A Systematic Approach to Perioperative Smoking Cessation

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Background: There is compelling evidence that smoking leads to poor postoperative outcomes including increased incidence of wound infection, respiratory infection, sepsis, cardiac arrest, and mortality. There is also compelling evidence that smoking cessation before surgery leads to improved outcomes. A recent meta-analysis found that brief smoking interventions may be insufficient to change postoperative outcomes. However, more intensive evidence-based smoking cessation interventions do improve postoperative outcomes and lead to long-term smoking abstinence. From a healthcare perspective, this raises a question of how to best provide effective perioperative smoking cessation treatment to a population.

Methods: Duke University Health System recently developed a systematic approach to perioperative smoking cessation. In this report, we outline evidence-based principles for perioperative smoking cessation and describe initial results from a perioperative smoking cessation program.

Results: In the first 100 days of the Duke Perioperative Smoking Cessation Program, we received 420 referrals. Participants had a mean pack-year history of 50.3 (packs/day×years smoking; SD 32.5), a mean Fagerström Test for Nicotine Dependence score of 4.5 (SD 2.5), and a mean expired breath carbon monoxide of 11.8 (SD 7.5) parts per million. Mean days from initial perioperative smoking cessation visit to surgery was 21.4 (SD 22.3).

Discussion: This model of perioperative smoking cessation is in the early stages of development; however, evidence-based perioperative smoking cessation services can be effective across a health system.

Key Words: smoking cessation—perioperative—tobacco.

(*Tech Orthop* 2019;00: 000–000)

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BACKGROUND

The Current State of Smoking and Smoking Cessation in the United States

Smoking is the leading preventable cause of morbidity and mortality in the United States,[1] causing 480,000 deaths per year.[2] Smoking also causes lung disease, heart disease, peripheral vascular disease, stroke, thromboembolic disease, diabetes, bone fractures, cataracts, and other medical problems.[3] Efforts to control and treat tobacco dependence have resulted in a decrease in US smoking rates from 42% in the 1964 Surgeon General's Report[4] to ~14% today.[5] Smoking now occurs primarily among people with low education,[6] low income,[7] and high rates of psychiatric disorders.[8] Each of these factors—low income, low education, and mental health disorders—poses significant barriers to successful smoking cessation.[9–11] Although roughly 70% of smokers report a desire to quit smoking,[12] the success rate today for smokers who try to quit without the help of a medical provider is only 3% to 5%.[13]

Evidence-based Smoking Cessation Treatment

There are currently 7 Food and Drug Administration (FDA)-approved smoking cessation medications (varenicline, bupropion, nicotine patch, gum, lozenge, inhaler, and nasal spray), each of which doubles a smoker's chance of quitting.[14] In addition, there are now multiple evidence-based behavioral treatments (motivational interviewing, cognitive behavioral therapy, mindfulness training, and group therapy)[15–17] that also greatly increase a smoker's chances of quitting.[18,19] Evidence supports the combined use of pharmacotherapy and behavioral treatment for smokers,[20] an approach that is now considered to be the standard of care for smoking cessation treatment.[21,22] Medical providers now ask patients about their smoking status in 91% to 95% of all medical visits.[23] Unfortunately, treatment for smoking is only offered in 18% of these encounters.[23] Data suggest that this opportunity is squandered primarily because providers are too busy managing more acute medical problems or feel that they have insufficient training in tobacco treatment.[24] In fact, 74% of primary care clinicians report receiving no formal training in tobacco dependence treatment.[25] Fortunately, there has been a rapid expansion of training programs, such that there is now 20 accredited tobacco treatment specialist (TTS) training programs in the United States.[20,26] Specialized tobacco treatment programs such as those at Mayo, MD Anderson, or Duke are staffed by TTS providers and report sustained biochemically confirmed smoking abstinence rates from 27% to 39%, almost 10 times as high as an unassisted quit attempt.[22,27,28]

Surgical Outcomes: Smokers, Former Smokers, and Nonsmokers

Smoking is associated with poor postoperative outcomes. A study by the American College of Surgeons compared 103,795 smokers to 82,304 matched nonsmokers and found that smoking was associated with a significant increase in postoperative incisional infection [odds ratio (OR) = 1.3], organ space infection (OR = 1.4), sepsis (OR = 1.3), pneumonia (OR = 1.8), unplanned intubation (OR = 1.9), myocardial infarction (OR = 1.8), cardiac arrest (OR = 1.6), stroke (OR = 1.7), and 30-day postoperative mortality (OR = 1.4).[29] A follow-up study compared 125,192 current smokers to 78,763 matched former smokers (abstinent > 1 y) and 78,169 matched never smokers to see if quitting smoking improved postsurgical outcomes; results showed that former smokers had similar 30-day postoperative mortality as nonsmokers.[30] Those who quit smoking before surgery showed significantly fewer respiratory and vascular events.[30]

How Long Before Surgery Should a Smoker Stop Smoking?

For several decades now, investigators have been conducting research to better understand the length of time that smokers need to be abstinent before surgery to experience

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The authors declare that they have nothing to disclose.

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postoperative benefits from smoking abstinence. A 1989 randomized controlled trial by Warner et al[31,32] initially addressed this question showing that 8 weeks of presurgical smoking abstinence led to a 4-fold reduction in postoperative respiratory complications (14.5% vs. 57.1%). Researchers hypothesized that perhaps quitting smoking caused increased mucous production, leading to postoperative respiratory complications, especially in those who quit near the time of surgery. Addressing this concern, 2 studies found a mild increase in coughing in the first 2 weeks after quitting.[33,34] Other studies reviewing longer periods of abstinence showed an overall decrease in coughing after quitting.[35,36] Only 1 study evaluated intraoperative sputum production comparing current smokers, smokers who quit before surgery, and never smokers.[37] In this study, current and recently quit smokers were significantly more likely to have an increased intraoperative sputum production when compared with never smokers (current = 18.3%; recent quit = 17.9% vs. never = 9.4%).[37] A key conclusion of this study was that quitting smoking before surgery did not lead to a significant change in intraoperative mucous production. A 2011 meta-analysis of 9 studies addressed the necessary duration of presurgical smoking abstinence and found that abstinence of under 8 weeks showed no significant increase or decrease in all postoperative outcomes.[38] From this data, some surgical publications provided a recommendation that smokers should be advised to quit smoking only if they are able to be abstinent for at least 8 weeks before surgery.[39,40] Then, in 2012, a review of 25 studies by Wong et al[41] found that compared with continued smoking, presurgical smoking abstinence led to the following: under 4 weeks abstinent—no difference between groups in respiratory complications, 4 to 8 weeks abstinent—lower rate of respiratory complications [relative risk (RR) = 0.77] over 8 weeks abstinent—even lower rate of respiratory complications (RR = 0.53). In this same study, Wong et al[41] found that wound healing improved when compared with continued smoking when smokers were abstinent for a minimum of 3 to 4 weeks before surgery (RR = 0.69). Attempts to quit smoking should always be understood in the broader context that smoking cessation any time in life confers profound health benefits.[42] Furthermore, at any given time, most smokers are not willing to make a quit attempt, but the advent of surgery often creates a teachable moment when a person is willing to attempt significant behavior change.[43] When a surgery is scheduled within a shorter timeframe (ie, a couple of weeks), quitting smoking may not confer significant postoperative benefits; however, in this case, many would argue that providers should promote a quit attempt because of the substantial life-long health benefits of quitting smoking.

Guidelines for Perioperative Smoking Cessation

The United States Preventive Services Task Force does not provide a specific recommendation regarding perioperative smoking cessation but instead recommends that all adults be asked about tobacco use at every health visit[44] and that clinicians should advise adults to stop using tobacco, and provide behavioral treatment and FDA-approved pharmacotherapy.[45] In 2017, the Société Française d'Anesthésie et de Réanimation (French) guidelines were established for perioperative smoking cessation, citing evidence that smokers versus nonsmokers had a 20% increased risk of hospital mortality and a 40% increased risk in all major perioperative complications (deep infection, pneumonia, unscheduled intubation, pulmonary embolism, ventilation > 48 h, stroke, coma > 24 h, cardiac arrest, myocardial infarction, transfusion > 5 U, sepsis, septic shock).[46] This guideline supports smoking cessation at any time before surgery and the use of perioperative nicotine replacement (Fig. 1).[47] In 2018, the American Society of Anesthesiologists reaffirmed prior recommendations that all patients should abstain from smoking for as long as possible before and after surgery and should obtain help in doing so.[48]

Postoperative Nicotine Replacement

An integral issue also debated over several decades is that of the benefit versus harm of using postoperative nicotine replacement. A 1992 study found poor wound healing in smokers compared with nonsmokers and concluded that

1. We recommend offering behavioral management and the prescription of a nicotine substitute product for smoking cessation before any scheduled surgical intervention (Grade 1+)

2. We recommend preoperative smoking cessation independently of the timing of the intervention, even though the benefits increase proportionally with the length of cessation (Grade 1+).

3. We recommend that all professionals involved in the care pathway (surgeons, anesthetist-intensivists, care givers) inform smokers of the positive effects of quitting and offer them dedicated management and personalized follow-up (Grade 1+).

4. For children undergoing surgery, we recommend parental smoking cessation or removal of the child from environmental tobacco smoke as long as possible before the intervention (Grade 1+).

FIGURE 1. 2017 guideline (Societe Franaise d'Anesthsie et de Reanimation).

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nicotine may be responsible through vasoconstriction, microvascular occlusion, and tissue ischemia.[49] One study showed that a relatively high dose of transdermal nicotine was associated with decreased osseointegration in rat femurs with titanium implants.[36] Another study showed that high dose transdermal nicotine was associated with poor bone healing after tibial fracture in rabbits.[50] In addition, a study showed that rats who underwent transverse rectus abdominus myocutaneous flap procedures showed greater flap necrosis after the administration of transdermal nicotine.[40,41] In response, many surgeons, especially those in plastics and orthopedics, have chosen to avoid the use of nicotine replacement therapy (NRT) in their patients and instead ask that their patients quit smoking without the use of nicotine replacement.[51] This may be changing somewhat; a 2015 review of human postoperative nicotine replacement found no evidence that nicotine replacement was associated with poor wound closure, wound healing, or cardiovascular events; it also criticized prior animal studies for the use of higher doses of nicotine than is normally used in human NRT.[38] The practice of giving NRT before surgery to help smokers quit must also be viewed in the wider context of smoking cessation in general. The detrimental impacts of smoking on wound healing and postoperative outcomes are well documented,[29] and NRT roughly doubles the chance that a smoker will be able to quit smoking.[14] It is reasonable to think that the benefits of using NRT in preoperative setting may outweigh the concerns regarding high dose NRT in postoperative healing.[52]

Interventions for Perioperative Smoking Cessation

If we assume that perioperative smoking cessation is desirable, the question becomes, "What interventions should be employed to treat smokers in a perioperative setting?" Recent data challenge traditional approaches in which surgeons simply advise their smokers to quit and perhaps prescribe a nicotine patch. A 2014 Cochrane review[52] examined 13 trials that were divided into 2 types of interventions: *brief interventions*, typically 1 session, mostly under 20 minutes of total counseling time; and *intensive interventions*, including multiple counseling sessions ideally starting ≥ 4 weeks before surgery, mostly over 30 minutes of total counseling time. Both brief and intensive interventions led to smoking cessation, although brief intervention led to very modest increases in smoking cessation (RR = 1.30), and intensive interventions led to smoking cessation rates that were 10-fold that of controls (RR = 10.76). Critically, intensive interventions showed a significant reduction in all postsurgical complications (RR = 0.42) and in postoperative wound complications (RR = 0.32). Brief interventions did not show a reduction in either postsurgical complications or wound infection. Finally, intensive interventions showed an effect on long-term (12 mo) postsurgical smoking abstinence (RR = 2.96), whereas brief interventions conferred no effect on long-term abstinence (RR = 1.09). Many of the trials in this meta-analysis used NRT, although 1 trial used varenicline and showed an effect on long-term (12 mo) smoking cessation (RR = 1.45). Findings from this meta-analysis cast doubt on the effectiveness of brief advice as a lone strategy for perioperative smoking cessation and suggest that whenever possible, more intensive interventions should be used. Given the limited time that surgeons have to manage nonsurgical problems, one might argue that these findings suggest a model in which smokers considering surgery are referred to a specialized service for intensive smoking cessation treatment.

Systematic Approach to Perioperative Smoking Cessation Within a Health System

Health systems commonly aspire to implement practice guidelines and other algorithmic treatment pathways when evidence is sufficient to provide guidance across a population. Examples of systematic recommendations include well-person exams, vaccines, and screening tests. Given the strength of the evidence supporting perioperative smoking cessation, it is now reasonable that health systems develop treatment pathways to facilitate perioperative smoking cessation. At Duke University, we recently developed a perioperative smoking cessation program with an infrastructure capable of providing intensive smoking cessation counseling and evidence-based pharmacotherapy to all smokers within the health system considering nonemergent surgery. Below is a description of this program with details describing our efforts to align this program with existing evidence.

Program Overview

The Duke Perioperative Smoking Cessation Program (Table 1) provides a treatment pathway to which smokers may be referred before surgery and scheduled for smoking cessation treatment. As soon as surgery is scheduled, patient outreach is initiated, so that the patient is scheduled as quickly as possible for smoking cessation services. Smoking cessation is encouraged in such a way as to maximize the abstinence period before surgery. Consistent with current recommendations, smoking cessation is encouraged in most cases even if surgery is scheduled sooner than 3 to 4 weeks from initial contact. Patients are provided with medications (combination pharmacotherapy) as determined by a medical provider trained as a TTS and provided with intensive behavioral treatment tailored to the unique challenges of the smokers. All FDA-approved smoking cessation medications are used; however, consistent with current recommendations, preference is often given to the use of varenicline and combination nicotine replacement.[22] In addition to preoperative management, patients are seen after hospitalization to support long-term postsurgical abstinence. All patients receive carbon monoxide (CO) breath testing with reports provided back to surgical providers on biochemically verified abstinence status. Duke Smoking Cessation Program (DSCP) providers are all trained through the Duke-UNC Tobacco Treatment Specialist Training Program and receive ongoing mentorship from senior providers. This training provides a level of rigor necessary for clinical management of smokers with complex medical presentations. DSCP providers deliver services within a research infrastructure that uses uniform data collection methods across clinics, including collection of data from CO breath testing, demographics, smoking history, smoking-related illness, mental illness, financial variables, smoking cessation pharmacotherapy, and behavioral treatment.

TABLE 1. Duke Model—Principles Supporting a Systematic Approach to Perioperative Smoking Cessation

(1) Provide smoking cessation services to smokers regardless of the length of time until surgery
(2) Provide treatment pathways that promote the longest period of presurgical abstinence possible
(3) Provide both preoperative treatment and postoperative follow-up
(4) Provide individualized evidence-based medication by a medical Tobacco Treatment Specialist (eg, combination pharmacotherapy, long and short-acting nicotine, varenicline, and bupropion)
(5) Provide individualized intensive behavioral treatment by a behavioral Tobacco Treatment Specialist
(6) Provide system-wide program referral system through direct patient outreach

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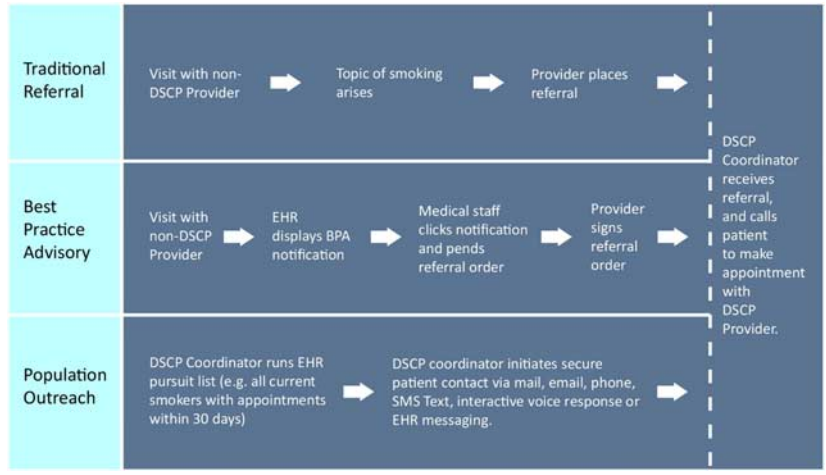

FIGURE 2. Patient outreach pathways. BPA indicates best practice advisory; DSCP, Duke Smoking Cessation Program; EHR, electronic health record.

Program Referral

Patient engagement occurs through 3 pathways—traditional referral, best practice advisory (BPA), and population outreach (Fig. 2). The traditional referral occurs when a surgeon sees a patient before surgery, asks about smoking, and then refers the patient to the perioperative smoking cessation program. To reinforce traditional referrals, program providers conduct training with surgeons and surgical staff on how to refer their patients to the program. BPA refers to a method of patient engagement in which the electronic health record (EHR) displays a BPA alert to a clinician when the EHR is opened and a patient is listed within the EHR as a current smoker. Clinicians and staff are trained on the use of BPA. Population outreach refers to a patient engagement method in which the perioperative smoking cessation staff generates a pursuit list through the EHR that includes all patients scheduled for surgery who are also listed as current smokers within the EHR. Once the pursuit list is generated, program staff contacts each patient on the list via phone, mail, text, email, interactive voice response, or EHR messaging to offer a referral to perioperative smoking cessation services.

RESULTS

In the first 100 days of Duke Perioperative Smoking Cessation Program operations, 420 presurgical smokers were referred to treatment. The mean age of these patients was 56.34 (SD = 9.95; range = 29 to 75). There was a roughly even distribution between males and females and a somewhat higher percentage of black patients (Table 2); this closely reflects the sex and racial distribution of Durham, NC. The largest number of cases were referred by general surgery, orthopedics, plastics, and cardiothoracic surgery (Table 3). On average the first visit with a smoking cessation provider occurred 21.4 (SD = 22.3) days before surgery (range = 2 to 104 d). With this population we found: years smoked = 39.2 (SD = 15.2; range 4 to 57); lifetime mean cigarettes per day = 23.4 (SD = 11.4; range = 6 to 40); pack-year (packs/day×years smoking) = 50.3 (SD = 32.5; range 1.2 to 102); Fagerström Test for Nicotine Dependence = 4.5 (SD = 2.5; range = 0 to 9); CO breath test = 11.8 parts per million (ppm; SD = 7.5 ppm; range 1 to 27 ppm). On average, the Duke Perioperative Smoking Cessation Program patients demonstrated high levels of smoking history (50 pack-years) and average nicotine dependence (4.5). Patients may have reduced their smoking before their initial visit, as CO scores were a little lower than expected.

DISCUSSION

There is now compelling evidence that smokers should quit smoking before surgery. To overcome barriers, we have developed a dedicated smoking cessation program with medical and behavioral providers trained as TTSs. Regarding perioperative treatment intensity, brief advice, even with nicotine replacement, appears to have a nonsignificant impact on postoperative outcomes and no impact on long-term smoking abstinence.[40] Within the Duke program, behavioral treatments provided by TTSs are intensive and tailored to individual patient challenges including management of triggers, urges, smoking withdrawal, stress, anxiety, depression,

TABLE 2. Sex and Race

	n (%)
Female	195 (46.43)
Male	225 (53.57)
American Indian/Alaskan Native	1 (0.72)
Asian	1 (0.24)
Black	235 (55.95)
White	168 (40.00)
≥2 races/other	4 (0.95)
Race not reported	9 (2.14)
Total	420 (100)

TABLE 3. Surgical Service

	Percentage
Cardiothoracic	10.68
General surgery	34.95
Gynecology	8.74
Neurosurgery	1.94
Orthopedics	17.48
Head and neck	7.77
Plastic surgery	13.59
Urology	4.85
Total	100.00

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weight gain, social and motivational challenges. Regarding the use of medications, nicotine patch, gum, or lozenge alone is no longer considered a standard-of-care treatment.[14] Instead, medical providers who are trained as TTSs commonly prescribe combination therapy,[53] prequit treatment,[54] extended treatment (which may use modified medication dosing),[55–57] and second-line medications or adaptive protocols[58,59] to reach maximal treatment effect. Regarding the timing of treatment, evidence strongly supports smoking abstinence for ≥ 4 weeks before surgery but also suggests that smoking cessation within the 4-week window does not lead to increased postsurgical complications.[41] We have aligned this program with French and American guidelines specifically and US guidelines more generally to provide treatment to smokers whenever possible. The Duke program provides education to surgical providers on program services and referral routes and leverages EHR-based referrals, including BPA and population outreach methods.

The core goals for a perioperative smoking cessation program are to provide high-quality evidence-based treatment to smokers and to provide services for as many smokers undergoing surgery as possible. It is paramount that all who are involved in perioperative management recommend smoking cessation and refer patients to evidence-based treatment before surgery. At Duke, steps are being taken to provide a systematic perioperative treatment pathway with access to evidence-based smoking cessation treatment whenever a nonemergent surgery is planned. This systematic approach does not relieve the surgeon or anesthesiologist of their critical role in recommending and referring patients for smoking cessation. Rather this approach provides support by connecting these patients with standard-of-care services. We do not suggest that this model will be the best approach, but rather suggest it is one example of how a health system might implement evidence-based practice across its surgical population.

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