quit smoking, and how to best cope during the process [37]. E-learning may be a helpful adjuvant and should be explored more as it has the potential to increase delivery of information.

## Quitlines and Text Message Systems

Quitlines are telephone-based interventions providing information and support to people interested in or trying to quit smoking [38]. Services include counseling, recorded messages, mailed materials, and access to pharmacotherapy. Quitlines provide the advantages of easy access and follow-up. In surgical patients, several multimodal interventions that incorporated quitlines were effective in increasing abstinence at the time of surgery and at 12 months [6, 17, 27]. In the context of quitting before surgery, quitline services have been demonstrated to be feasible and well received by patients and providers [39]. To improve the use of quitlines in perioperative setting, clinicians should recommend and refer patients to quitlines [40].

Text message systems are taking advantage of the rising use of mobile phones to provide an accessible method to help patients with quitting [41]. Patients subscribed to these services are sent text messages with information on the benefits of abstinence and tips for quitting. Patients can often reply to messages to learn more about a certain topic. In the general population, these interventions are established and are proven to be effective in helping to achieve abstinence [41]. In the perioperative setting, one study surveying patients undergoing surgery showed that they were responsive to text message interventions [42]. As such, text message systems hold promise and their effectiveness should be examined more in surgical populations.

## Pharmacotherapy

Pharmacotherapy for smoking cessation includes various forms of nicotine replacement therapy (NRT), bupropion, and varenicline (Table 1).

### Nicotine Replacement Therapy

NRT supplies the patient with lower doses of nicotine to decrease withdrawal symptoms and cravings [43]. Forms of NRT include patches, gums, lozenges, inhaler, and nasal sprays. NRTs are well proven to assist with cessation and increase the quit rate by 50–60% compared with placebo [43]. The most effective form of therapy with NRT involves combining a patch for sustained nicotine levels with other forms of NRT for immediate release when needed [44]. In perioperative patients, many multifaceted interventions with counseling and NRT have been shown to be effective in increasing abstinence and reducing complications if started early enough [6, 11, 12, 27, 45–50]. NRT has been demonstrated in large trials to be safe, even in patients with cardiovascular disease [51, 52]. In patients undergoing surgery, the use of NRT does not increase wound healing complications [53].

**Table 1** Smoking cessation pharmacotherapy

Medication	Main mechanism	Precautions	Usage (all can be continued postoperatively)
Nicotine patch	Provides nicotine to decrease withdrawal symptoms and cravings without toxic combustion products	Possible insomnia. Not recommended in severe eczema and psoriasis	1 patch/day If > 10 cigarettes/day (12 weeks): 21 mg for 4 weeks, 14 mg for 4 weeks, 7 mg for 4 weeks If < 10 cigarettes/day (8 weeks): 14 mg for 4 weeks, 7 mg for 4 weeks
Nicotine gum	Same as nicotine patch	No eating or drinking 20 min before use	1 piece every 1–2 h for 6 weeks, followed by gradual reduction over 6 weeks If > 20 cigarettes/day: 4 mg If < 20 cigarettes/day: 2 mg
Nicotine lozenge	Same as nicotine patch	No eating or drinking 20 min before use	Weeks 1–6: 1 piece every 1–2 h Weeks 7–9: 1 piece every 2–4 h Weeks 10–12: 1 piece every 4–8 h
Nicotine inhaler	Same as nicotine patch	Resembles cigarette. May precipitate bronchospasm	6–16 cartridges/day for 6 weeks, followed by gradual reduction over 6 weeks
Nicotine nasal spray	Same as nicotine patch	May cause nasal irritation. Risk of nicotine overdose and addiction	1–2 sprays/h for 12 weeks
Bupropion	Inhibition of dopamine and norepinephrine uptake	Possible insomnia and dry mouth. Contraindicated in patients predisposed to seizures and with eating disorders	Start 1–2 weeks before quitting 150 mg once daily for 3 days, followed by 150 mg twice daily for 12 weeks
Varenicline	Partial agonist of $\alpha 4\beta 2$ nicotinic acetylcholine receptor	Possible nausea and insomnia. Possible increased risk of seizures and suicidality. Caution when operating heavy machinery	Start 1–2 weeks before quitting 0.5 mg once daily for 3 days, followed by 0.5 mg twice daily for 4 days, and then 1 mg twice daily for 12 weeks

NRT should be recommended to patients to assist with smoking cessation in the perioperative period.

### Bupropion

Bupropion, sold under the brand names Wellbutrin and Zyban, is an anti-depressant medication that is also used for smoking cessation [54]. Its main mechanism of action is inhibition of dopamine and norepinephrine reuptake [54]. Bupropion has been shown to be more effective than placebo by 1.8 times in helping smokers quit [55]. Examining the perioperative use of bupropion, one RCT found that bupropion lowered daily cigarette consumption at the time of surgery; however, there was no effect on abstinence rates [56]. Bupropion is not associated with increased cardiovascular or neuropsychiatric risk; however, there is a low risk for decreased seizure threshold [51, 55, 57]. More studies need to be performed to assess the effectiveness of bupropion in surgical patients.

### Varenicline

Varenicline, sold under the brand names Chantix and Champix, is a partial agonist of the  $\alpha 4\beta 2$  nicotinic acetylcholine receptor [58]. A Cochrane review showed that varenicline was 1.7 times more effective than NRT and 1.8 times more effective than bupropion for helping patients quit [55]. In

patients undergoing surgery, two RCTs have examined the use of varenicline in the context of a multimodal perioperative smoking cessation program [17, 28]. Both trials continued varenicline postoperatively and found that it led to increased abstinence at 1, 3, 6, and 12 months postoperatively. No postoperative complications were observed. Recent studies have shown that varenicline is not associated with increased cardiovascular or neuropsychiatric adverse effects [51, 55, 57].

### E-cigarettes

E-cigarettes, also known as electronic nicotine delivery systems, are devices which heat liquids comprised of variable nicotine concentrations to produce an aerosol for inhalational use [59]. More patients are starting to use e-cigarettes to aid in quitting [42, 59]. In the general population, a Cochrane meta-analysis of two RCTs showed that nicotine-containing e-cigarettes led to greater cessation at 6 months compared with placebo e-cigarettes [60]. A more recent RCT comparing e-cigarettes with NRT found that e-cigarettes were more effective than NRT with regard to abstinence at 12 months [61]. In the surgical population, a pilot study comparing e-cigarettes with NRT found that quit rates on the day of surgery were similar for the two methods [62]. There are also studies in patients undergoing surgery that show that use of e-cigarettes is feasible in the perioperative setting and that

patients are interested in trying e-cigarettes to help them quit [42, 63]. However, 530 cases of lung injury and 7 deaths from the use of e-cigarettes have been recently reported in the USA [64]. In light of these reports, the Centers for Disease Control and Prevention is recommending refraining from the use of e-cigarettes [64]. As such, one should be cautious to use e-cigarettes to aid in quitting until more information is known.

## Barriers to Implementation

Despite the evidence for the benefits of smoking cessation and the efficacy of interventions, the delivery of smoking cessation interventions by perioperative physicians is lacking [3, 65]. One reason is because even though smoking cessation interventions in the general population have been shown to be efficacious, less is known about the effect and feasibility of interventions in the perioperative period. We hope that this review helps to clarify the evidence for interventions in the perioperative period. Another common barrier to implementation is lack of time. This can be improved if multiple healthcare providers take ownership in counseling on smoking cessation, as outlined in this review, to form an integrated pathway. Referral to quitlines and text message systems and the use of other educational tools can also help. Another potential problem is cost. However, it is important to realize that the major positive impacts of smoking cessation should offset costs in the long term.

## Conclusion

There is strong evidence for increased perioperative risks with smoking and the benefits associated with quitting. Multimodal perioperative smoking cessation interventions have been demonstrated to improve surgical outcomes and increase abstinence from smoking. Ideally, interventions should start at least 4 weeks preoperatively, include patient follow-up, involve collaboration between multiple healthcare providers, and utilize accessible patient education tools and appropriate pharmacotherapy. In addition to improving surgical outcomes, perioperative smoking cessation interventions can increase long-term abstinence and thus have the potential to address the larger public health problem of smoking. It is time for perioperative healthcare providers to take advantage of the “teachable moment” that surgery presents and implement perioperative smoking cessation programs.

## Compliance with Ethical Standards

**Conflict of Interest** Dong An declares that he has no conflict of interest. Jean Wong has received research funding from the Ontario Ministry of Health and Long-Term Care, the Anesthesia Patient Safety Foundation,

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  - Of major importance
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